The Impact of Federal Reserve's Conventional and Unconventional Monetary Policies on Equity Prices

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Abstract

I estimate the effects of the Federal Reserve's forward guidance and large-scale asset purchases, along with the effects of interest rate changes under conventional policy, on the U.S. equity market, and assess the reasons for stock price responses. Although the overall stock market respond meaningfully to a surprise change in the federal funds rate with a high level of statistical significance, a heterogeneity in responses is observed among different sectors in the stock market. In contrast, forward guidance is found to have relatively homogeneous effects on sector-wise stock market performance. Such effects are large in magnitude and highly statistically significant. However, large-scale asset purchases exhibit minimal effects on equity price movements. The present value of future excess returns emerged as the most important channel through which the surprise changes in the federal funds rate as well as forward guidance and large-scale asset purchases affect current equity prices. The present value of future dividends and the real interest rates are found to make minor contributions the propagation of policy shocks. However, the relative contribution of future dividends, real interest rates and excess returns vary across sectors.

Keywords: forward guidance, quantitative easing, asset purchases, zero lower bound

JEL Classification: E52, E58

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1 Introduction

The ability of monetary policy to achieve its long term objective of stabilizing macroeconomic variables such as inflation, output and employment largely depends on the effectiveness of the policy transmission channels. Given the importance of the asset price channel in the overall monetary transmission mechanism, it is critical to understand the link between monetary policy actions and asset prices. In the meantime, turbulent economic and financial conditions in recent years warranted central banks to use a broad spectrum of monetary policy instruments rather than resorting to conventional monetary policy tools. In such as a context, this research attempts to analyze the impact of Federal Reserve's monetary policy actions, both conventional and unconventional, on one of the most important financial markets, the equities market.

Under conventional monetary policy I consider the surprise changes in the federal funds rate on FOMC announcement days, while under unconventional monetary policy I consider the two most extensively used policies - forward guidance and large scale asset purchases (LSAPs). Under forward guidance, a central bank attempts to influence expectations about the future path of the policy interest rate. Under LSAPs, a central bank purchases large quantities of longer-term Treasury securities and mortgage-backed securities to influence long-term interest rates. For this paper, monetary policy surprises are taken from Swanson (2020), which separately identifies surprise changes in the federal funds rate, forward guidance, and LSAPs on FOMC announcement days by extending the high-frequency approach of Gurkaynak, Sack, and Swanson (2005). Equity price changes are measured by the movements in the S&P 500 Index, where prices at the aggregate level as well as at economic sector levels are considered.

The first part of the study focuses on assessing the impact of monetary policy surprises on different sectors of the stock market. Swanson (2020) analyses the effects of interest rate, forward guidance and LSAP shocks on the overall stock price index. I widen the scope of this analysis by assessing the effects on sector-wise stock price indexes. By doing so, it is possible to gauge how various sectors in the economy perceive different policy actions of the Federal Reserve. The estimates show that although the overall stock market respond strongly to a surprise change in the federal funds rate with a high level of statistical significance, a heterogeneity in responses is observed among different sectors in the stock market with some sectors displaying an increased interest rate response, whereas certain other sectors report small coefficients with are not statistically significant. Forward guidance is also estimated to have meaningful and highly statistically significant effects on overall stock prices. More importantly, forward guidance is reported to have a relatively homogeneous effect on sector-wise stock market performance. Almost all sectors exhibit statistically significant coefficients for forward guidance shocks, while the variation in the magnitude of coefficient values across sectors is not as large

as that for the federal funds rate. Meanwhile, the effects of LSAPs on overall equity prices as well as on sectoral equity prices are not statistically significant.

The second part of the study performs a variance decomposition of excess equity returns (i.e., the equity premiums) following the vector autoregression (VAR) based methodology used in Campbell (1991), Campbell and Ammer (1993) and Bernanke and Kuttner (2005). This analysis helps determine the relative contributions of news about the real interest rates, dividends and expected future excess returns to fluctuations in the current period's excess return. The studies by Campbell and Ammer (1993) and Bernanke and Kuttner (2005) focus only on the excess equity returns calculated based on the overall price index. However, I expand on this by focusing on sector-wise equity returns, in addition to overall equity returns, thereby analyzing the variance decompositions for different sectors of the economy. The results show that the the variance in future excess returns emerge as the dominant factor determining the current period's equity premium both for the overall stock price index and most of the sector indexes. Dividends and the future real interest rates record minor contributions to the equity premium, with dividends reporting a slightly larger contribution than the real rates. However, the relative contribution of future dividends, real interest rates and excess returns vary across sectors.

The last part of the study focuses on analyzing the impact of different monetary policy surprises using the methodology in Bernanke and Kuttner (2005). This approach works within the VAR based framework introduced in Campbell and Ammer (1993). This part of the study is an extension to Bernanke and Kuttner (2005), since Bernanke and Kuttner (2005) focus only on interest rate surprises, whereas I focus on forward guidance and LSAP surprises in addition to that. Accordingly, the dynamic responses to the three types of monetary policy surprises are estimated. Overall, the resultant impulse responses exhibit intuitive and meaningful changes in macroeconomic variables to monetary tightening/loosening scenarios under both conventional and unconventional tools. Moreover, since the current period's excess equity return can be specified in terms of the discounted sums of future excess equity returns, current and future real interest rates and dividends, these factors can be considered as the channels through with the monetary policy actions get transmitted to the equity prices. Therefore, in order to assess the relative importance of each of these channels, the present value estimates for one standard deviation surprises in the federal funds rate, forward guidance and LSAPs are estimated. The results indicate that the future excess returns account for a major share of the current period's response in equity premium, while dividends and the real interest rates account for a minor share. This result holds true for each type of monetary policy shock considered. For surprises in the federal funds rate, the real interest rates make a marginally higher contribution than

dividends. For forward guidance, dividends record the second largest relative contribution, while the real interest rates record a significantly small contribution. With regard to LSAP shocks, the contribution of dividends is surprisingly negative, although the real interest rates make a positive contribution as one would expect. The sector-wise decomposition broadly follows the patterns observed for the overall stock market, with some notable variations across sectors for LSAP surprises.

The remainder of the paper is structured as follows. Section 2 briefly summarizes some selected literature, which are closely related to my study. In Section 3, I elaborate on the data used for the study including the monetary policy surprises. Section 4 presents regression estimates for the impact of policy surprises on equity prices. In section 5, I provide a variance decomposition analysis of excess equity returns, while in section 6 the effects of monetary policy surprises are analyzed within the framework developed under section 5. Section 7 summarizes the results and concludes.

2 Related Literature

There are a number of studies assessing the impact of surprises in the federal funds rate, federal reserve's forward guidance announcements, and LSAPs or quantitative easing on the U.S. asset markets. Such studies include Bernanke and Kuttner (2005), Gurkaynak et al. (2005), Gagnon, Raskin, Remache, and Sack (2011), Krishnamurthy and Vissing-Jorgensen (2011), D'Amico, English, López-Salido, and Nelson (2012), Joyce, Miles, Scott, and Vayanos (2012) and Swanson (2020) among others. However, only a selected set of papers are summarized in this section since those studies have some methodological similarities to my paper, and more importantly I have expanded on them in some way.

In an early study, Gurkaynak et al. (2005) investigate the effects of federal reserve's policy actions on asset prices using a high-frequency event study approach. The study finds that the effects of monetary policy on asset prices are best characterized by two factors, which are identified as the "current federal funds rate target" factor and "future path of policy" factor. In today's terminology, the seconds factor corresponds to forward guidance. According to their findings, the two factors are found to have important but differing effects on asset prices. Swanson (2020) extends this analysis by separately identifying surprise changes in the federal funds rate, forward guidance, and LSAPs. Overall, the paper shows that forward guidance and LSAPs had substantial and statistically significant effects on asset prices. In particular, forward guidance is estimated to have a highly statistically significant effect on equity prices, with the magnitude of the effect amplifying during the ZLB period. In contrast, the effects of LSAP surprises on stock prices are not found to be significant. The analyses in Swanson (2020)

however is limited to the overall stock price index, whereas I assess the effects on sector-wise stock price indexes as well.

Bernanke and Kuttner (2005) is another early study which analyzes the impact of surprise changes in policy interest rates on equity prices. A technique proposed by Kuttner (2001) is used to construct a measure of the surprise changes in policy interest rates, and the results show that the stock market reacts reasonably strongly to interest rate surprises. The analysis is carried out both in the aggregate level and at industry portfolio levels as measured by the CRSP value-weighted index. The paper then adapt the methodology introduced by Campbell (1991) and Campbell and Ammer (1993) to explore as to what explains the equity price response. Under this, the paper asses how the policy surprises affect future interest rates, dividends, and excess returns of equities, and finds out that the impact on equity prices comes mainly through the policy's effect on expected future excess equity returns. Nonetheless, the studies by Campbell and Ammer (1993) and Bernanke and Kuttner (2005) focus only on excess equity returns calculated based on the overall price index. However, I expand on this by decomposing the excess equity returns for different sectors of the economy. Furthermore, Bernanke and Kuttner (2005)'s analysis is limited to conventional monetary policy, where the dynamic responses are evaluated only for interest rate surprises. In contrast, I assess the dynamic responses to forward guidance and LSAP shocks in addition to the conventional interest rate surprises.

3 Data and Policy Surprises

3.1 Monetary Policy Surprises

Separately identifying the effects of forward guidance and LSAPs could be challenging due to several reasons: some of the announcements by FOMC provide information about both types of policies simultaneously; only the unanticipated component of monetary policy should be determined as financial markets are forward-looking; and FOMC can even surprise markets through inaction (Swanson, 2020). In order to address these problems, Swanson (2020) extends the high-frequency approach of Gurkaynak et al. (2005) to separately identify forward guidance and LSAP surprises, in addition to interest rate shocks. Monetary policy surprises for this study are taken from Swanson (2020), where the full sample includes estimates of policy surprises on FOMC announcement days from July 1991 to June 2019.

The methodology followed by Swanson (2020) starts with calculating the high-frequency (30-minute) responses of the prices of the federal funds futures, Eurodollar futures, Treasury securities, equities and foreign exchange, bracketing each FOMC announcement. These responses are then arranged as a factor model. Following Cragg and Donald (1997) and Gurkaynak et al.

