Low Interest Rates and Asset Allocation: Evidence from Mutual Fund Flows *

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Abstract

This paper studies the effect of monetary policy on investors' asset allocation decisions by using data on aggregated and disaggregated mutual fund flows. First, we find that following an expansionary monetary policy, both equity funds and bond funds receive large inflows. Specific to asset classes, investors move money from large-cap assets to mid-cap and small-cap assets in the near term and then shift assets from domestic to developed and emerging markets. This leads us to the hypothesis that equity investors become more risk-taking when the interest rate is low, we then test this with individual funds panel data, our results indeed confirm this hypothesis. By contrast, bond investors become more risk-averse and move money into highly safe investment-grade funds and diversified global funds. Furthermore, we offer empirical evidence that the Fed's long-lasting zero lower bound policy (ZLB) increases both equity investors' and bond investors' appetite for risk-taking, although it has a much greater impact on bond investors than equity investors. Bond investors change from being risk-averse during the normal interest rate period to become risk-taking during the ZLB period.

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JEL Codes: E52, G11, G23

1 Introduction

During the 2008 financial crisis, the Federal Reserve (Fed) moved the federal funds rate (FFR) down to the 0 to 0.25 percent range, which is also known as zero lower bound (ZLB) policy. In December 2015, the Fed began to raise the FFR gradually, but the period of rising interest rates only lasted several years. In early 2019, the Fed began to reduce the FFR again. The decrease and the use of unconventional policy tools have been accelerating recently in response to the COVID-19 pandemic. In a series of emergency responses, the Fed lowered its target for the FFR to the ZLB on March 15, 2020, and the rate is likely to remain at the ZLB in the foreseeable future. A low interest rate environment has therefore become the new normal for the economy. Monetary policy actions in a zero lower bound environment may have profound effects on investors' asset allocation decisions, including asset allocation in mutual funds.

Mutual funds account for a large share of U.S. households investment: in 2019, there were around 59 million households who owned shares in mutual funds as shown in Figure 1. [1] Given the large scale of mutual funds in financial markets and their importance to households' wealth, understanding how mutual funds respond to monetary policy is significant. Over the past decade, the U.S. bond mutual funds have experienced very large inflows. As shown in the right panel of Figure 2, both taxable bond funds, and municipal bond funds gained large net inflows since 2009. [2] While there are different potential explanations for this increase in bond fund flows, the Fed's long-lasting monetary policy easing may be one of the most important factors. The low short-term interest rates and the relatively steep yield curve during this period likely enticed some investors to

[1] According to the sources from the Investment Company Institute and US Census Bureau, the total number of US households in 2019 is 128.6 million, there is 45.5% of households who own mutual funds, which is rounding to 59 million.

[2] The municipal bonds especially gained significant inflows since 2017, which is likely related to the recent tax reform, the Tax Cuts and Jobs Act (TCJA), passed in December 2017. This new tax law caps the deduction for state and local taxes at 10,000 dollars. Which is likely to push some investors towards municipal bonds for tax purposes.

shift out of money market funds, whose yields were barely above zero, and into bond mutual funds. During the same period, there were very significant outflows from equity mutual funds, especially the domestic equity funds as shown in the left panel of Figure 2. Although the Fed's monetary policy may also play a role in this, the connection between monetary policy and the stock market is potentially much more complicated than the relationship between monetary policy and the bond market. We will provide detailed explanations in section 2.

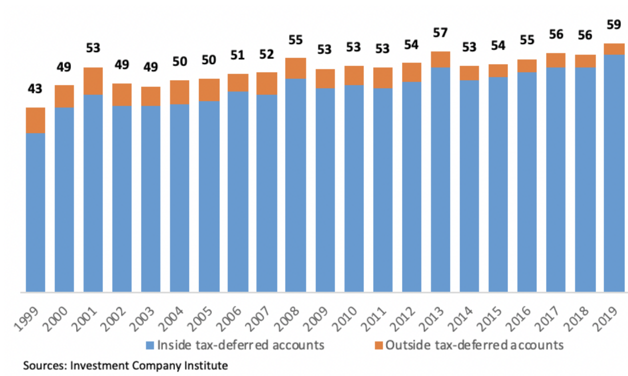

Figure 1: Millions of U.S. households owning mutual funds by account type

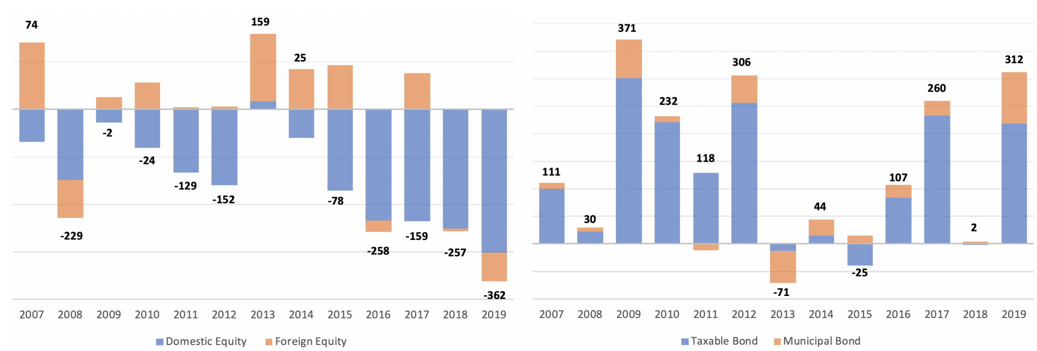

Figure 2: Annual aggregate equity and bond mutual fund net flows (in billions of U.S. dollars) 2007-2019

In this paper, we examine the impact of the Fed's monetary policy actions in a low interest rate environment on investor behavior. We use both equity mutual funds and bond mutual funds data to investigate whether equity investors and bond investors behave differently in terms of their appetite for risk-taking. There are several ways in which the Fed's monetary policy can influence the risk-taking behavior of investors. One of them is through reaching for yield. Brown, Harlow, and Starks

(1996) show that fund managers increase risk-taking to improve their performance rank compared to their peers and attract more investors. Rajan (2006) finds that a low rate policy induces investors to move into risky assets in a bid to boost total returns. Di Maggio and Kacperczyk (2017) study the impact of the ZLB policy on the U.S. money market fund industry. They find that in response to ZLB policy, some money market funds change their product offerings by investing in riskier asset classes. Choi and Kronlund (2017) examine "reaching for yield" in U.S. corporate bond mutual funds. They find that funds generate higher returns and attract more inflows when they reach for yield, especially in periods of low-interest rates.

We begin our analysis through sign-restricted vector autoregressions (VAR). The first part of the analysis is based on time-series data on aggregate U.S. mutual fund flows over the 2007-2019 period. We find that in response to the Fed's expansionary monetary policy, both equity mutual funds and bond mutual funds gain inflows. Specific to asset classes, equity investors respond to an expansionary monetary policy by rebalancing portfolio from large-cap equities to mid-cap and small-cap equities in the beginning, and then to foreign equities. Bond investors direct money toward investment grade and global bond mutual funds. We also find there is a substitution effect between equity mutual funds and equity exchange-traded funds (ETFs); this substitution effect does not exist in bonds. Finally, the lower interest rate also drives investors from short-term money market funds to long-term mutual funds.

These impulse response results imply that the Fed's monetary policy indeed has important impacts on investors' asset allocation decisions, but we still don't know what are the underlying mechanisms behind these fund flows moving directions. Why do we see these fund flow patterns? Therefore, we further complement the VAR analysis with panel regression analysis that uses disaggregated mutual funds data. The key advantage of the disaggregated fund flow panel data is that we can obtain detailed information for each fund, like the riskiness of each fund. We then examine the role of the risk-taking channel of monetary policy transmission on these fund flow dynamics. We find that equity investors have a greater appetite for risk-taking when the Fed decreases the policy rates. In contrast, bond investors become more risk-averse when interest rates are lower.

This paper is related to three strands of the literature. First, we contribute to the broad literature on the link between monetary policy and financial markets. The previous literature mainly examines the impact of monetary policy on asset prices. Thorbecke (1997) finds that monetary policy exerts large effects on ex-ante and ex-post stock returns. Ehrmann and Fratzscher (2004) present evidence that individual stocks react in a highly heterogeneous fashion to U.S. monetary policy shocks and this heterogeneity is related to financial constraints and Tobin's q. Chen (2007) finds that monetary shocks have asymmetric effects on stock returns, that is, monetary policy has much larger effects during bear-market periods than during bull-market periods. Cieslak, Morse, and Vissing-Jorgensen (2019) find that the equity premium realized in the US and worldwide is earned entirely in even weeks starting from the last FOMC meeting. Daniel, Garlappi, and Xiao (2018) find that low interest rates lead to a significantly higher demand for income-generating assets such as high-dividend stocks and high-yield bonds. We extend this literature by studying the connection between monetary policy and investor asset allocation behavior.

Second, this paper also makes a contribution to the literature on the risk-taking channel of monetary policy. Bernanke and Kuttner (2005) find that monetary policy shocks affect the perceived riskiness of stocks. Dell'Ariccia, Laeven, and Suarez (2017) present evidence of a risk-taking channel of monetary policy for banks and show that lower interest rates increases bank risk-taking. Lian, Ma, and Wang (2018) show that low interest rates lead to significantly higher allocations to risky assets among diverse populations by using randomized investment experiments. Our paper empirically documents that there is increasing risk-taking behavior for equity mutual funds in response to the expansionary monetary policy, and we offer new evidence that investors in bond mutual funds are not more risk-taking. In addition, we examine the effect of ZLB policy on investors' risk appetite. Our results show that during the Fed's ZLB policy period, both equity and bond investors become more risk-taking in response to the Fed's further expansionary monetary policy.

Third, this paper also contributes to the literature on mutual fund flows. A large literature focuses on the relation between fund flows and returns (Chevalier and Ellison, 1997; Berk and

Green, 2004; Goldstein, Jiang, and Ng, 2017; Franzoni and Schmalz, 2017). In this paper, we go beyond flow-return relations and study the impact of low interest rate policy on fund flows. We find that the large outflows from equity mutual funds and inflows into bond mutual funds in the past decades can not be explained by their returns. The outflows are more likely driven by two other forces. First, the fast development of ETFs drives money from equity mutual funds to equity ETFs. Second, and more importantly, the long-lasting low interest rate environment makes bonds much more attractive. Bonds not only serve as a safe-haven asset but at the same time help investors achieve relatively higher returns.

Our paper is most closely related to Banegas, Montes-Rojas, and Siga (2016) and Hau and Lai (2016). Banegas et al. (2016) show that monetary policy shocks can help to explain mutual fund flow dynamics and that the effect of these shocks differs by investment strategy. However, they did not explore the underlying mechanism behind these flow dynamics, like why do they see inflows into equity mutual funds and outflows from bond mutual funds in response to a tightening monetary policy shock. In their study, they also only considered the FFR-based monetary policy shocks during the ZLB period. In this paper, we extend the analysis and compare the VAR results identified with EFFR to the Wu-Xia shadow rate and Divisia M4, our results show that the three monetary policy measures produce similar results. Hau and Lai (2016) use Eurozone cross-country variation in the tightness of monetary policy to examine its influence on equity and money market flows. In line with a powerful risk-shifting channel, they find that fund investors in countries with decreased real interest rates shift their portfolio investment out of the money market and into the riskier equity market. We add to this literature by considering U.S. mutual fund flows data and by examining the responses of detailed asset classes for both equity mutual funds and bond mutual funds, such as large-cap, small-cap, emerging market equity funds, investment grade, high-yield bond funds.

In addition, we offer empirical evidence that the Fed's ZLB policy leads to higher asset allocations to equity, in contrast, bonds become less attractive during the ZLB period than the normal interest rate period. The ZLB policy also has a significant impact on investors' risk appetite, we find that the ZLB policy makes both equity and bond investors become more risk-taking.

The remainder of this paper is organized as follows. Section 2 presents the data and institutional background of mutual funds. Section 3 analyzes the fund flow dynamics through sign-restricted VARs by using aggregated fund flows data. Section 4 studies the role of the risk-taking channel of monetary policy transmission and the zero lower bound policy on both equity and bond investors' asset allocation decisions. Section 5 concludes the paper.

2 Data and institutional background

2.1 Data

This paper uses both aggregate and disaggregate mutual fund flows data. The aggregate mutual fund flows data is collected from the Investment Company Institute (ICI), and the fund flow is monthly time series data expressed in billions of U.S. dollars from January 2007 to December 2019. We also use a shorter sample dataset of various asset classes of mutual fund flows from January 2016 to December 2019, which includes big-cap, mid-cap, small-cap, developed market and emerging market equity mutual funds, investment grade, high yield, government, global bond mutual funds, money market funds, and ETFs.

The disaggregate mutual fund flows data is collected from the CRSP Survivorship-Bias-Free Mutual Fund Database. This is panel data that contains fund returns, total net assets (TNA), management fees, turnover ratios, and other fund characteristics. We include both equity mutual funds and corporate bond mutual funds, and both samples are quarterly data from January 1999 to December 2019. It also involves some sample selection criteria in order to eliminate null values or outliers. In particular, we exclude equity funds with a percentage of funds invested in common stocks less than 90% and bond funds with a percentage of funds invested in corporate bonds less than 90%. There is a total of 84 quarters in this final sample, with 619 equity mutual funds and 261 bond mutual funds. Following the prior literature on fund flows, the fund flow is calculated using the following Equation 1:

$$Fundflows_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1} \times (1 + R_{i,t})}{TNA_{i,t-1}} \tag{1}$$

where $TNA_{i,t}$ is fund i's total net asset in millions of U.S. dollars at time t, $R_{i,t}$ is the quarterly fund return.

2.2 Mutual funds demand

Mutual fund investment is very popular among U.S. investors, especially because it allows investors to own stocks or bonds of hundreds of companies at once and spread out the risk. Households have a variety of financial goals for their mutual fund investments, with one of the main goals being using mutual funds to save for retirement. [3]

Based on data from the Investment Company Institute, the total combined assets of US mutual funds and ETFs are $25.7 trillion at the end of 2019. In Figure 3 we see that equity funds account for 58 percent of the total assets, with domestic equity funds constituting 43 percent and foreign equity funds constituting 15 percent. Bond funds hold 21 percent. Money market funds account for 14 percent. Hybrid funds and other funds, such as those that invest primarily in commodities, held the remaining 7 percent.

The overall demand for mutual funds can be measured by fund flows with net outflows indicating lower demand from investors. Similarly, net inflows imply more demand for a specific asset class. Net outflows occur when the amount of shares redeemed exceeds the number of new purchases of shares by investors. Therefore, investors can learn where capital is being invested in terms of asset class or geography based on the fund flow information. Fund flows into fixed income securities may suggest a lack of confidence in equities and a flight to safety in most cases.

[3]The other main reason is to reduce their taxable income. In Figure 1 we see that the majority of households own mutual funds through tax-deferred accounts, such as 401(k) and other defined contribution (DC) plans, individual retirement accounts (IRAs), and variable annuities. With a tax-deferred account, income tax is not paid the year the funds are earned. Instead, tax paid on withdrawals in the future. This is a big advantage because it provides a way to save and grow investments tax-free.

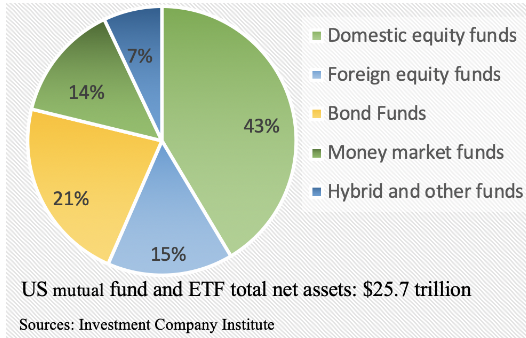

Figure 3: Percentage of total net assets at year end 2019

One of the potential reasons that we see large outflows from equity mutual funds may be related to the increasing popularity of ETFs. Figure 4 shows the aggregated mutual fund flows and ETFs fund flows from January 2016 to December 2019. There were inflows into ETFs in every asset class. The flow direction is the same between bond ETFs and bond mutual funds, with large inflows into both. However, the direction of flows goes in opposite directions for equity ETFs and equity mutual funds. During this period, there were 625.2 billion domestic equity ETF inflows, and the outflows from the domestic equity mutual funds were 1024 billion. The increasing demand for ETFs indeed can partially explain the sharp drop in equity mutual funds demand. However, this still does not fully account for all the outflows from equity mutual funds, the outflows from equity mutual funds are much larger than the inflows into ETFs. Other potential reasons for explaining these patterns may be related to the Fed's tightening monetary policy from late 2015 to late 2018. During this period, the Fed increased the federal funds rate nine times.

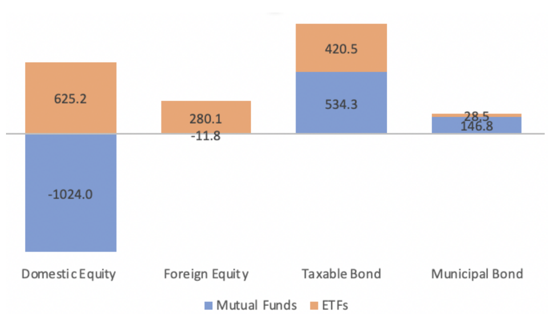

Figure 4: Mutual fund vs ETFs fund flows (in billions of U.S. dollars) by asset class 2016-2019

2.3 Fund flows and returns

In general, mutual fund flows are not very responsive to fund performance since the majority of mutual funds is held inside retirement accounts, and these investors are much less likely to adjust their retirement portfolio based on the market volatility. Indeed, in Figure 5 we see that for both equity funds and bond funds, the response of flows to their returns is symmetric about zero. It suggests that regardless of whether returns are negative or positive, there is always a similar amount of inflows and outflows from the funds.