Table 1: Sector Indexes of S&P 500

Sector Index	Weight*
Energy	2.1 %
Materials	2.6 %
Industrials	8.3 %
Consumer Discretionary	11.6 %
Consumer Staples	7.0 %
Health Care	14.2 %
Financials	9.7 %
Information Technology	28.2 %
Communication Services†	10.8 %
Utilities	3.0 %
Real Estate‡	2.6 %

* Weight in overall S&P 500 index as of Sep 30, 2020

† Formerly Telecommunication Services

‡ Spun off from the Financial sector in 2016

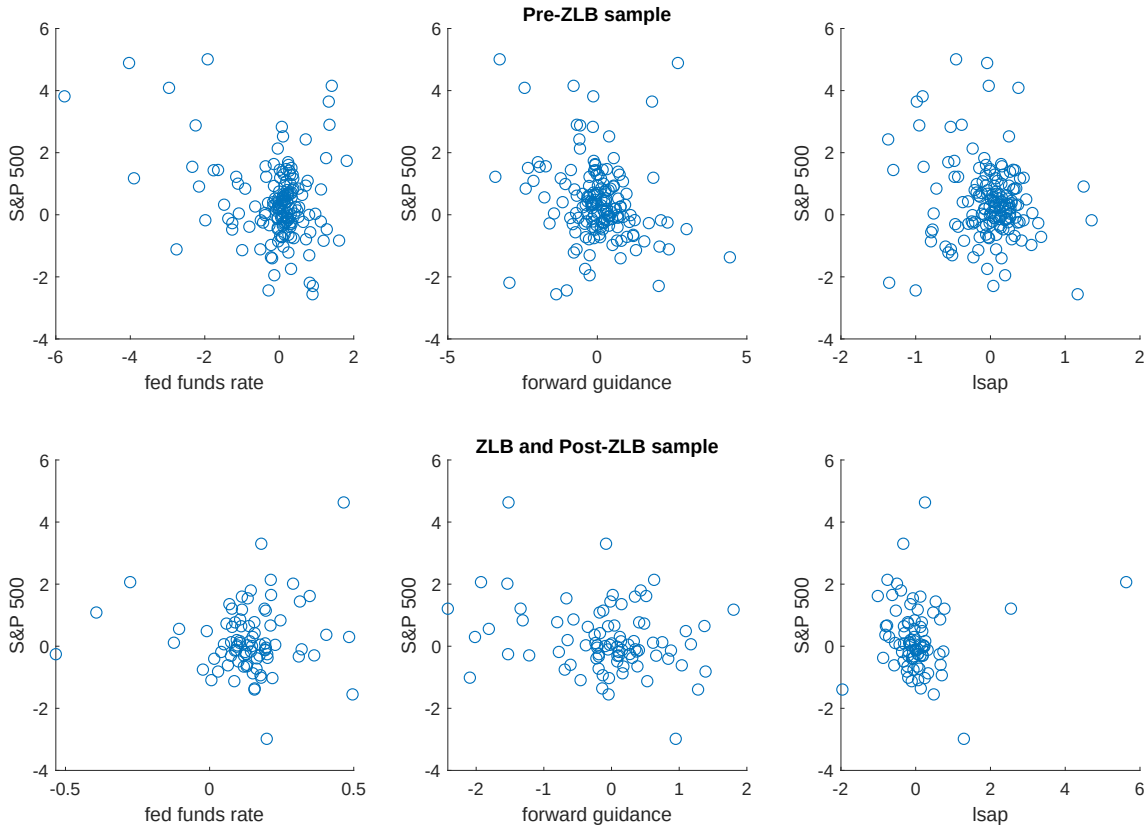
(2005), the rank of the unobserved factors is found to be three, suggesting that the observed data are well explained by a model with three factors. Since the principal components by themselves do not have a structural interpretation, identifying assumptions are imposed to choose an appropriate rotation matrix such that the rotated factors have a structural interpretation. The key identification restrictions considered are: the changes in forward guidance and LSAPs have no effect on the current federal funds rate, and the LSAP factor is as small as possible in the pre-ZLB period. With these identification assumptions, Swanson (2020) argues that the resulting factors closely correspond to changes in the federal funds rate, forward guidance and LSAPs, respectively.[1] Finally, these rotated factors are normalized to have a unit standard deviation. The signs of the estimated factors are such that positive values in the federal funds rate and forward guidance factors correspond to a contractionary policy shock, where as positive values in the LSAP factor correspond to an expansionary shock.

3.2 **Equity Prices**

Equity price changes are measured using the S&P 500 stock market index. Daily data from July 1991 to June 2019 of the overall price index as well as its sector-wise indexes are used for the analysis. The sector-wise indexes of S&P 500 are based on the Global Industry Classification Standard (GICS) industry taxonomy developed by the S&P Dow Jones Indices and MSCI. The GICS structure comprises of 11 sectors, 24 industry groups and 69 industries, where all public companies in the S&P 500 index are categorized under. A list of GICS sectors

[1]Please refer Swanson (2020) for mathematical details of the factor model, identification restrictions, robustness checks, and details on the correspondence of estimated factors to notable FOMC announcements.

Figure 1: Daily change in the S&P 500 Index and Estimated Factors



and their respective weights in the S&P 500 index as of end September 2020 are summarized in Table 1.

4 Estimation of Equity Price Responses

This section estimates the effects of the surprise changes in monetary policy on FOMC announcement days on stock market performance. Once the respective daily changes in different stock price indexes are calculated, the response of stock prices to each of the monetary policy surprises identified in Swanson (2020) can be directly calculated using high-frequency regressions. However, before investigating into the regression results, it is interesting to visually examine the calculated changes in the S&P 500 Index and the estimated factors in a scatter plot first. The top panel of Figure 1 shows the respective data for the Pre-ZLB period (i.e. Jul.1991–Dec.2008). The three scatter plots in the top panel suggests that it is likely for the three monetary policy factors to have a negative regression coefficient for the corresponding period. Furthermore, it can be noted that both forward guidance and LSAP factor estimates are distributed equally around zero to a greater extent. Nonetheless, extreme negative values can be observed for the federal funds rate factor.

The bottom panel of Figure 1 depicts the estimated policy surprises against the respective daily changes in the S&P 500 index for the ZLB and post-ZLB period (i.e. Jan.2009 –Jun.2019). Some degree of negative correlation is visible between the estimated forward guidance factors and stock prices. However, such a clear relationship is not visible for the federal funds rate as well as LSAP surprises. Meanwhile, a clear outlier is visible in the scatter plot for LSAPs, which corresponds to the "QE1" LSAP announcement in March 18, 2009. This announcement is considered to be very influential since that was the first time the FOMC announced an LSAP program as an expansionary monetary policy tool when its traditional policy instrument was constrained at the ZLB. Moreover, this seems to have been a major surprise to financial markets, given the large size of the LSAP factor estimated in March 2009.

4.1 **Effects on Overall Equity Prices**

I begin the analysis by estimating the effects of the surprise changes in the federal funds rate, forward guidance and LSAPs on overall stock prices. Accordingly, following Swanson (2020), OLS regressions of the following form are carried out:

$$\Delta y_t = \alpha + \beta \tilde{F}_t + \varepsilon_t, \tag{1}$$

where Δy denotes the daily change in the (log) equity price index multiplied by 100, $\tilde{F}$ denotes the monetary policy factors, and ε is the residual. Furthermore, t indexes the FOMC announcement dates. The regressions are similar to those of Swanson (2020) except for the fact that I consider daily changes in equity prices in contrast to a 30-minute response. Furthermore, I repeat the estimates for two other stock price indexes (i.e. the Dow Jones Industrial Average and NASDAQ Composite Index) in addition to S&P 500, which is the primary index of analysis. Table 2 presents estimated effects of policy surprises for the overall equity price indexes for the full sample from July 1991 to June 2019 as well as its sub samples.

In the pre-ZLB period (Panel B of Table 2), the coefficient on the federal funds rate factor is negative and highly statistically significant, indicating that a one-standard-deviation surprise increase in the federal funds rate causes the S&P 500 Index to fall by 0.38 percent. With regard to forward guidance, the estimated coefficient is again negative and highly statistically significant. As such, the S&P 500 Index is estimated to fall by 0.25 percent during this period for a one-standard-deviation tightening of forward guidance. However, the R^2 of the regression takes a low value of 0.14 as there could be many idiosyncratic factors affecting stock prices in any given period.

For the ZLB period (Panel C of Table 2), forward guidance causes the S&P 500 Index to fall by 0.44 percent. The effects are highly statistically significant, and more importantly they are larger than the pre-ZLB period effects suggesting the relatively important role played

Table 2: Estimated Effects on Overall Equity Prices

	S&P 500	Dow Jones industrial average	NASDAQ composite index
Panel A: Full sample, Jul.1991–Jun.2019 (241 obs.)			
change in federal funds rate	-0.38***	-0.31***	-0.73***
	(0.09)	(0.08)	(0.12)
change in forward guidance	-0.27***	-0.25***	-0.17*
	(0.07)	(0.07)	(0.10)
change in LSAPs	-0.09	-0.11	-0.05
	(0.12)	(0.11)	(0.17)
Regression R^2	0.12	0.11	0.14
Panel B: Pre-ZLB sample, Jul.1991–Dec.2008 (157 obs.)			
change in federal funds rate	-0.38***	-0.31***	-0.74***
	(0.09)	(0.09)	(0.14)
change in forward guidance	-0.25***	-0.25***	-0.13
	(0.09)	(0.08)	(0.13)
Regression R^2	0.14	0.13	0.16
Panel C: ZLB sample, Jan.2009–Nov.2015 (55 obs.)			
change in forward guidance	-0.44**	-0.41**	-0.38*
	(0.22)	(0.19)	(0.22)
change in LSAPs	-0.07	-0.12	-0.06
	(0.18)	(0.16)	(0.19)
Regression R^2	0.08	0.09	0.06
Panel D: Post-ZLB sample, Dec.2015–Jun.2019 (29 obs.)			
change in federal funds rate	-0.83	-0.75	-1.00
	(0.74)	(0.78)	(0.99)
change in forward guidance	-0.30*	-0.17	-0.36
	(0.17)	(0.18)	(0.23)
change in LSAPs	0.34	0.24	0.09
	(0.52)	(0.54)	(0.69)
Regression R^2	0.14	0.06	0.11

***, **, and * denote statistical significance at 1, 5 and 10 percent levels, respectively. Standard errors are reported in parentheses.

by forward guidance during the ZLB period. The coefficient on the LSAPs is not statistically significant and remains negative. The negative sign of the coefficient however is puzzling, since an increase in LSAP factor corresponds to a monetary easing and causes interest rates to fall. Panel D of Table 2) provides the estimates for the post-ZLB period. The resulting effects of monetary policy factors are broadly similar to the previous periods, although the sample size remains relatively short. However, the LSAPs coefficient, though not statistically significant,

reports the anticipated sign for an expansionary shock.