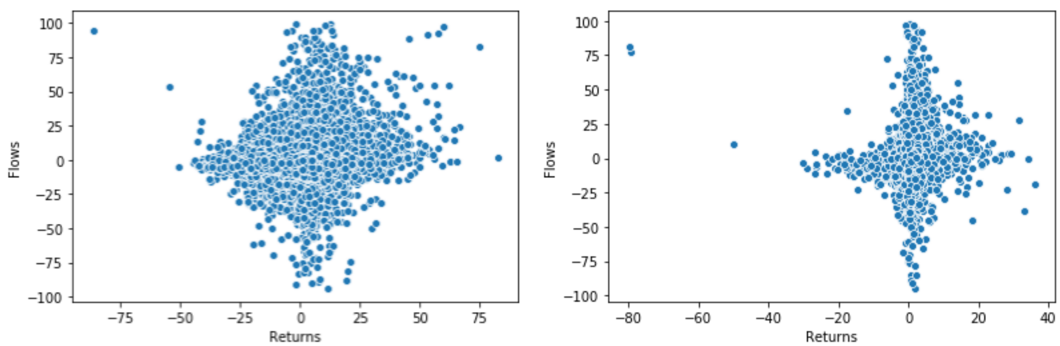

Figure 5: Mutual funds flow-return relationship

Figure 6 shows the aggregate fund flows, equity, and bond performance from 2007 to 2019, and their relation to different interest rate environment. Before the ZLB, that is, from January 2007 to December 2008, the federal funds rate dropped from 5.25 percent to 0.16 percent, and there were 156.1 billion equity outflows. In contrast, the inflows into bond funds were 156.7 billion dollars. During this period we see the S&P 500 had -41.8% returns, and the Barclay aggregate bond index had 11.6% returns, suggesting that the outflows in equity funds and inflows in bond funds during this period were likely driven by the overwhelming under-performance in stocks and out-performance in bonds.

However, the difference in equity and bond fund flows can not always be explained by their difference in returns. During the ZLB period, that is, from January 2009 to December 2015, the federal funds rate stayed between zero and 25 basis points. There were huge inflows into bond funds, that is, about 974.9 billion dollars, and the outflows from equity funds were 201 billion dollars. During the same period, the S&P 500 had 126.3% returns, and the Barclay aggregate bond index had 32.5% returns. The stock market had much better performance than bonds, but we still see outflows from equity funds and very significant inflows to bond funds. Therefore, the difference in fund flows is not only related to returns. Similarly, after the ZLB, that is, from January 2016 to December 2019, the outflows from equity funds are even larger, totaling 1035.8 billion, and the bond funds kept gaining inflows. The S&P 500 had 58% returns, and bonds' return was only 9.1%, but we still see large outflows from equity to bond funds.

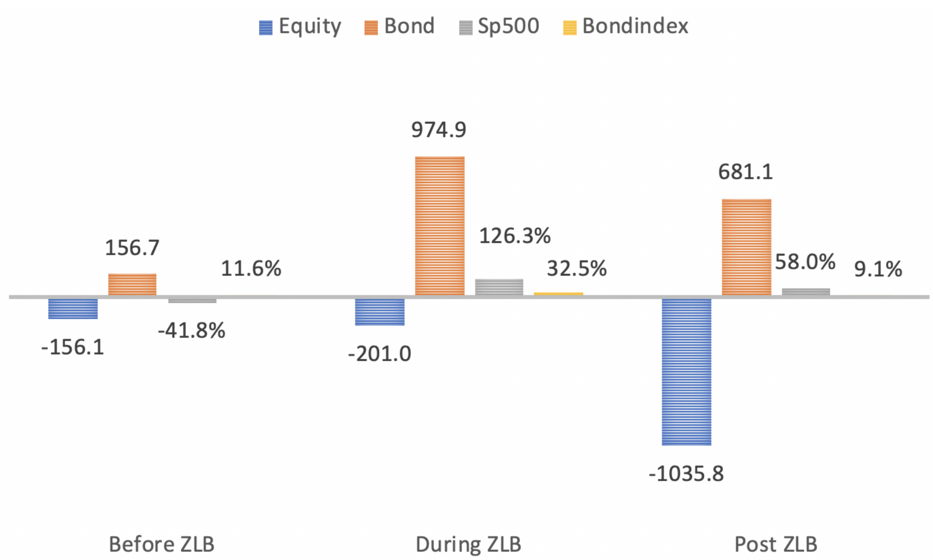

Figure 6: Net fund flows (in billions of U.S. dollars), S&P 500 and Barclay aggregate bond returns in different interest environments 2007-2019

3 Evidence from aggregated fund flows

3.1 Monetary Policy Measures

In this paper, the data sample covers the period from 2007 to 2019, which includes the whole ZLB period. When the FFR was bounded below zero, the FFR can not fully capture the extent of monetary policy easing. To circumvent this problem, a number of researchers construct shadow rates to measure the stance of monetary policy during the ZLB period (Wu and Xia, 2016; Krippner, 2015; Lombardi and Zhu, 2018). Unlike the effective federal funds rate, the shadow rate is not bounded below by zero. Francis, Jackson, and Owyang (2020) show that the shadow rates act as a good proxy for monetary policy throughout the ZLB environment. An alternative approach uses changes in a monetary aggregate as a monetary policy measure. Keating, Kelly, Smith, and Valcarcel (2019) propose using Divisia M4 (DM4) as the policy indicator variable. Their results show DM4 is also suitable for measuring the effects of monetary policy during the ZLB environment. The constructed shadow rate series and the DM4 indicator provide empirical researchers a tool to study monetary policy in vector autoregressive (VAR) models without needing to account for structural breaks during the ZLB period.

Figure 7 plots the time series data of the effective federal funds rate, the Wu-Xia shadow rate, and the Divisia M4. From December 16, 2008, to December 15, 2015 period, the EFFR was between 0 to 0.25 percent, and the shadow rate was negative during the period of expansionary monetary policy. On December 16, 2015, the Fed raised the target range for the federal funds rate to 0.25 to 0.50 percent. Whenever the federal funds rate is at least 0.25 percent, the shadow rate is identical to EFFR. The direction of the year over the year growth rate of Divisia M4 is opposite to the EFFR, corresponding to an increase of the money supply along with a decrease in EFFR. In Figure 8 we can see the Wu-Xia shadow rate and the spread between 10-year Treasury bonds and 3-month treasury bills show movements in the opposite direction. When the Fed implements monetary policy easing, either through reducing the federal funds rate or increases in the balance sheets, the 10-year, and 3-month spread increases. This indicates the spread between the 10 year and the 3-month rates (T10Y3MM) is another monetary policy indicator besides the FFR. Hence, this variable T10Y3MM will also be included in our empirical VAR models.

3.2 Evidence from sign-restricted VARs

Following the work of Uhlig (2005), there has been more and more research that applies structural VARs identified with sign restrictions. The methodology is popular among empirical researchers because sign restrictions partially identify the model without imposing additional restrictions, and

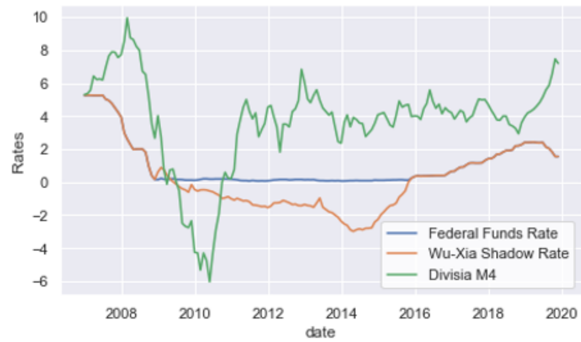

Figure 7: Time series of EFFR, Wu-Xia shadow rate and Divisia M4

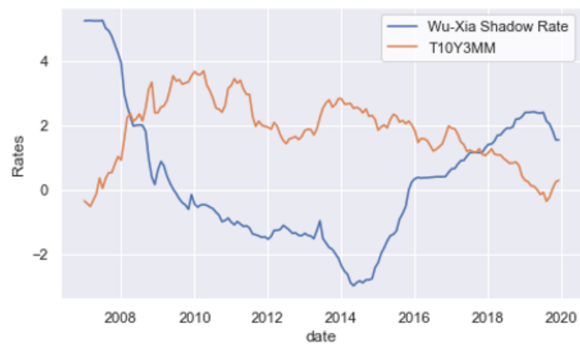

Figure 8: Time series of Wu-Xia shadow rate and T10Y3MM

they also lead to conclusions that are typically robust. While the traditional structural VARs fully identify the model and the shocks, the results are limited to only a single model (Uhlig, 2005; Inoue and Kilian, 2013). Uhlig (2005) proposes two approaches to implement sign-restricted identification, the pure-sign-restriction approach and the penalty-function approach. Mountford and Uhlig (2009) later extended the penalty-function approach to the identification of multiple shocks. Soon after that, Rubio-Ramirez, Waggoner, and Zha (2010) developed a new algorithm to implement sign restrictions identification. Their algorithm is a generalization of Uhlig's pure-sign-restriction approach and the main difference lies in the approach when dealing with several shocks.

The structural VAR (SVAR) can be written in form:

$$A(L)y_t = \varepsilon_t \tag{2}$$

where y_t is a series of endogenous variables. $A(L)$ is a matrix of polynomial with lag operator L, and ε_t is a vector of orthogonalized disturbances. We discuss the variables included in the vector y_t for each specification in the subsequent subsections.

We then apply the Uhlig's pure-sign-restriction approach to our structural VAR model. [4] This model assumes a normal prior for the VAR coefficients and an inverse Wishart prior for the covariance matrix. The prior for the VAR parameters can be specified as follows:

$$p(b) \sim N(\hat{b}_0, H) \tag{3}$$

$$p(\Sigma) \sim IW(\bar{S}, \alpha) \tag{4}$$

where $\hat{b}_0$ is a $(N \times (N \times L)) \times 1$ vector which denotes the OLS estimates of the VAR coefficients with N variables and lag L, H is a $[N \times (N \times L)] \times [N \times (N \times L)]$ matrix where the diagonal elements denote the variance of each corresponding coefficient, $\bar{S}$ is a scalar matrix, α is the prior degrees of freedom. In a sign-restricted VAR model, first we need to decide the signs of the responses, and then specify for how long these restrictions apply after the impact of the shock.

3.2.1 Base results

Before we get into the main question that we are interested in, that is, how do equity mutual fund flows and corporate bond mutual fund flows respond to the Fed's monetary policy? We first explore the connection between equity, bond performance and monetary policy, since both the equity mutual fund flows and the bond mutual fund flows are correlated with their benchmark performance. The S&P 500 returns and Bloomberg Barclays US Aggregate Bond Index returns are widely used benchmarks for equity and bond performance. In our first VAR benchmark model, we include four variables, EFFR, industrial production, S&P 500 returns, and bond index returns, with all four variables expressed in percentage changes. Table 1 shows the expansionary monetary policy shock is identified by imposing the restrictions that the impulse response of effective federal

[4] Arias, Rubio-Ramírez, and Waggoner (2018) show the dangers of using Uhlig's penalty function approach when dealing with sign and zero restrictions. Therefore, we use the pure-sign-restriction approach instead of the penalty function approach.

funds rate is negative for at least the first three months following the shock. At the same time, the impulse response of industrial production is positive for at least the first three months following the shock. In our VAR model, we select three lags based on the Akaike information criterion (AIC) criterion.

Table 1: Identification of the expansionary monetary policy shock

Variable	EFFR	Industrial Production
Sign Restrictions (3 months)	≤ 0	≥ 0

Figure 9 shows the impulse response of both S&P 500 returns and bond index returns to the expansionary monetary policy shock. Following the conventional approach in the SVAR literature on monetary policy, our impulse response plots show the median as well as the 16% and the 84% quantiles, the X-axis shows the time horizon, that is, the response time in months. Overall, in response to an expansionary monetary policy, stock returns jump much higher and stay strongly positive for 4 months. The response of bond returns is ambiguous, it increases in the first two months but then decreases and becomes negative.

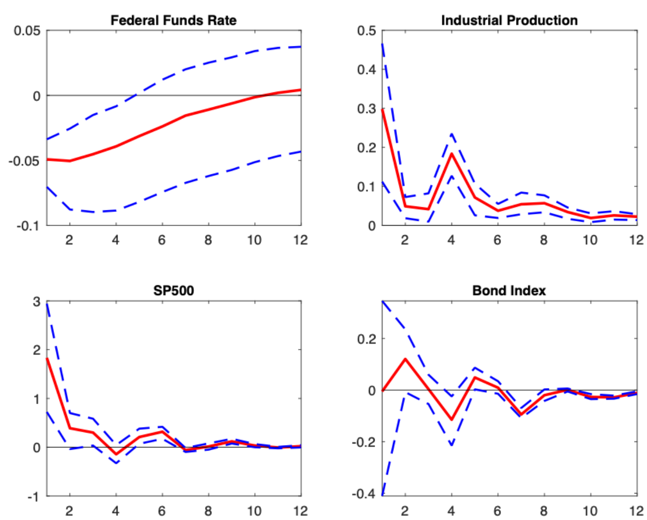

Figure 9: Impulse response of stock and bond markets to a monetary shock

We then add both S&P 500 returns and Barclays bond index returns into our next benchmark VAR model, this model investigates how do mutual fund investors react to a monetary policy shock? Therefore, our second benchmark VAR model consists of six variables: EFFR, the spread between 10-Year Treasury Constant Maturity, and 3-Month Treasury Constant Maturity (T10Y3MM), S&P 500 returns, Barclays bond index returns, equity fund flows and bond fund flows. The AIC order selection criterion also suggests 3 lags in the VAR model.

Table 2 shows the sign-restricted identification schemes of the expansionary monetary policy shock. When the monetary policy is measured by the effective federal funds rate, it assumes that the expansionary monetary policy is identified by three months of decrease in EFFR, at the same time, a three months of increase of T10Y3MM and S&P 500 returns. The sign restriction for EFFR is rather conventional for expansionary monetary policy, the sign restriction of variable T10Y3MM and SP500 is that an easing monetary policy leads to optimism in the financial markets, as imposed for example, in (Hesse, Hofmann, and Weber, 2018). Investors expect the economy to perform well in the future, hence, demand higher yields in the long-term treasury bond compared to the short-term treasury bills.

Table 2: Identification of expansionary monetary policy shock with different monetary policy measures

Variable	Monetary Policy			T10Y3MM	SP500
	EFFR	Shadow Rate	DM4		
Sign Restrictions (3 months)	≤ 0	≤ 0	≥ 0	≥ 0	≥ 0

Figure 10 presents the impulse response results of an expansionary monetary policy shock identified using the EFFR. It shows that an expansionary monetary policy shock leads to an increase in both equity fund flows and bond fund flows, and the responses of both equity funds and bond funds remain positive in the first 12 months. The responses are especially large in the beginning, a one standard deviation easing monetary policy shock leads to contemporaneously 6 billion U.S. dollars equity fund inflows and 8 billion U.S. dollars bond fund inflows.

Figure 11 shows the impulse response to a monetary policy easing shock identified using the Wu-Xia shadow rate and changes in the Divisia M4. As shown in Table 2, the sign-restricted identification when using the Wu-Xia shadow rate is the same as EFFR: three months of decrease in

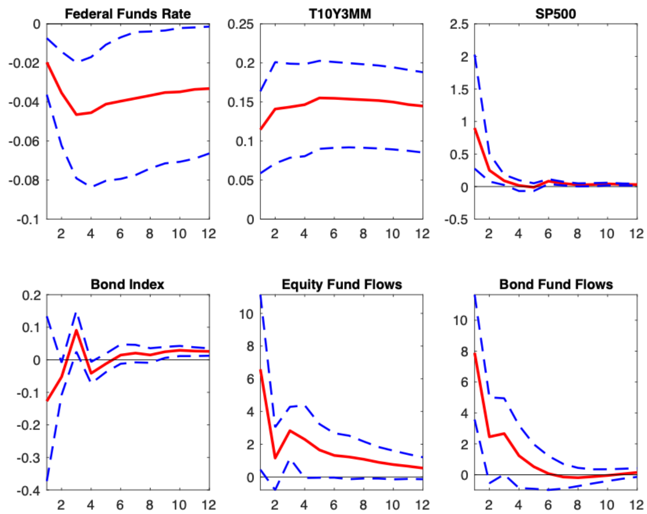

Figure 10: Impulse responses to a monetary policy shock identified with EFFR

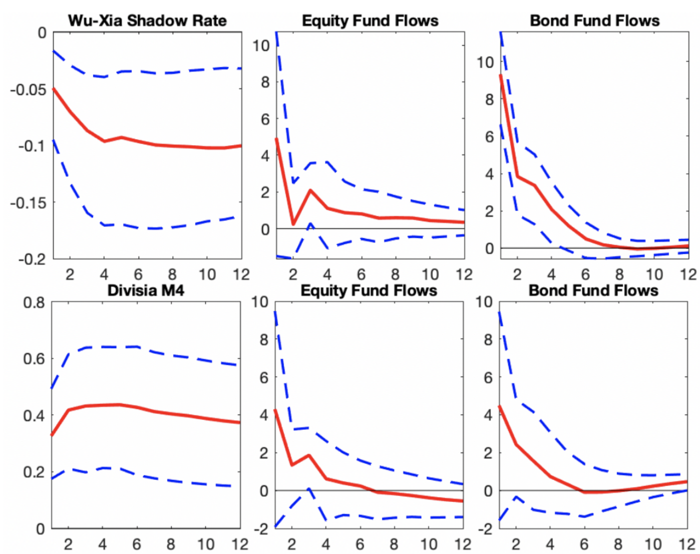

Figure 11: Impulse responses to a monetary policy shock identified with Wu-Xia shadow rate (top) and Divisia M4 (bottom)

the Wu-Xia shadow rate accompanied by a contemporaneous three-month increase of T10Y3MM and S&P 500 returns. Because the Divisia M4 is a money supply measure, the identification of Divisia M4 is modified to reflect this. The monetary policy shock in the Divisia M4 is identified assuming three months of increase in Divisia M4, and at the same time, three months of increase of T10Y3MM and SP500 returns, corresponding to a monetary policy easing. Both the Wu-Xia shadow rate and Divisia M4 results show an expansionary monetary policy shock leads to inflows in equity funds and bond funds, which are similar to the results identified with EFFR. The similar results among the three different monetary policy measures are not surprising, since we use a sign-restricted identification scheme based on three variables, and the limitation of EFFR in the ZLB period is overcame through the including variable T10Y3MM and S&P 500. This also tells us that the federal funds rate can still be used in an empirical VAR model even if the sample includes the ZLB period.