The full sample effects are given in Panel A of Table 2, which is an aggregate of the effects estimated for the three sub-samples. Overall, the estimated coefficients for the federal funds rate surprises are very similar to Swanson (2020), which in turn closely follows the estimates in Bernanke and Kuttner (2005) and Gurkaynak et al. (2005). Nonetheless, the resultant coefficients for forward guidance are larger than Swanson (2020), which reports a coefficient of -0.14 for the full sample in comparison to -0.27 reported in Table 2. This could suggest that it takes more time to propagate the full impact of forward guidance to stock prices, as Swanson (2020) uses price changes in a shorter 30-minute window. The estimated LSAP coefficients are not statistically significant as in Swanson (2020). However, in contrast to Swanson (2020), coefficients in the full sample as well in the ZLB sample take a negative value.

As a robustness check, I perform the same regressions for the Dow Jones Industrial Average and NASDAQ Composite Index. The results are reported in the last two columns of Table 2. The coefficient estimates for the Dow Jones Industrial Average closely correspond to those of the S&P 500 Index in terms of the sign, magnitude and the level of statistical significance. For the NASDAQ Composite Index, some degree of deviation can be observed in the magnitude and the significance level of the coefficient estimates. This could be attributed to the fact that the NASDAQ index is heavily weighted towards companies in the Information Technology (IT) sector. Moreover, some similarities can be found between the estimates for the NASDAQ Index and IT sector estimates of S&P 500, which will be presented in the following section. Overall, it is evident that the surprise changes in the federal funds rate and announcements under forward guidance had meaningful and significant effects on equity prices during the period under review. Nonetheless, the effects of LSAPs on overall equity prices are not statistically significant, and may indicate puzzling outcomes as well.

4.2 **Sectoral Effects on Equity Prices**

Although many studies focus on finding the effects of different monetary policy instruments on the stock market performance as a whole, little attention has been given to sector-wise stock price responses. Therefore, in this section I assess the impact of monetary policy surprises on different sectors of the stock market. By doing so, one would be able to get an idea as to how different sectors in the economy perceive Federal Reserve's policy actions, both conventional and unconventional.

In order to asses the sectoral equity price movements in response to policy shocks, I repeat the exercise carried out before by estimating OLS regressions of the form given by equation 1 for different sector of the stock market. The set of policy surprises remains the same - i.e. interest

rate, forward guidance and LSAP shocks estimated by Swanson (2020). However, instead of the overall stock price index, the daily changes in the S&P 500 sector indexes as classified under GICS are used as the right hand side variable. Estimates are carried out for all 11 GICS sectors of S&P 500. Table 3 presents the estimated effects on sector-wise stock price indexes for the full sample as well as its sub samples.

Estimates based on sector-wise stock price indexes reveal that some sectors are more sensitive to interest rate surprises than others, whereas certain other sectors do not show any statistically significant interest rate sensitivity. As shown in Table 3, IT and Consumer Discretionary are the most interest rate sensitive sectors both in the full sample (Panel A) and in the pre-ZLB sample (Panel B). Industrials and Financials exhibit a moderate interest rate sensitivity, while Materials and Communication Services show a low sensitivity. No statistically significant relationships are found for Energy, Consumer Staples, Health Care, Utilities and Real Estate sectors, with the coefficients remaining small in magnitude in most cases. Results for the federal funds rate surprises are broadly in line with the findings of Bernanke and Kuttner (2005), though the study uses a different stock price index (the CRSP index) and a different sector classification. Bernanke and Kuttner (2005) find that Telecommunications, High-tech, and Durables are the three most interest rate sensitive industries, whereas Energy, Utilities and Health Care are the three least sensitive industries.

With regard to forward guidance, estimates reveal that announcements pertaining to the future path of policy actions are having a more "across the board" impact on stock prices, in comparison to the effects estimated for the current federal funds rate. In the full sample (Panel A), all sectors except IT are having statistically significant coefficients for forward guidance. Further, the variation in the magnitude of coefficient values across sectors is not as large as that for the federal funds rate. Even in the pre-ZLB (Panel B) and ZLB (Panel C) periods, most of the sectors exhibit highly statistically significant coefficients for the forward guidance factor. Another interesting result is that, compared to the pre-ZLB period, the effects of forward guidance were larger for all sectors in the ZLB period, except the Financials sector. This suggests that in the absence of conventional monetary policy tools with the onset of the ZLB, the Federal Reserve's commitment to a future path of interest rates had a bigger effect on almost all sectors of the economy, compared to the preceding period. Overall, the sector-wise analysis suggests that forward guidance is having a more homogeneous and widespread impact on stock prices than changes to the current federal funds rate, and its impact has amplified during the ZLB period.

For LSAPs, most of the sectors are found to have a negative coefficient in the ZLB period (Panel C), in line with the puzzling outcome observed for the overall stock price indexes for

Table 3: Estimated Effects on Equity Prices - S&P 500 Sectoral Analysis

	Energy	Materials	Industrials	Consumer discretionary	Consumer staples	Health care	Financials	IT	Communication services	Utilities	Real estate[a]
Panel A: Full sample, Jul.1991–Jun.2019 (241 obs.)											
change in federal funds rate	0.14	-0.35***	-0.49***	-0.68***	0.11	0.05	-0.49***	-0.86***	-0.27**	0.07	-0.49
	(0.11)	(0.11)	(0.09)	(0.10)	(0.08)	(0.09)	(0.16)	(0.14)	(0.11)	(0.09)	(0.36)
change in forward guidance	-0.36***	-0.32***	-0.26***	-0.28***	-0.32***	-0.31***	-0.35***	-0.17	-0.34***	-0.35***	-0.44**
	(0.09)	(0.09)	(0.08)	(0.08)	(0.06)	(0.07)	(0.13)	(0.12)	(0.09)	(0.07)	(0.19)
change in LSAPs	-0.27*	-0.22	-0.16	-0.14	-0.09	0.00	0.10	-0.06	0.13	0.31**	-0.08
	(0.15)	(0.15)	(0.13)	(0.14)	(0.10)	(0.12)	(0.22)	(0.20)	(0.15)	(0.13)	(0.29)
Regression R^2	0.08	0.10	0.15	0.19	0.11	0.07	0.07	0.14	0.08	0.11	0.04
Panel B: Pre-ZLB sample, Jul.1991–Dec.2008 (157 obs.)											
change in federal funds rate	0.16	-0.35***	-0.48***	-0.67***	0.12	0.05	-0.49***	-0.87***	-0.29**	0.08	-0.48
	(0.11)	(0.11)	(0.10)	(0.11)	(0.08)	(0.10)	(0.15)	(0.17)	(0.12)	(0.10)	(0.44)
change in forward guidance	-0.34***	-0.28***	-0.25***	-0.26**	-0.33***	-0.32***	-0.37***	-0.14	-0.26**	-0.22**	-0.23
	(0.10)	(0.10)	(0.09)	(0.10)	(0.07)	(0.09)	(0.14)	(0.16)	(0.11)	(0.09)	(0.28)
Regression R^2	0.08	0.10	0.18	0.22	0.12	0.08	0.10	0.15	0.07	0.04	0.03
Panel C: ZLB sample, Jan.2009–Nov.2015 (55 obs.)											
change in forward guidance	-0.61**	-0.56*	-0.49**	-0.44*	-0.47***	-0.46**	-0.26	-0.33	-0.62***	-0.83***	-0.70
	(0.27)	(0.28)	(0.23)	(0.23)	(0.15)	(0.17)	(0.48)	(0.21)	(0.18)	(0.18)	(0.42)
change in LSAPs	-0.33	-0.09	-0.14	0.04	-0.23*	-0.22	0.55	-0.08	-0.06	0.13	0.30*
	(0.23)	(0.24)	(0.19)	(0.20)	(0.12)	(0.15)	(0.41)	(0.18)	(0.15)	(0.15)	(0.36)
Regression R^2	0.09	0.08	0.08	0.08	0.16	0.12	0.06	0.05	0.21	0.38	0.10
Panel D: Post-ZLB sample, Dec.2015–Jun.2019 (29 obs.)											
change in federal funds rate	-2.25	-1.88*	-1.23	-0.92	0.35	-0.19	-1.04	-1.22	-0.47	-0.16	-0.05
	(1.44)	(0.99)	(0.95)	(0.95)	(0.91)	(0.89)	(0.84)	(1.12)	(1.44)	(1.10)	(1.17)
change in forward guidance	-0.61*	-0.52**	-0.27	-0.29	-0.32	-0.2	0.18	-0.38	-0.85**	-0.68**	-0.82***
	(0.33)	(0.23)	(0.22)	(0.22)	(0.21)	(0.21)	(0.19)	(0.26)	(0.33)	(0.26)	(0.27)
change in LSAPs	0.30	0.64	0.42	0.09	0.77	0.15	-0.05	-0.04	2.22**	1.86**	1.13
	(1.00)	(0.69)	(0.66)	(0.66)	(0.63)	(0.62)	(0.58)	(0.78)	(1.00)	(0.76)	(0.81)
Regression R^2	0.17	0.25	0.11	0.09	0.12	0.04	0.10	0.11	0.27	0.30	0.28

***, **, and * denote statistical significance at 1, 5 and 10 percent levels, respectively.
Standard errors are reported in parentheses.