3.2.2 Results for asset classes

In order to gain more insights into the effect of monetary policy on investors' asset allocation decisions, next, we will study how different asset classes respond to an easing monetary policy shock. Investors' demand varies across specific categories of equity and bond funds, and asset allocation has a significant effect on a portfolio's performance. Different asset classes tend to act in different ways because they have very different attributes, such as risk, liquidity, volatility, etc. For example, although on average equity has higher returns than bonds, bonds are still among the most popular portfolio choices for investors. Bonds provide necessary diversification, in contrast, stock-only portfolios are abnormally volatile. Bonds may end up reducing returns, but investors are more than compensated by the reduction in risk.

The identification schemes of monetary policy shock in this section are also based on Table 2. Specifically, we choose EFFR as the monetary policy measure, since our data for asset classes is from January 2016 to December 2019, the Wu-Xia shadow rate is the same as the EFFR. Figure 12 shows the impulse response of various equity classes to the expansionary monetary policy shock with the bond fund flows as a control variable. It shows the median as well as the 16% and the 84% quantiles for the sample of impulse responses.

A one standard deviation expansionary monetary policy shock has an immediate negative impact on the large-cap fund flows and the impact lasts six months. By contrast, the response of mid-cap and small-cap funds is positive in the first three months. The outflows from large-cap

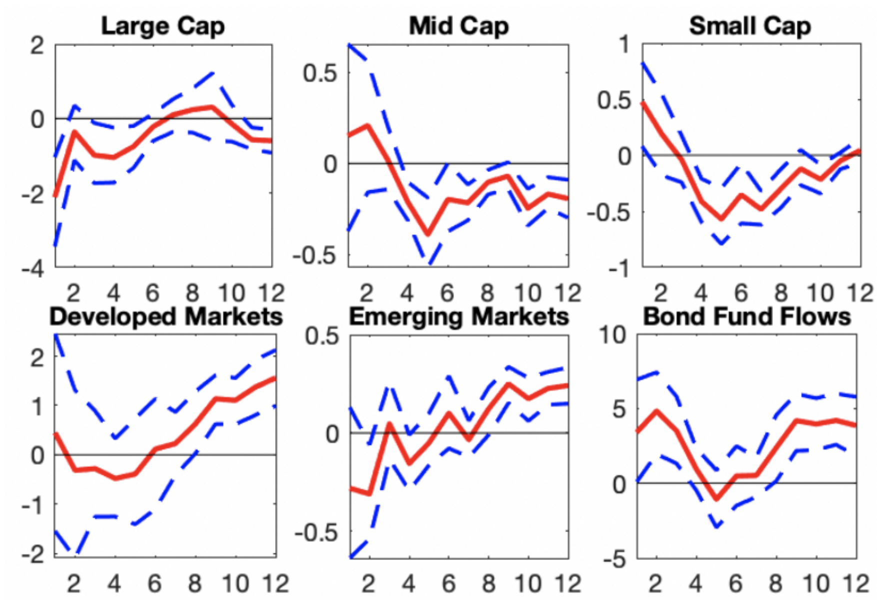

Figure 12: Impulse response of various equity asset classes

and inflows into mid-cap and small-cap suggest investors' risk-shifting behavior. In response to an easing monetary policy shock, investors allocate portfolios from safe large-cap assets to more risky mid-cap and small-cap assets. The responses of developed markets and emerging market funds are increasing steadily over the 12-month horizon from negative to positive. This may indicate that the foreign equity funds adjust slowly to a monetary policy shock, as indicated by the fact that it took six months to see inflows to more risky foreign equity assets, like developed markets, and emerging markets funds. At the same time, we see that there are outflows from domestic equity assets, as indicated by the outflows from mid-cap and small-cap after four months.

Figure 13 shows the impulse response of various bond classes to an expansionary monetary policy shock with the equity fund flows as a control variable. The expansionary monetary policy shock leads to large inflows to the investment-grade bond funds, the effect stays positive during the entire first 12 months. A one standard deviation expansionary monetary policy shock results in over two billion dollar inflows into investment-grade bond funds. The high yield funds are not very responsive to the monetary policy shock. The different responses between investment-grade and high-yield investors are likely driven by the fact that investment-grade bonds are primarily exposed to interest rate risk, and high-yield bonds face little interest rate risk but are much more exposed to default and credit spread risk. There are inflows into the government funds initially but the responses become negative after three months. There are also inflows into the global bond funds and the flow stays positive for 12 months. The response of municipal bonds is positive in the first five months and turns negative after that.

The explanation for these large inflows to investment-grade bonds and global bonds is that in a long-lasting low-interest environment where the financial outlook remains pessimistic investors become more risk-averse, and are much less willing to accept high risk. Hence, they buy more highly safe investment-grade bonds, and they also try to diversify their portfolios by purchasing global bonds.

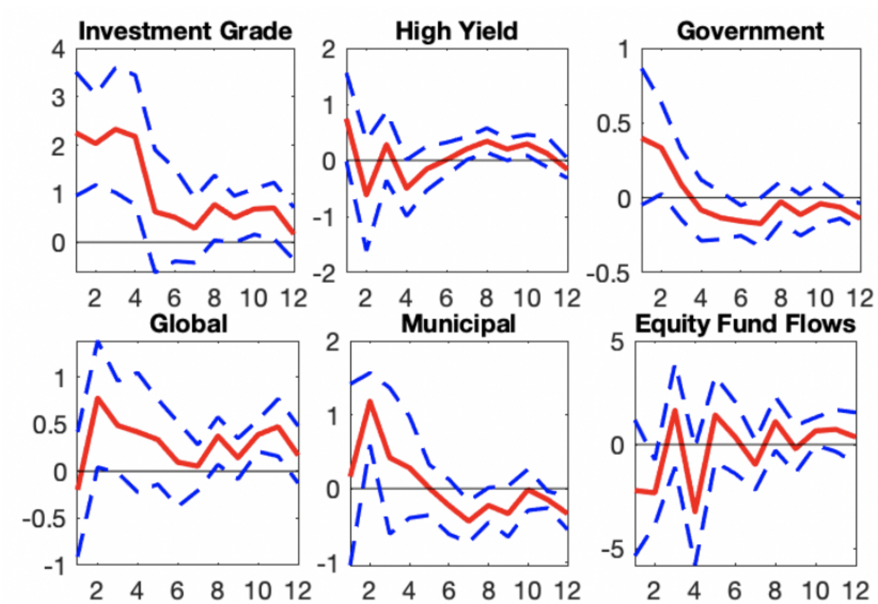

Figure 13: Impulse response of various bond asset classes

Figure 14 shows the comparison of impulse response between long-term mutual funds and money market funds. A money market fund is a type of mutual fund that invests in high-quality, short-term debt instruments, cash, and cash equivalents. As the figure shows, in response to an expansionary monetary policy shock, mutual funds receive large inflows, one standard deviation expansionary monetary policy shock translates to 8 billion mutual fund inflows, and the positive effect remains statistically significant for the 12 months. By contrast, money market funds have large outflows when the Fed lowers the federal funds rate.

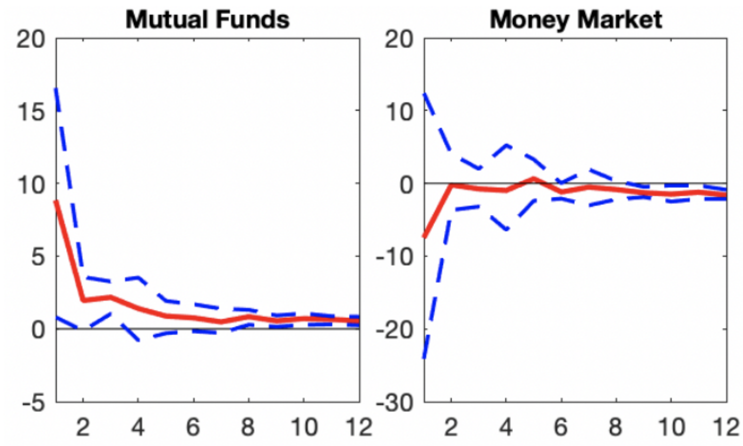

Figure 14: Impulse response of mutual funds and money market funds

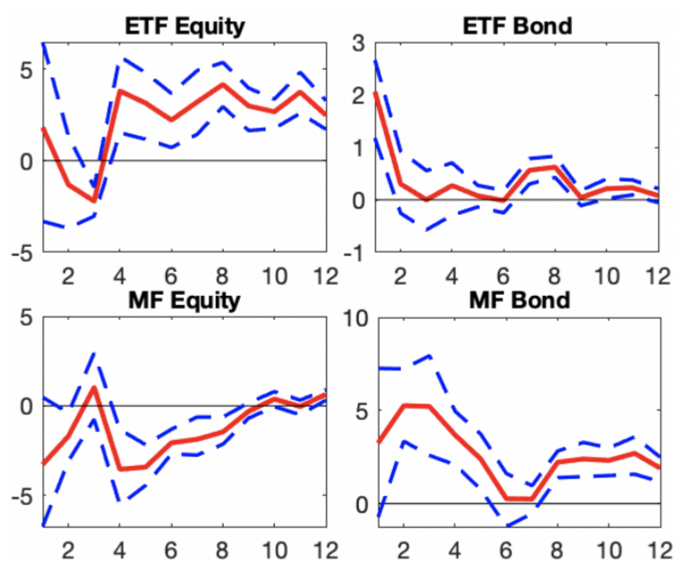

Figure 15: Impulse response of mutual funds and ETFs

In the past several years, ETFs have been growing extremely fast. ETFs are usually cheaper to own than mutual funds and more liquid, meaning they can be bought and sold on the open market. All this makes the ETFs an attractive alternative to mutual funds. Figure 15 presents the impulse response of both mutual funds and ETFs to an easing monetary policy shock. Specifically, we compare the impulse response between equity ETFs and equity mutual funds, bond ETFs and bond mutual funds. In response to an easing monetary policy shock, equity ETF funds receive inflows initially, followed by a short period of outflows, but soon receive a large number of inflows. The responses stay at a positive level for the rest of the year. By contrast, mutual funds respond negatively in the beginning. The response jumps to positive for a very short period of time, but then changes to negative again, and stays at the net outflow level. The opposite response between equity ETF funds and equity mutual funds indicates there is a substitution effect between the two asset classes. This finding is also documented in Agapova (2011), where they used seemingly unrelated regressions (SUR) regressions to estimate the substitution effect, and the results show that mutual funds and ETFs are substitutes, but not perfect substitutes for one another. As for the bond funds, there is no substitution effect between ETFs and mutual funds. Monetary policy easing has a positive effect on both ETF bond funds and mutual fund bond funds, both funds receive large inflows.

4 Evidence from disaggregated fund flows

From the previous aggregated fund flow results, we find that in response to an expansionary monetary policy shock, both the equity funds and bond funds receive large inflows. In addition, specific to the flow dynamic of asset classes, equity investors move money from large-cap to mid-cap and small-cap equities in the beginning, and then from domestic equities to foreign equities. Bond investors move money into investment-grade bonds and global bonds. These results imply that the Fed's monetary policy indeed has important impacts on investors' asset allocation decisions, but we don't know what are the underlying mechanisms behind these fund flows moving directions. A key question is why do we see these fund flow patterns?

In this section, we will first explore the flow dynamics for both equity funds and bond funds based on the fund flow panel data. Will we see inflows into both equity and bond funds when the Fed decreases the interest rate? which was the pattern indicated by the aggregate data. With this disaggregated fund flow panel data, we can obtain detailed information for each individual fund and can control for various idiosyncratic factors. We will then be able to examine the role of the risk-taking channel of monetary policy transmission on these fund flow dynamics based on panel regressions. Specifically, we will answer the following questions: in response to the Fed's expansionary monetary policy, will the equity investors and bond investors both become more risk-taking or not?

4.1 Summary statistics

The disaggregated fund flow sample consists of 619 equity funds and 261 bond funds, it is quarterly data from January 1999 to December 2019. As shown in Table 3, panel A presents descriptive statistics on equity fund characteristics and panel B presents descriptive statistics on bond fund characteristics. $mgmtfee$ represents the fund management fee, $turnover$ represents the fund turnover ratio, TNA represents the total net asset value of the fund, $size$ is derived from $log(TNA)$, $yield$ represents the dividend yields, $volatility$ is the standard deviation of the fund return for the past three years, $instfund$ identifies if a fund is an institutional fund or retail fund, $qret$ represents the quarterly return of the fund, $flows$ represents net inflows into the fund, which is calculated based on Equation 1. TNA is in millions of U.S. dollars, $instfund$ is a dummy variable, all other variables are in percentages.

Table 3: Summary statistics of the mutual fund sample

	mgmt fee	turnover	TNA	size	yield	volatility	inst fund	qret	flows
Panel A: Equity Funds									
count	51,996	51,996	51,996	51,996	51,996	51,996	51,996	51,996	51,996
mean	0.678	59.642	3105.088	2.803	0.816	4.950	0.138	2.225	-1.043
std	0.264	53.695	9993.274	0.765	1.093	2.160	0.345	9.730	8.840
min	-4.595	0.000	0.200	0.114	0.000	0.787	0.000	-86.449	-93.782
median	0.681	45.000	620.800	2.793	0.515	4.543	0.000	3.026	-1.914
max	2.530	922.000	307394.600	5.488	28.550	88.663	1.000	82.758	99.138
Panel B: Bond Funds									
count	21,924	21,924	21,924	21,924	21,924	21,924	21,924	21,924	21,924
mean	0.433	145.589	1565.293	2.686	1.763	1.226	0.238	1.113	-0.326
std	0.191	204.173	3370.380	0.670	2.101	1.043	0.426	2.934	9.926
min	-2.139	0.000	5.000	0.699	0.001	0.000	0.000	-79.876	-94.826
median	0.450	77.000	463.800	2.666	0.753	0.976	0.000	0.905	-1.497
max	1.650	3454.000	64742.600	4.811	15.467	13.894	1.000	36.151	97.629

Figure 16 shows the cross-sectional means of fund returns and flows with error bands showing a 95% confidence interval. The equity returns are much more volatile than the bond returns, and over the past 20 years, there are more inflows into bond funds than equity funds.

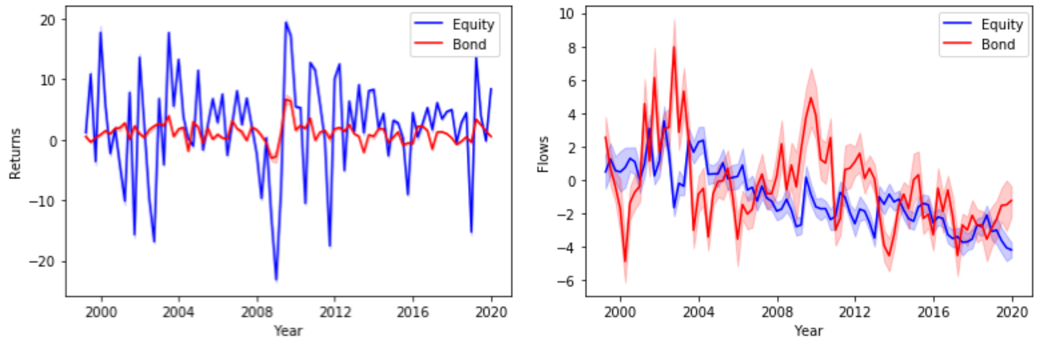

Figure 16: Fund returns (left) and flows (right) with 95% confidence interval 1999-2019

4.2 Fund flows and changes in FFR

In this section, we will study the relationship between FFR changes and fund flows, and we will compare the results among three different policy rates: the effective federal funds rate, the Wu-Xia shadow rate. As a robustness check, we also include the results for the real federal funds rate. Figure 17 presents the time series plots of the effective federal funds rate, the real federal funds rate, and the Wu-Xia shadow rate. The real federal funds rate is the effective federal funds rate minus 12-month core PCE inflation. The shadow rate is negative during the ZLB period. Similarly, because our sample covers a period when inflation was stable, the real FFR and the EFFR are mostly parallel.

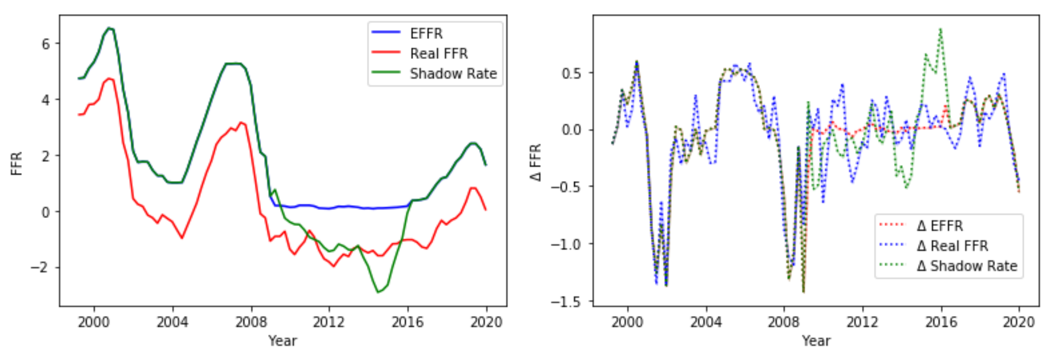

Figure 17: EFFR, real FFR and Wu-Xia shadow rate and their quarterly changes

We estimate the relationships between FFR changes and fund flows with the following panel regression:

$$Fundflows_{it} = \alpha + \beta.\triangle FFR_t + \gamma.Z_{it} + \mu_i + \varepsilon_{it} \tag{5}$$

where $Z_{i,t}$ represents control variables, include dividend yields, fund returns, and fund size (log(TNA)), etc. $\triangle FFR_t$ is the quarterly changes of the federal fund rate at time t, it's measured by EFFR, real FFR, and the Wu-Xia shadow rate. μ_i is a fixed individual effect.