[a]The Real estate sector was introduced in 2016. Before that, Real estate was an industry group in the Financials sector. Therefore, when constructing the data series, Real estate sector index data from September 19, 2016 are combined with Real estate industry group's sub-index level data prior to September 19, 2016. However, such data is available only from October 2001.

the same period. A few sectors exhibit positive coefficients during this period supporting the direct effects associated with asset purchases. However, none of the sectors are found to have a highly statistically significant coefficient. This pattern reverses in the post-ZLB period (Panel D) where most of the sectors exhibit positive coefficients for LSAPs with some being highly statistically significant. Meanwhile, as highlighted before, "QE1" LSAP announcement on March 18, 2009 has been identified as a very influential announcement made at a time when financial markets were functioning very poorly (Swanson, 2020). Accordingly, the analysis is repeated excluding the LSAP announcement in March 2009. The results for the S&P 500 Index and its sector indexes are reported in the Appendix in Table A.1 and Table A.2, respectively. The main change comes through the estimates for the ZLB period. Once the influential data point is removed, the negative coefficients for the LSAP factor becomes more negative (large in magnitude), while positive coefficients become less positive or turn negative. The reason for this outcome is evident from the last scatter plot in the bottom panel of Figure 1, where one can observe that the respective data point, which is the rightmost outlier, is clearly in favor of a positive coefficient. Therefore, exclusion of the March 2009 FOMC announcement amplify the puzzling outcome for LSAPs in terms of the coefficient sign, during the ZLB period.

It is noteworthy that for LSAPs, both the overall stock price index and most of the sector indexes report coefficients which are not statistically significant. Furthermore, the sign of the estimated coefficients, in most cases, is not inline with the direct expansionary effects expected from asset purchases. However, there are other studies reporting similar findings. For example, Joyce, Lasaosa, Stevens, and Tong (2011) find that equity prices in the UK reacted in a less uniform way after the Bank of England's quantitative easing announcements. Joyce et al. (2011) state that there are two opposing forces impacting equity prices. Low long-term yields due to LSAPs should increase the present value of future dividends, thereby raising equity prices. Furthermore, as investors attempt to rebalance their portfolios towards more risky assets, the equity risk premium should fall, thus putting further upward pressure on equity prices. On the other hand, LSAP announcements may also give information about the outlook for the economy, and if that is worse than expected, expectations for future dividends could fall and risk premia could rise, thereby putting downward pressure on equity prices. Therefore, the immediate LSAP impact may not be clear. Meanwhile, the negative sign recorded for some of the LSAP coefficients is in line with the findings of Glick and Leduc (2012), whose estimates show that expansionary LSAP surprises resulted in a drop in the S&P 500 Index, while contractionary surprises were accompanied by rising stock prices. Glick and Leduc (2012) attribute this outcome to the signaling effects of LSAP announcements about the future economic outlook.

5 Variance Decomposition of Equity Returns

The previous section focused on quantifying the effects of monetary policy shocks on stock market performance. Next, I concentrate on analyzing the channels through which these policy shocks affect stock prices by following the two stage approach used in Bernanke and Kuttner (2005). Bernanke and Kuttner (2005) states that there are three main reasons for a policy shock to result in a change in stock prices: changes in expected future dividends, a rise or fall in the future expected real interest rates, or a change in the expected excess returns associated with stocks. The first stage of the approach followed by Bernanke and Kuttner (2005) involves performing a variance decomposition analysis by means of a forecasting VAR to ascertain the key factors contributing to the variations in excess equity returns. Section 5 elaborates on this first stage and presents the relevant results. The second stage involves estimating dynamic responses to the three types of policy shocks considered above by modifying the VAR structure developed in the first stage, and section 6 focuses on this.

5.1 The Methodology Used

I follow the methodology used in Campbell (1991) and Campbell and Ammer (1993) to decompose the excess equity returns during the period from July 1991 to June 2019. As such, a VAR model is used to decompose current period excess stock returns into changes in expectations of future dividends, real interest rates and excess stock returns in the future. This decomposition, based on Campbell and Ammer (1993), can be written as:

$$e^{y}_{t+1} = \tilde{e}^{d}_{t+1} - \tilde{e}^{r}_{t+1} - \tilde{e}^{y}_{t+1}, \tag{2}$$

where y, d and r represent excess stock returns, dividends and real interest rates, respectively. The revision in expectations between periods t and $t+1$ is denoted by e_{t+1}, while the tilde denotes a discounted sum of future values.

The relationship given by equation 2 is simple and intuitive. The revision in expectations for the current period's excess stock return is positively related to the revisions in expectations about future dividends. Accordingly, an increase in expected future dividends is associated with an increase in stock prices. However, the current period's excess stock return is negatively related to changes in expected future real interest rates which are used to discount those dividends. Changes in the expected future excess returns are also negatively related to the current period's excess stock return. This is because if the present value of future cash flows remains constant, an increase in stock prices in the future should be accompanied by a decrease in stock prices in the current period.

Campbell (1991) as well as Campbell and Ammer (1993) model expectations using a first order VAR of the form

$$z_{t+1} = Az_t \ + \ \omega_{t+1}, \tag{3}$$

capturing the dynamic correlations between the excess equity return and related variables, where z_{t+1} is a vector having the excess stock returns, real interest rates and other forecasting variables. As the VAR in equation 3 is specified to obtain proxies for the relevant expectations, innovations related to equation 2 are given by

$$e^y_{t+1} = s_y\omega_{t+1}, \tag{4}$$

$$\tilde{e}^y_{t+1} = s_y\rho A(1-\rho A)^{-1}\omega_{t+1}, \tag{5}$$

$$\tilde{e}^r_{t+1} = s_r(1-\rho A)^{-1}\omega_{t+1}, \tag{6}$$

$$\tilde{e}^d_{t+1} = e^y_{t+1} + \tilde{e}^r_{t+1} + \tilde{e}^y_{t+1}, \tag{7}$$

where ρ is a discount factor, and s_y and s_r are relevant selection vectors[2]. Meanwhile, equation 2 implies that the variance of excess stock returns can be written as the following combination of variances and covariances:

$$\begin{aligned} Var(e^y_{t+1}) =& Var(\tilde{e}^d_{t+1}) + Var(\tilde{e}^r_{t+1}) + Var(\tilde{e}^y_{t+1}) \\ & - 2Cov(\tilde{e}^d_{t+1}, \tilde{e}^r_{t+1}) - 2Cov(\tilde{e}^d_{t+1}, \tilde{e}^y_{t+1}) + 2Cov(\tilde{e}^r_{t+1}, \tilde{e}^y_{t+1}). \end{aligned} \tag{8}$$

Equation 8 gives an idea about the relative contributions of news about real interest rates, dividends, and expected future excess returns to variations in the current excess return associated with holding equities.

5.2 **Estimation Outcomes**

A first-order VAR as given in equation 3 is estimated using monthly data from July 1991 to June 2019. Following Bernanke and Kuttner (2005), the state vector, z_t, is specified as

$$z_t = [y_t, \ r_t, \ \Delta i_t, \ s_t, \ d_t - p_t, \ ri_t]'. \tag{9}$$

The excess return on equities, y_t, is the total return on equities as measured by the S&P 500 total returns index, minus the risk-free rate (the short term interest rate). The real interest rate, r_t, is calculated as the short term interest rate minus the log difference (year-on-year) in the nonseasonally-adjusted CPI. The monthly change in the short term interest rate is given by Δi_t, while s_t is the spread between the 10-year constant maturity Treasury yield and the short term interest rate. The (log) dividend price ratio (dividend yield) is denoted by $d_t - p_t$, while ri_t denotes the relative interest rate defined as the current 3-month Treasury bill rate minus its 12-month lagged moving average.

[2]Please see Campbell and Ammer (1993) for details of the derivation.

Table 4: Variance Decomposition of Excess Equity Returns

	Total	Share (%)
Var(excess return)	**16.47**	
Var(dividends)	0.66	3.98
Var(real rate)	0.21	1.25
Var(future excess returns)	9.84	59.74
-2 Cov(dividends, real rate)	0.05	0.33
-2 Cov(dividends, future excess return)	4.05	24.61
2 Cov(future excess return, real rate)	1.66	10.08

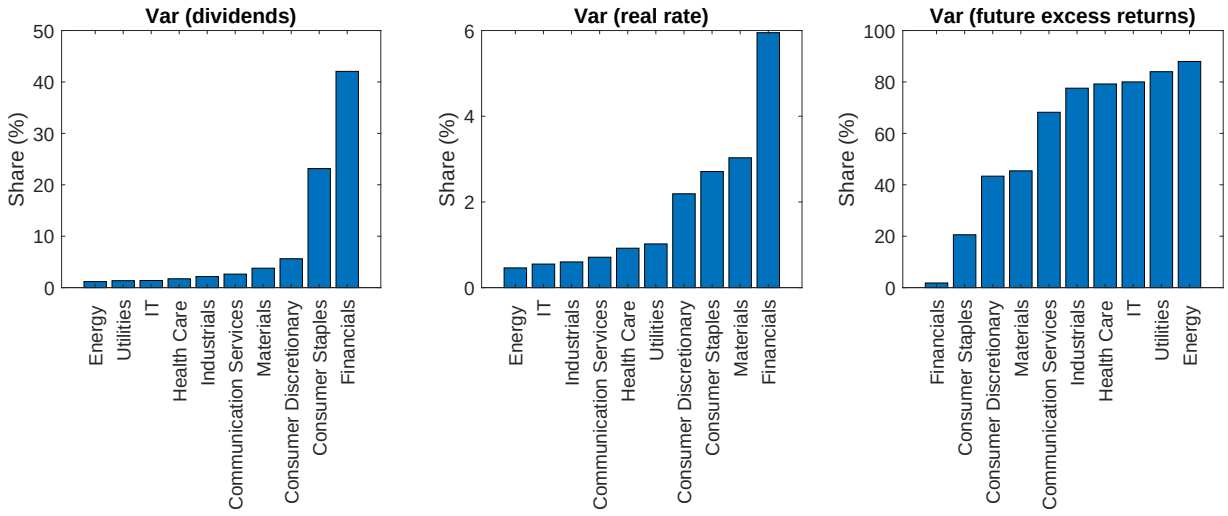
In order to estimate the forecasting VAR, the effective federal funds rate is used as a measure of the short term interest rate. Nonetheless, the ZLB episode from January 2009 to November 2015 could be of concern since the movements in short term interest rates were constrained by the effective lower bound. In order to overcome this issue, the shadow federal funds rate derived by Wu and Xia (2016) is used as an alternative measure of the federal funds rate for the ZLB period [3]. The CPI is based on the price index computed for all urban consumers in the U.S., and the dividend price ratio is based on an updated stock market data set used in Shiller (2015). Following Campbell and Ammer (1993), the discount factor ρ is set to 0.9962.

Once the VAR is estimated, its coefficient matrix (A) together with the innovations (ω_{t+1}) for the estimation period are used to calculate the relevant revisions in expectations as defined by equations 4 to 7. Then, a variance decomposition of excess equity returns, as specified in equation 8, is carried out and the results are presented in Table 4. The first column with estimation results provides the absolute value of the respective variances and covariance related calculations. The last column expresses each item's contribution as a percentage of the variance in the current period's excess return.

The variance in future excess returns dominates, accounting for around 60 per cent of the variation in current equity returns during July 1991 to June 2019. This is in comparison to 70.5 per cent found in Campbell and Ammer (1993) for the 1952-1987 period, and 76.0 per cent

[3]Campbell and Ammer (1993) use 1-month Treasury yield as the measure of short term interest rate, while Bernanke and Kuttner (2005) use a combination of 1-month and 3-month Treasury yields. However, using such measures during the ZLB period could lead to issues.

Figure 2: Variance Decomposition in S&P 500 Sectors



found in Bernanke and Kuttner (2005) for the 1973-2002 period. Dividends, however, make a smaller contribution of 4.0 per cent during the period under analysis, which is lower than 14.6 per cent recorded in Campbell and Ammer (1993) and 24.6 per cent in Bernanke and Kuttner (2005). The contribution of the real interest rate remains the smallest at 1.3 per cent. This is in line with 1.3 per cent found in Campbell and Ammer (1993) and 1.4 per cent in Bernanke and Kuttner (2005). The covariances account for the balance, which is about a third of the variance in the current period's excess return.

In addition to the variance decomposition analysis carried out for the overall stock price index, I repeat the variance decomposition procedure for the sectors of the stock market considered before. In order to perform this exercise, first I compute the sector-wise total returns on equities based on the GICS sector indexes of S&P 500 (total returns indexes). Next, I compute a dividend yield series for each sector under consideration as the stock market data set of Shiller (2015) contains dividend yields only for the overall index. Accordingly, a proxy for monthly dividends is derived using the difference between the total returns index and price returns index. Then, the dividend yield is calculated as the sum of dividends for a 12-month period divided by the price returns index for the relevant month. Dividend yield calculated in this manner for the overall S&P 500 Index closely tracks the dividend yield series given in Shiller (2015).

With the excess equity return and dividend yield series calculated for each stock market sector, I repeat the VAR based analysis performed above with the rest of the variables remaining the same[4]. The details of the sectoral variances of expected future dividends, real interest rates

[4]The Real Estate sector is not considered for this analysis due to the unavailability of a longer data series for the total returns index. For the IT sector, a smoothed series of the total returns index is used (monthly

Table 5: Effect of Policy Surprises on Forecast Errors

Forecast Error Variable (regressand)	Federal funds rate	Forward guidance	LSAP
excess stock return	-0.892	-0.428	0.121
	(0.319)	(0.267)	(0.444)
real interest rate	0.047	0.013	0.006
	(0.03)	(0.025)	(0.042)
change in interest rate	0.06	-0.004	-0.018
	(0.011)	(0.01)	(0.016)
interest rate spread	-0.052	0.037	0.013
	(0.019)	(0.016)	(0.026)
dividend price ratio	0.001	0.002	0.002
	(0.002)	(0.002)	(0.003)
relative interest rate	0.05	0.008	0.03
	(0.012)	(0.01)	(0.017)

Standard errors are reported in parentheses.

and excess returns, and the respective covariance calculations are given in the Appendix in Table A.3. Figure 2 summarizes this by depicting the relative contribution of each of the factors for the current period's excess equity returns, arranged in an ascending order. The analysis reveals that even for the individual sectors, the variations in the future excess returns is the key factor driving the current performance of equities. Financials and Consumer Staples sectors are the only exceptions to this. Future dividends and the real interest rates continue to report a relatively low contribution. Financials and Consumer Staples emerge as the sectors with the largest contribution of future dividends for the current period's equity premium, while the Financials sector records the highest relative contribution of the real interest rate as well. Energy sector records the lowest relative contribution of future dividends as well as the real interest rates, while reporting the highest contribution of future excess returns.

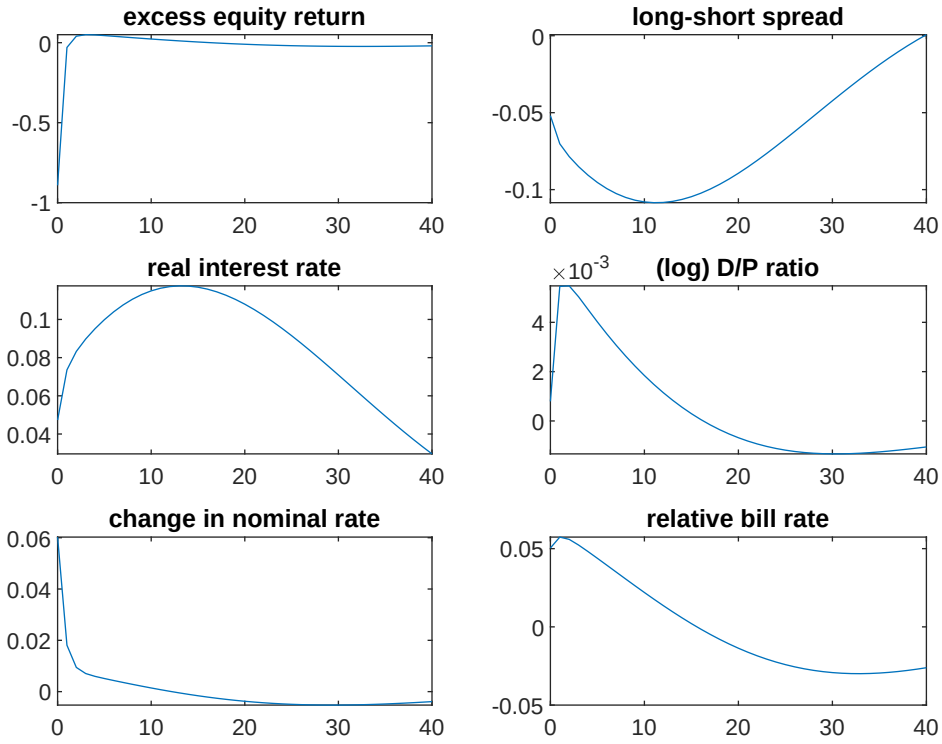
6 The Effects of Monetary Policy Surprises

In this section, I analyze the impact of the monetary policy surprises considered above, following the methodology in Bernanke and Kuttner (2005). Accordingly, the proxies for the Federal Reserve's policy surprises are included in the VAR based framework introduced above as exogenous variables. The modified VAR takes the following form:

$$z_{t+1} = Az_t \ + \ \phi\tilde{F}_{t+1} \ + \ \tilde{\omega}_{t+1}, \tag{10}$$

averages instead of the month end values). This is done to overcome the extreme values resulting from excessive volatility in stock prices mainly during the dot com bubble period.

Figure 3: Impulse Responses to a Federal Funds Rate Surprise



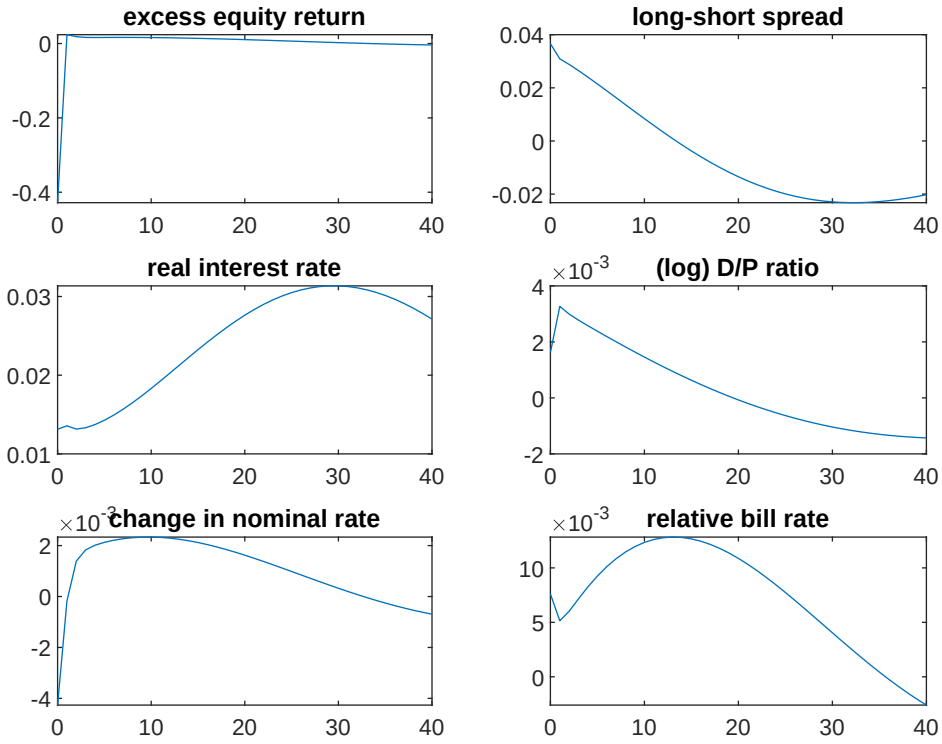
where $\tilde{F}$ denotes the monetary policy factors pertaining to surprise changes in the federal funds rate, forward guidance, and LSAPs estimated in Swanson (2020). The contemporaneous response of variables in z_{t+1} to the unanticipated monetary policy changes in period $t+1$ is captured by ϕ. The new error term is denoted by $\tilde{\omega}_{t+1}$ and it is orthogonal to the policy surprises by construction.