We are particularly interested in the coefficient of $\triangle FFR_t$. The coefficient β captures the impact of monetary policy on fund flows. According to previous VAR results of aggregated fund flows, we expect β to be negative, which means when the Fed decreases the FFR, there are inflows into both equity funds and bond funds. Table 4 presents the estimation results of Equation 5. To address issues of residual serial dependence for a fund over time, we cluster the standard errors by the fund. In all regressions, we include fund-fixed effects. Column 1-3 present the equity results, column 4-6 present bond results.

Consider first the results for equity funds, in column (1), we find that when we use EFFR as the monetary policy measure, the estimated coefficient β is negative and statistically significant at the 1% level. The coefficient on $\triangle FFR_t$ is -0.539, indicating that a one percentage point decrease in the EFFR corresponds to a 0.539% increase in equity inflows. Similarly, when we use the real rate (column 2) and the shadow rate (column 3) as the monetary policy measures, the estimated coefficients are also negative, all suggesting that equity fund flows respond positively to the Fed's expansionary monetary policy.

Table 4: Fund flows and federal funds rate changes

	Equity			Bond		
	(1) EFFR	(2) Real	(3) Shadow	(4) EFFR	(5) Real	(6) Shadow
const	-7.367***	-7.313***	-7.337***	-6.635***	-6.606***	-6.407***
	[0.944]	[0.941]	[0.950]	[0.989]	[0.987]	[0.987]
mgmt fee	2.480***	2.458***	2.511***	-0.330	-0.257	-0.306
	[0.809]	[0.806]	[0.814]	[1.216]	[1.217]	[1.215]
turnover	0.005**	0.005**	0.005**	0.002	0.002	0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
size	1.199***	1.191***	1.185***	1.850***	1.835***	1.797***
	[0.279]	[0.278]	[0.279]	[0.361]	[0.360]	[0.360]
yield	-0.231**	-0.227**	-0.226**	0.098*	0.088	0.108*
	[0.092]	[0.092]	[0.092]	[0.057]	[0.057]	[0.057]
inst fund	1.194**	1.198**	1.190**	-0.471	-0.479	-0.449
	[0.578]	[0.577]	[0.578]	[1.005]	[1.006]	[1.010]
qret	0.099***	0.100***	0.096***	0.386***	0.384***	0.357***
	[0.008]	[0.008]	[0.008]	[0.074]	[0.074]	[0.073]
volatility	0.159***	0.154***	0.157***	0.530***	0.526***	0.465***
	[0.050]	[0.049]	[0.051]	[0.153]	[0.155]	[0.157]
$\triangle FFR$	-0.539***	-0.646***	-0.312**	-2.353***	-2.183***	-1.946***
	[0.143]	[0.131]	[0.124]	[0.285]	[0.237]	[0.229]
Fund FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,996	51,996	51,996	21,924	21,924	21,924
R-squared	0.018	0.019	0.018	0.029	0.027	0.027

Standard errors (in parentheses) are clustered at the fund level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

For the bond funds, as shown in column (4), the estimated coefficient is -2.353, and it is statistically significant at the 1% level. This indicates that a decrease of 1 percentage point in the EFFR corresponds to a 2.353% increase of bond fund inflows. This value is much larger than the corresponding results for equity, which suggests bond investors are much more responsive to the FFR changes than equity investors. Similar conclusions are also documented with the real rate (column 5) and shadow rate (column 6).

Overall, consistent with the findings from aggregated fund flows data, we find that in response to the Fed's expansionary monetary policy, both equity funds and bond funds receive large inflows.

4.3 The role of risk-taking

In order to understand the underlying mechanism of these flow dynamics, we will examine the effect of risk-taking on fund flows. In this paper, funds' relative riskiness was measured in terms of their exposure to market factor $\beta_{i,t}$, which is estimated by Carhart four-factor model (Carhart, 1997):

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_{i,t}.(R_{m,t} - R_{f,t}) + s_{i,t}.SMB_t + h_{i,t}.HML_t + m_{i,t}.MOM_t + \varepsilon_{i,t} \tag{6}$$

here, $R_{i,t}$ is the portfolio's expected rate of return, $R_{f,t}$ is the risk-free return rate, and $R_{m,t}$ is the market return. SMB_t (Small Minus Big) , HML_t (High Minus Low), MOM_t (Winners Minus Losers).

Table 5: Estimated betas from rolling regression

	count	mean	std	min	10%	25%	50%	75%	90%	max
Equity	51,996	0.978	0.223	-1.344	0.750	0.885	0.988	1.077	1.195	5.573
Bond	21,924	0.081	0.175	-0.849	-0.070	-0.018	0.028	0.147	0.319	1.638

$\beta_{i,t}$ is then updated monthly based on a 36 months rolling window. Table 5 presents the summary statistics of estimated β. The mean value of equity β is 0.978 and the bond's mean β is 0.081. But within equity and bond asset classes, the range of β is high, the maximum value of equity funds is 5.573, and the minimum is -1.344. The maximum value of bond funds is 1.638, and the minimum is -0.849.

Figure 18 plots the time series of estimated equity β and bond β from the rolling regressions. Bond β is much smaller than equity β, it indicates bond has much lower risk than equity overall. The β is much larger during the 2008 financial crisis, indicating a higher systemic risk for both equity and bonds during that time.

After obtaining the risk measure for each individual fund, we then estimate the following fixed

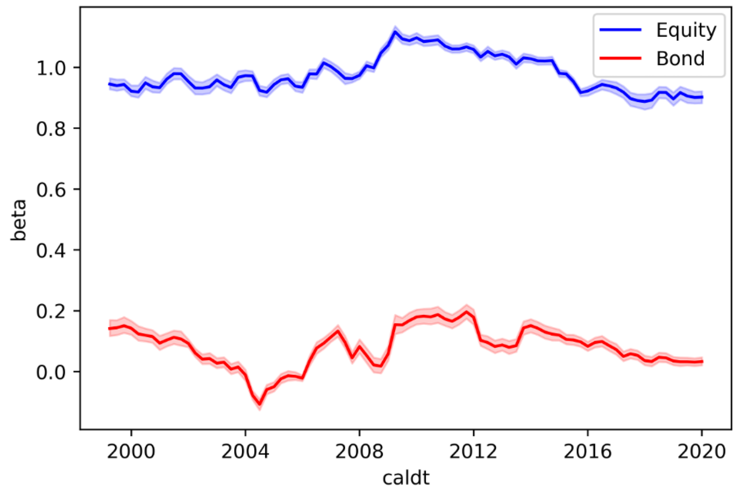

Figure 18: Time series of estimated betas with 95% confidence interval

two-way panel regression to study the effect of risk-taking on fund flows:

$$Fundflows_{i,t} = \alpha + \gamma_1 highrisk_{i,t} + \gamma_2 \triangle FFR_t \times highrisk_{i,t} + \gamma_3 Z_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{7}$$

where $Z_{i,t}$ represents control variables, include dividend yields, fund return, and fund size ($log(TNA)$), etc. $\triangle FFR_t$ is the quarterly changes of the federal fund rate at time t. We will also compare the results among three different monetary policy measures: the EFFR, the real FFR, and the Wu-Xia shadow rate. λ_t is a fixed time effect. $highrisk_{i,t}$ is a dummy variable, we classify an equity or bond fund as high-risk if its estimated β is greater than the 90th percentile of the β of all equity or bond funds, respectively. We are mostly interested in the coefficient of interaction term γ_2, it measures a one percentage point change in the federal funds rate, how much additional fund flows do high-risk funds receive relative to low-risk funds. If low-interest rate monetary policy indeed makes investors more risk-taking, we should expect the coefficient γ_2 to be negative.