Equation 10 is estimated separately for each type of policy surprise, in which case ϕ is a 6×1 vector[5]. I follow the two-step approach where an estimate for ϕ is obtained by first estimating the VAR parameters and then regressing the 1-step-ahead forecast error of the VAR (i.e. ω_{t+1} in equation 3) on relevant monetary policy surprises. Similar to section 5, the estimates are based on monthly data from July 1991 to June 2019. However, it is noteworthy that the original policy surprises are calculated for the FOMC announcement days. Therefore, the policy surprises are aggregated across months to perform the second stage of the estimates. The estimated coefficients of the second stage of the regression, which are the constituents of ϕ, are summarized in Table 5. Overall, the reported coefficients have the expected sign for each type of policy surprise.

The above estimates are then used to calculate the dynamic responses of the variables in the VAR to the three monetary policy surprises under consideration. As such, the response

[5]If all factors are incorporated in a single estimate, ϕ would be a 6×3 vector.

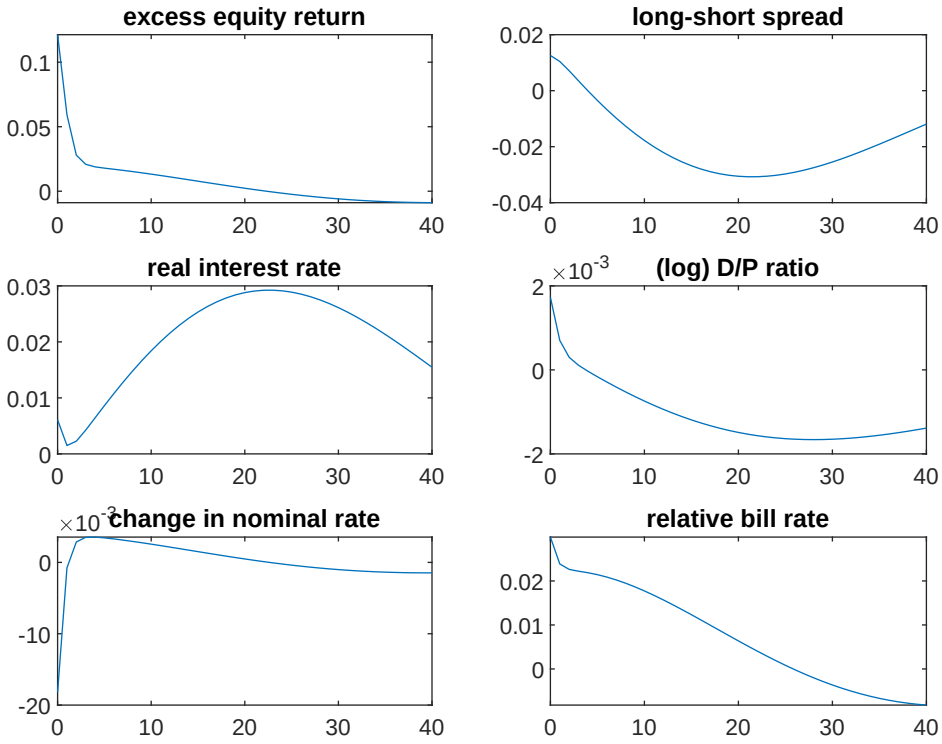
Figure 4: Impulse Responses to a Forward Guidance Surprise



in the k^{th} month to a one standard deviation monetary policy surprise can be calculated as $A^k\phi$. Figure 3 displays the impulse responses calculated in this way for a surprise increase in the federal funds rate. The contractionary funds rate surprise leads to an initial decline in the excess equity returns. The increases in the real interest rate, nominal interest rate, relative bill rate, and the decline in the long-short spread can be attributed to the increase in short term interest rates due to monetary tightening. Meanwhile, the (log) dividend-price ratio shows a marginal increase in response to the contractionary surprise. The direction of the initial responses are intuitive, and they are similar to those reported in Bernanke and Kuttner (2005).

Bernanke and Kuttner (2005)'s analysis is limited to surprises in the federal funds rate. In addition to the federal funds rate, I present the dynamic responses to forward guidance and LSAP surprises. Accordingly, the impulse responses calculated for a contractionary one standard deviation forward guidance surprise are depicted in Figure 4. The responses are broadly similar to those of a contractionary funds rate surprise, except for the notable observation that some of the interest rate responses peak with a time lag. This could be attributed to the fact that forward guidance is about the Federal Reserve's commitment to the future path of interest rates and not about the immediate interest rate changes. However, the magnitude of the responses is observed to be small compared to the responses for a federal funds rate surprise.

Figure 5: Impulse Responses to a LSAP Surprise



The impulse responses estimated for an expansionary one standard deviation LSAP surprise are depicted in Figure 5. The initial response of the excess equity return is positive and consistent with an expansionary policy shock. The nominal interest rate respond with a decline, which is also consistent with an expansionary shock. The long-short spread increases initially owing to the decline in short term interest rates. However, the long-short spread contracts with a time lag, possibly reflecting the LSAP effects on long-term interest rates.

While a visual analysis of the dynamic responses estimated above provides us with an approximate idea of the relative importance of expected future excess returns, interest rates and dividends in explaining the current period's equity premium, quantifying the discounted sums of these variables would provide a straightforward answer. Therefore, I follow the approach of Bernanke and Kuttner (2005) to calculate the discounted sums of expected future excess returns, interest rates and dividends for the policy shocks considered above.

According to equation 4, the response of the current period's excess equity returns to a given policy shock is simply $s_y\phi$. The present value of the response of expected future excess returns to the respective policy surprises is derived by equation 5, which takes the following form:

$$s_y\rho A(1-\rho A)^{-1}\phi. \tag{11}$$

Table 6: The Impact of Monetary Policy on Dividends, Interest Rates, and Future Returns

	Federal funds rate	Forward guidance	LSAPs
Current excess return (e^y)	-0.892	-0.428	0.121
Dividends ($\tilde{e}^d$)	-0.053	-0.096	-0.046
Share	6.0%	22.5%	-37.6%
Real interest rate ($\tilde{e}^r$)	0.073	0.018	-0.027
Share	8.2%	4.2%	22.4%
Future excess returns ($\tilde{e}^y$)	0.765	0.314	-0.140
Share	85.8%	73.3%	115.2%

Decomposition of the excess equity returns for a given policy surprise based on the relation $e^y_{t+1} = \tilde{e}^d_{t+1} - \tilde{e}^r_{t+1} - \tilde{e}^y_{t+1}$.

In a similar way, based on equation 6, the present value of the response of current and future real interest rates is given by,

$$s_r(1 - \rho A)^{-1}\phi. \tag{12}$$

Finally, the present value of the response of current and expected future dividends is calculated as a residual from equation 2, which can be stated as:

$$s_y\phi + s_y\rho A(1 - \rho A)^{-1}\phi + s_r(1 - \rho A)^{-1}\phi. \tag{13}$$

The present value estimates for one standard deviation surprises in the federal funds rate, forward guidance and LSAPs are summarized in table 6. The first row provides the responses in the current period's excess return for each type of policy shock. The next three rows report the responses of dividends, real interest rate and future excess returns for the given shocks, where the individual responses with the correct signs add up to the value reported in the first row as these are the constituents of the current period's excess return. The results indicate that for all types of monetary policy shocks future excess returns account for a major share of the current period's response in equity premium, while dividends and the real interest rates account for a minor share. With regard to the surprises in the federal funds rate, the real interest rates make a marginally higher contribution than dividends. For forward guidance, dividends record the second largest relative contribution, while the real interest rates record a significantly small contribution. The contribution of dividends for LSAP shocks is surprisingly negative, indicating that an expansionary policy shock results in a contraction in the expected stream of future dividends. The real interest rates, however, make a positive contribution for LSAP surprises, as one would expect.

Table 7: The Impact of Monetary Policy on Dividends, Interest Rates, and Future Returns - Sectoral Analysis

	Energy	Materials	Industrials	Consumer discretionary	Consumer staples	Health care	Financials	IT	Communication services	Utilities
Panel A: Federal funds rate surprise										
Current excess return (e^y)	-0.189	-0.814	-1.133	-1.156	-0.202	-0.499	-0.884	-0.416	-1.109	-0.173
Dividends ($\tilde{e}^d$)	0.076	-0.024	-0.035	-0.157	0.102	0.047	-0.494	0.04	-0.04	0.063
Share	-40.0%	3.0%	3.1%	13.6%	-50.3%	-9.3%	55.8%	-9.6%	3.6%	-36.7%
Real interest rate ($\tilde{e}^r$)	0.020	0.064	0.03	0.149	0.017	0.036	0.221	0.024	0.061	0.009
Share	10.4%	7.9%	2.6%	12.9%	8.3%	7.1%	25.0%	5.9%	5.5%	5.1%
Future excess returns ($\tilde{e}^y$)	0.245	0.726	1.068	0.851	0.287	0.51	0.169	0.431	1.008	0.227
Share	129.6%	89.2%	94.3%	73.6%	142.0%	102.2%	19.1%	103.7%	90.9%	131.7%
Panel B: Forward guidance surprise										
Current excess return (e^y)	-0.508	-0.648	-0.436	-0.61	-0.34	-0.415	-0.528	-0.159	-0.046	-0.348
Dividends ($\tilde{e}^d$)	-0.063	-0.145	-0.078	-0.157	-0.194	-0.055	-0.386	-0.04	-0.038	-0.035
Share	12.4%	22.3%	17.9%	25.8%	57.0%	13.3%	73.0%	25.0%	81.9%	10.2%
Real interest rate ($\tilde{e}^r$)	-0.02	0.1	-0.011	0.069	0.036	0.003	0.118	-0.013	-0.014	0.003
Share	-4.0%	15.5%	-2.4%	11.2%	10.7%	0.7%	22.4%	-8.3%	-30.7%	0.9%
Future excess returns ($\tilde{e}^y$)	0.465	0.403	0.369	0.384	0.11	0.357	0.025	0.132	0.023	0.309
Share	91.7%	62.2%	84.5%	63.0%	32.3%	86.0%	4.7%	83.3%	48.8%	89.0%
Panel C: LSAP surprise										
Current excess return (e^y)	-0.353	0.215	0.059	-0.119	0.182	0.583	0.566	-0.12	-0.064	0.019
Dividends ($\tilde{e}^d$)	-0.079	-0.029	-0.051	-0.09	-0.048	-0.026	0.269	-0.084	-0.105	-0.051
Share	22.3%	-13.7%	-85.8%	75.4%	-26.4%	-4.5%	47.6%	70.4%	164.2%	-277.3%
Real interest rate ($\tilde{e}^r$)	-0.022	-0.003	-0.019	0.002	-0.052	-0.058	-0.14	-0.038	-0.038	-0.02
Share	-6.4%	1.6%	32.9%	1.5%	28.8%	9.9%	24.7%	-31.8%	-59.5%	107.9%
Future excess returns ($\tilde{e}^y$)	0.297	-0.241	-0.09	0.027	-0.178	-0.552	-0.157	0.073	-0.003	-0.05
Share	84.1%	112.1%	152.9%	23.1%	97.6%	94.5%	27.7%	61.4%	-4.6%	269.4%

Decomposition of the excess equity returns for a given policy surprise based on the relation $e^y_{t+1} = \tilde{e}^d_{t+1} - \tilde{e}^r_{t+1} - \tilde{e}^y_{t+1}$.

In addition to assessing the impact of monetary policy surprises on the overall stock price index, I repeat the exercise with sector indexes in order to decompose the excess equity returns for different sectors of the stock market. Accordingly, sectoral present value estimates for one standard deviation surprises in the federal funds rate, forward guidance and LSAPs are summarized in table 7. The analysis reveals that all sectors except the Financials sector have the present value of future excess returns as the main contributor to the current period's equity premium. Although the sector-wise decomposition broadly follows the patterns observed for the overall stock market, some notable variations can be observed across sectors. The most notable heterogeneity is evident for the LSAP surprises, where the response of the current period's excess returns is a mix of both positive and negative values.

6.1 Relating Regression Estimates to the Decomposition of Excess Equity Returns

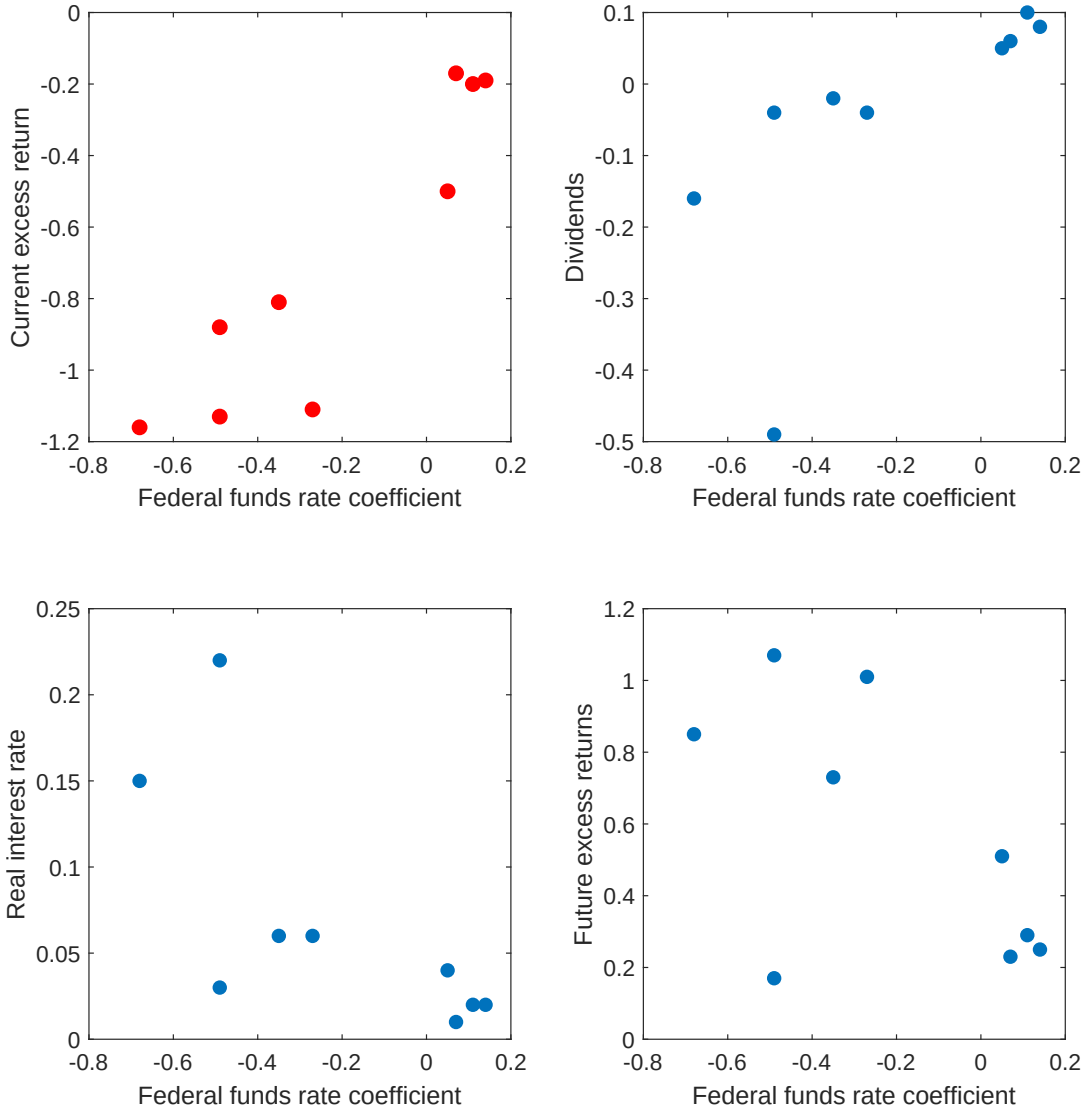
In this section, I attempt to relate the sector-wise OLS regression coefficients found in section 4 to the estimates of the current period's excess equity return responses, for the three types of monetary policy shocks under consideration. Both approaches try to quantify the effects on equity returns for a given policy shock. However, one should note that the construction of equity returns is different in the two approaches. In section 4, I considered daily equity returns, whereas in sections 5 and 6, I consider monthly excess equity returns. Therefore, this comparison should be made keeping in mind this difference in construction.

Figure 6 relates the OLS regression coefficients estimated for a federal funds rate shock to the response of the current period's excess return and its constituents for the same policy surprise. Each dot of a scatter plot corresponds to a GISC sector[6]. The x-axis represents the OLS coefficient, while the y-axis represents the relevant response. The first scatter plot depicts the response of the the current period's excess return, where we can note a clear relationship between the two estimates. The sectors which are more interest rate sensitive than others (i.e. sectors with larger negative coefficients) report large excess equity responses. The constituents of the current period's excess return (i.e. dividends, the real interest rates and future excess returns), which are presented in the next three scatter plots, also depict meaningful and consistent relations with the OLS regression coefficients.

In Figure 7, I try to visually relate the OLS regression coefficients estimated for forward guidance and LSAP shocks to the respective responses of the current period's excess return. The first scatter plot corresponds to a forward guidance surprise, where a clear relationship is not evident. However, for an LSAP shock, a weakly positive relationship between the two

[6]The IT sector is excluded because of the use of a smoothed total returns index, thus making it not directly comparable with the other sectors.

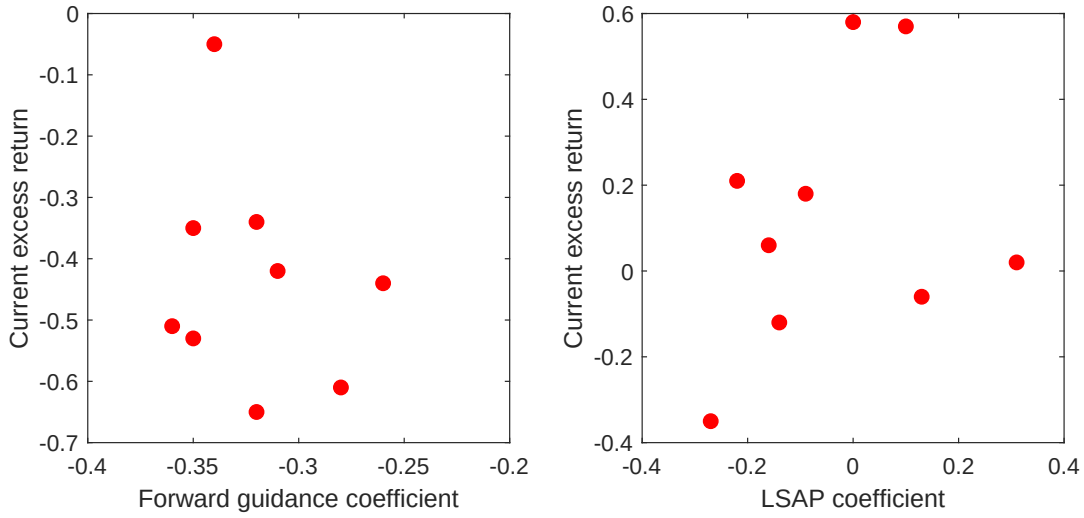
Figure 6: Excess Equity Returns versus Estimated OLS Coefficients: Federal Funds Rate Shock



estimates can be observed. Moreover, the second plot in Figure 7 indicates that a negative LSAP coefficient can be associated with a negative or a small positive response in the current excess returns. This is an important relationship because in sections 4, it was not possible to ascertain the reason for having an unexpected negative sign for some of the OLS coefficients estimated for LSAPs.