Table 6 shows the estimation results of Equation 7. Consider first the results for equity funds (column 1-3), in column (1), we find that when we use EFFR as the monetary policy measure, the estimated coefficient γ_2 is negative and statistically significant at the 1% level. It indicates that high-risk funds receive more inflows when the interest rate decreases. A one percentage point decrease in federal funds rate leads to 1.102% more inflows into high-risk equity funds than low-

Table 6: Fund flows, fed funds rates, and risk-taking

	Equity			Bond		
	(1) EFFR	(2) Real	(3) Shadow	(4) EFFR	(5) Real	(6) Shadow
const	-5.516***	-5.509***	-5.524***	-4.264***	-4.270***	-4.298***
	[0.874]	[0.874]	[0.874]	[1.054]	[1.052]	[1.055]
mgmt fee	-0.298	-0.297	-0.296	-2.641**	-2.634**	-2.655**
	[0.695]	[0.695]	[0.694]	[1.302]	[1.301]	[1.302]
turnover	-0.003	-0.003	-0.003	0.002	0.002	0.002
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
size	1.731***	1.728***	1.733***	2.137***	2.134***	2.147***
	[0.256]	[0.256]	[0.256]	[0.380]	[0.380]	[0.380]
yield	-0.181**	-0.181**	-0.182**	-0.626***	-0.619***	-0.631***
	[0.086]	[0.086]	[0.086]	[0.141]	[0.142]	[0.142]
inst fund	1.375**	1.376**	1.378**	-0.464	-0.468	-0.464
	[0.552]	[0.552]	[0.552]	[0.907]	[0.906]	[0.908]
qret	0.263***	0.263***	0.262***	0.213**	0.210**	0.221**
	[0.020]	[0.020]	[0.020]	[0.095]	[0.093]	[0.093]
volatility	-0.089	-0.088	-0.088	0.125	0.126	0.134
	[0.064]	[0.064]	[0.064]	[0.229]	[0.229]	[0.230]
hrisk	-1.321***	-1.307***	-1.380***	-0.567	-0.497	-0.594
	[0.211]	[0.211]	[0.212]	[0.411]	[0.413]	[0.403]
$\triangle FFR \times hrisk$	-1.102***	-0.990***	-1.159***	1.067*	1.730***	0.614
	[0.352]	[0.340]	[0.321]	[0.632]	[0.497]	[0.448]
Fund FEs	Yes	Yes	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,996	51,996	51,996	21,924	21,924	21,924
R-squared	0.018	0.019	0.033	0.029	0.027	0.012

Standard errors (in parentheses) are clustered at the fund level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

risk equity funds. Note that these findings are obtained after controlling for characteristics of the fund such as its return, return volatility, fund size, etc. Controlling for return is particularly important to deal with the concern that our results are driven by investors' desire to take more risks when the return is high. Similarly, when we use real rate (column 2) and shadow rate (column 3) as the monetary policy measures, the estimated coefficients are also negative, all suggests investors are more risk-taking when the interest rate is low.

By contrast, the estimated coefficient of γ_2 is positive for the bond funds. As shown in column

(4), the estimated coefficient is 1.067, indicating that a decrease of 1 percentage point in the EFFR corresponds to a 1.067% of high-risk bond fund outflows. Similar conclusions are also documented with the real rate (column 5) and shadow rate (column 6). These results suggest that bond investors are not more risk-taking when the Fed decreases interest rate, instead they become more risk-averse.

This confirms that the fund flow dynamics we observed from previous VAR results are indeed driven by investors' riskiness preference. In our VAR results, our hypothesis is that in response to the Fed's expansionary monetary policy, the equity investors become more risk-taking. They move money from large-cap to mid-cap and small-cap equities in the beginning, and then to the foreign equities. The bond investors instead become more risk-averse, moving money into investment-grade bonds and global bonds.

4.4 The effect of zero lower bound policy

From January 2009 to December 2015, the Fed implemented the zero lower bound monetary policy. This long-lasting low-interest-rate policy may have a fundamental impact on investors' investing behavior. In this section, we will examine how investors change their asset allocation behavior and risk-taking appetite between the normal interest rate period (1999 to 2008 and 2016 to 2019) and the ZLB period (2009 to 2015).

Table 8 presents the results of Equation 5. Particularly, we compare the Flow-FFR relationship between the normal interest rate period and the ZLB period. The EFFR is used to measure the Fed's interest rate policy during the normal period. Since the EFFR is near zero during the ZLB period, we use the Wu-Xia shadow rate to measure the Fed's monetary policy stance during this period. The coefficient of $\triangle EFFR$ is -0.453 for equity funds and -2.288 for bond funds in the normal period. Both are negative and statistically significant at the 1% level. Similar to results in Table 4 for the whole sample (from 1999 to 2019), the magnitude of the coefficient is much larger for bond funds than equity funds. One percentage point decrease of $\triangle EFFR$ leads to 0.453% equity fund inflows and 2.288% bond fund inflows. During the ZLB period, the coefficient of

$\triangle Shadow$ is -0.476 for equity funds and -0.003 for bond funds. Both coefficients are still negative, but the magnitude of the bond coefficient now is much smaller than equity funds. Compared to the normal period, the response of equity fund inflows to a one percentage point decrease of FFR in the ZLB period is a little larger (-0.476 vs -0.453), but the response of bond fund flows in the ZLB period is much smaller than during the normal period (-0.003 vs -2.288). The results suggest that the Fed's ZLB policy has a much larger impact on bond markets than equity markets, and relative to equity, bonds become less attractive, a one percentage point decrease of $\triangle Shadow$ leads to negligible inflows into bond funds.

Table 7: Fund flows and federal funds rate changes

	Normal period		ZLB period	
	(1) Equity	(2) Bond	(3) Equity	(4) Bond
$\triangle EFFR$	-0.453***	-2.288***		
	[0.162]	[0.284]		
$\triangle Shadow$			-0.476**	-0.003
			[0.211]	[0.441]
Controls	Yes	Yes	Yes	Yes
Fund FEs	Yes	Yes	Yes	Yes
Observations	34,664	14,616	17,332	7,308
R-squared	0.032	0.028	0.014	0.034

Standard errors (in parentheses) are clustered at the fund level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Next, we examine how the ZLB policy affects investors' risk appetite. Table 8 presents the results of Equation 7 in the normal period and the ZLB period. During the normal period, the coefficient of $\triangle EFFR \times hrisk$ is -1.011 for equity funds and 1.144 for bond funds. Similar to the results in Table 6 for the whole sample (from 1999 to 2019), in response to the Fed's expansionary monetary policy, equity investors direct more money into high-risk funds, by contrast, bond investors decrease investment in high-risk funds. That is, during a normal interest rate period, equity investors have a greater appetite for risk-taking when the FFR decreases, and bond investors become more risk-averse instead. During the ZLB period, the coefficient of $\triangle Shadow \times hrisk$ is

-1.878 for equity funds and -1.106 for bond funds. Comparing to the normal period, the absolute value of the coefficient of equity funds in the ZLB period is larger than the normal period (-1.878 vs -1.011), indicating that the ZLB policy makes equity investors become even more risk-taking. As for the bond funds, the coefficient changes from positive to negative (1.144 vs -1.106), indicating the ZLB policy completely changes bond investors' risk preference, from being risk-averse to being risk-taking.

Table 8: Fund flows, fed funds rates, and risk-taking

	Normal period		ZLB period	
	(1) Equity	(2) Bond	(3) Equity	(4) Bond
$\triangle EFFR \times hrisk$	-1.011*** [0.349]	1.144* [0.713]		
$\triangle Shadow \times hrisk$			-1.878*** [0.726]	-1.106 [0.899]
Controls	Yes	Yes	Yes	Yes
Fund FEs	Yes	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes	Yes
Observations	34,664	14,616	17,332	7,308
R-squared	0.041	0.014	0.021	0.011

Standard errors (in parentheses) are clustered at the fund level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

5 Conclusion

This paper studies the effect of monetary policy on investors' asset allocation decisions by using data on aggregated and disaggregated mutual fund flows. We find that in response to the Fed's expansionary monetary policy, both the equity funds and bond funds receive large inflows, and the results are robust to different measures of monetary policy. Next, we find that equity investors have a greater appetite for risk-taking when the interest rate is lower, but bond investors instead become more risk-averse. The underlying reason for this is that investors consider bonds to be a "hedging asset" relative to equities. In a low-interest environment, bond investors strive to search for yields but with a low risk tolerance, therefore, direct money toward investment-grade bonds and global bonds. Investment-grade bonds with low risk but deliver relatively high yields, and global bonds act as diversification assets, both gain popularity among risk-averse bond investors. Equity investors in contrast become more risk-taking, shift money from high safety large-cap assets to riskier mid-cap and small-cap assets in the beginning, and later on move money from domestic equity funds to foreign equity funds.

In addition, we find that an expansionary monetary policy also drives money from money market funds to long-term mutual funds. Moreover, there is a substitution effect between the equity ETF funds and equity mutual funds, however, there is no substitution effect between bond ETFs and bond mutual funds.

Finally, our results suggest that the Fed's long-lasting ZLB policy has a fundamental impact on investors' asset allocation decisions and risk appetite. Specifically, the effect of the ZLB policy on bond markets is much larger than equity markets. We find that during the ZLB period, the bond markets become less attractive to investors. The explanation for this is that the ZLB policy makes both equity investors and bond investors become more risk-taking. Since overall equity is a more risky asset with higher returns than the bond, investors adjust their portfolio by increasing their allocation to equity and decrease their allocation to bonds in response to the Fed's ZLB policy.

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