At this point, I recall the two opposing forces associated with LSAP announcements as mentioned in Joyce et al. (2011). Low long-term yields due to LSAPs should increase the present value of future dividends, and this phenomenon is evident in Panel C of Table 7 where the signs of the real interest rate responses correspond to an expansionary policy shock. However, if LSAPs indicate that the outlook for the economy is worse than expected future dividends could fall, and this phenomenon is also evident in Table 7 where the signs of the dividend responses

Figure 7: Excess Equity Returns versus Estimated OLS Coefficients: Forward Guidance and LSAP Shocks



correspond to a contractionary policy shock. Furthermore, as investors attempt to rebalance their portfolios towards more risky assets following an LSAP announcement, the equity risk premium may fall. On the other hand, if LSAPs indicate that the outlook for the economy is worse than expected, risk premium could rise. The combined effect of the above could result in either an increase or a decrease in the risk premium. In Table 7, the behavior of risk premiums is captured by the future excess returns, where the results indicate that the sectors record both positive and negative signs implying that the risk premium is perceived in different ways by different sectors. More importantly, the current period's excess equity return is a combination of all the factors mentioned above. In this regard, we can observe that some sectors assign more weight to the expansionary forces, thereby resulting in an increase in excess returns, whereas for certain other sectors, contractionary forces outweigh the expansionary effects, thereby resulting in a decline in excess returns. However, this interpretation is suggestive, and not conclusive.

7 Conclusion

In the recent past, the ZLB constraint made many central banks around the world to pursue unconventional monetary policies to stimulate their economies. As a result, understanding the effects of unconventional monetary policy, and equally importantly, understanding the policy transmission mechanism has become a top priority. In such context, this research attempts to analyze the impact of Federal Reserve's conventional and unconventional monetary policy surprises, which are based on Swanson (2020), on the equities market, both at an aggregate level as well as at economic sector levels.

I show that although the overall stock market respond meaningfully to a surprise change in the federal funds rate with a high level of statistical significance, a heterogeneity in responses is observed among different sectors in the stock market. Some sectors display an increased interest rate response, whereas certain other sectors report small coefficients which are not even statistically significant. Forward guidance is also estimated to have meaningful and highly statistically significant effects on overall stock prices. However, it is interesting to see that forward guidance is having relatively homogeneous effects on sector-wise stock market performance. Moreover, almost all sectors exhibit statistically significant coefficients for forward guidance shocks, while the variation in the magnitude of coefficient values across sectors is not as large as that for the federal funds rate. Nonetheless, the effects of LSAPs on overall equity prices as well as on sectoral equity prices are not statistically significant. Furthermore, the estimates reveal some puzzling results for the ZLB period.

I assess the relative importance of the channels through which the monetary policy surprises under consideration affect equity prices. A decomposition of excess equity returns show that the future excess returns emerge as the dominant factor determining the current period's equity premium for both the overall stock price index and most of the sectoral indexes. Dividends and the future real interest rates record smaller contributions. For surprises in the federal funds rate, the real interest rates make a marginally higher contribution than dividends. For forward guidance, dividends record the second largest relative contribution, while the real interest rates record a significantly small contribution. With regard to LSAP shocks, the contribution of dividends is surprisingly negative, which may indicate an information effect associated with LSAPs. Nonetheless, the real interest rates make a positive contribution as expected. The relative contribution of future dividends, real interest rates and excess returns for the propagation of policy shocks is found to vary across sectors.

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Appendix

A Additional Empirical Results

Table A.1: Estimated Effects on Overall Equity Prices
(without March 2009 LSAP)

	S&P 500
Panel A: Full sample, Jul.1991–Jun.2019 (241 obs.)	
change in federal funds rate	-0.37***
	(-0.09)
change in forward guidance	-0.25***
	(0.07)
change in LSAPs	-0.27*
	(0.16)
Regression R^2	0.12
Panel C: ZLB sample, Jan.2009–Nov.2015 (55 obs.)	
change in forward guidance	-0.46**
	(0.21)
change in LSAPs	-0.41
	(0.27)
Regression R^2	0.10

***, **, and * denote statistical significance at 1, 5 and 10 percent levels, respectively.
Standard errors are reported in parentheses.

Table A.2: Estimated Effects on Equity Prices - S&P 500 Sectoral Analysis (without March 2009 LSAP)

	Energy	Materials	Industrials	Consumer discretionary	Consumer staples	Health care	Financials	IT	Communication services	Utilities	Real estate
Panel A: Full sample, Jul.1991–Jun.2019 (240 obs.)											
change in federal funds rate	0.15	-0.34***	-0.48***	-0.67***	0.11	0.05	-0.47***	-0.86***	-0.27**	0.08	-0.43
	(0.11)	(0.11)	(0.09)	(0.1)	(0.08)	(0.09)	(0.15)	(0.15)	(0.11)	(0.09)	(0.36)
change in forward guidance	-0.34***	-0.28***	-0.24***	-0.25***	-0.33***	-0.32***	-0.24*	-0.16	-0.33***	-0.34***	-0.39**
	(0.09)	(0.09)	(0.08)	(0.08)	(0.06)	(0.07)	(0.13)	(0.12)	(0.09)	(0.08)	(0.19)
change in LSAPs	-0.43**	-0.55***	-0.34**	-0.46**	-0.02	0.08	-0.77***	-0.14	0.08	0.27	-0.65*
	(0.19)	(0.19)	(0.16)	(0.18)	(0.13)	(0.16)	(0.27)	(0.26)	(0.19)	(0.16)	(0.38)
Regression R^2	0.09	0.11	0.15	0.2	0.11	0.07	0.09	0.14	0.08	0.09	0.06
Panel B: Pre-ZLB sample, Jul.1991–Dec.2008 (157 obs.)											
change in federal funds rate	0.16	-0.35***	-0.48***	-0.67***	0.12	0.05	-0.49***	-0.87***	-0.29**	0.08	-0.48
	(0.11)	(0.11)	(0.10)	(0.11)	(0.08)	(0.10)	(0.15)	(0.17)	(0.12)	(0.10)	(0.44)
change in forward guidance	-0.34***	-0.28***	-0.25***	-0.26**	-0.33***	-0.32***	-0.37***	-0.14	-0.26**	-0.22**	-0.23
	(0.10)	(0.10)	(0.09)	(0.10)	(0.07)	(0.09)	(0.14)	(0.16)	(0.11)	(0.09)	(0.28)
Regression R^2	0.08	0.10	0.18	0.22	0.12	0.08	0.10	0.15	0.07	0.04	0.03
Panel C: ZLB sample, Jan.2009–Nov.2015 (54 obs.)											
change in forward guidance	-0.64**	-0.6**	-0.52**	-0.47**	-0.46***	-0.46**	-0.36	-0.34	-0.64***	-0.84***	-0.73*
	(0.27)	(0.28)	(0.22)	(0.23)	(0.15)	(0.17)	(0.44)	(0.21)	(0.18)	(0.18)	(0.42)
change in LSAPs	-0.65*	-0.58	-0.46	-0.43	-0.17	-0.26	-0.84	-0.29	-0.30	0.04	-0.09
	(0.35)	(0.35)	(0.28)	(0.29)	(0.19)	(0.22)	(0.56)	(0.27)	(0.22)	(0.23)	(0.53)
Regression R^2	0.12	0.10	0.11	0.09	0.16	0.12	0.04	0.06	0.21	0.33	0.06
Panel D: Post-ZLB sample, Dec.2015–Jun.2019 (29 obs.)											
change in federal funds rate	-2.25	-1.88*	-1.23	-0.92	0.35	-0.19	-1.04	-1.22	-0.47	-0.16	-0.05
	(1.44)	(0.99)	(0.95)	(0.95)	(0.91)	(0.89)	(0.84)	(1.12)	(1.44)	(1.10)	(1.17)
change in forward guidance	-0.61*	-0.52**	-0.27	-0.29	-0.32	-0.2	0.18	-0.38	-0.85**	-0.68**	-0.82***
	(0.33)	(0.23)	(0.22)	(0.22)	(0.21)	(0.21)	(0.19)	(0.26)	(0.33)	(0.26)	(0.27)
change in LSAPs	0.30	0.64	0.42	0.09	0.77	0.15	-0.05	-0.04	2.22**	1.86**	1.13
	(1.00)	(0.69)	(0.66)	(0.66)	(0.63)	(0.62)	(0.58)	(0.78)	(1.00)	(0.76)	(0.81)
Regression R^2	0.17	0.25	0.11	0.09	0.12	0.04	0.10	0.11	0.27	0.30	0.28

***, **, and * denote statistical significance at 1, 5 and 10 percent levels, respectively.
Standard errors are reported in parentheses.

Table A.3: Variance Decomposition of Excess Equity Returns - Sectoral Analysis

		Var(excess returns)	Var(dividends)	Var(real rate)	Var(future excess returns)	-2 Cov(dividends, real rate)	-2 Cov(dividends, future excess return)	2 Cov(future excess return, real rate)
Energy	Value	28.56	0.33	0.13	25.12	-0.33	3.81	-0.52
	Share (%)		1.17	0.46	87.97	-1.14	13.34	-1.81
Materials	Value	30.73	1.16	0.93	13.96	1.54	6.81	6.34
	Share (%)		3.78	3.03	45.42	5	22.15	20.62
Industrials	Value	23.49	0.5	0.14	18.22	-0.26	4.5	0.38
	Share (%)		2.15	0.6	77.58	-1.11	19.16	1.63
Consumer Discretionary	Value	23.92	1.34	0.52	10.37	1.03	6.68	3.97
	Share (%)		5.62	2.19	43.36	4.29	27.93	16.61
Consumer Staples	Value	12.76	2.95	0.35	2.62	1.14	4.25	1.44
	Share (%)		23.15	2.71	20.56	8.95	33.33	11.3
Health Care	Value	18.15	0.31	0.17	14.38	-0.22	2.4	1.12
	Share (%)		1.72	0.92	79.22	-1.22	13.2	6.16
Financials	Value	35.75	15.04	2.13	0.65	10.55	5.28	2.11
	Share (%)		42.06	5.95	1.81	29.5	14.76	5.91
IT†	Value	29.27	0.41	0.16	23.42	-0.21	4.33	1.16
	Share (%)		1.39	0.55	80.02	-0.72	14.79	3.97
Communication Services	Value	27.64	0.73	0.2	18.85	0.00	5.76	2.1
	Share (%)		2.63	0.71	68.21	0.01	20.85	7.6
Utilities	Value	17.10	0.23	0.17	14.36	-0.25	1.47	1.11
	Share (%)		1.35	1.02	83.99	-1.46	8.62	6.48

† A smoothed data series of the total returns index (monthly average instead of the month end value) is used for the decomposition exercise. This is done to overcome the extreme values resulting from excessive volatility in stock prices mainly during the dot com bubble period.