Interest Rate Risk around Monetary Policy Announcements and Asset Duration*

Masayuki Okada†

February 8, 2026

Abstract

This paper empirically examines the monetary policy announcement premium by focusing on interest rate risk and asset duration. First, the average returns of long-duration Treasury bonds are higher than those of short-duration bonds on monetary policy announcement days. Second, the average returns of long-duration equities are statistically indistinguishable from those of short-duration equities on announcement days, whereas on non-announcement days, long-duration equities yield lower returns. This term structure on announcement days is attributed to the resolution of interest rate risk. Third, the elasticity of returns with respect to changes in interest rate risk is greater for long-duration assets than for short-duration assets, a result that holds for both bonds and equities.

Keywords: Monetary policy announcements; interest rate risk; asset duration; term structure of returns

JEL Classification: E43, E52, G12, G14

*I thank Kosuke Aoki, Jaroslav Borovička, Simon Gilchrist, Ricardo Lagos, Sydney Ludvigson, and Kenji Wada for helpful comments and suggestions. The author declares no competing interests and received no external funding for this research. The views expressed here are those of the author and not necessarily those of the Bank of Japan.

†Bank of Japan. 2-1-1 Nihonbashi-Hongokucho, Chuo-ku, Tokyo, Japan. 103-0021. Email: 12masayuki05@gmail.com

1 Introduction

This paper studies the monetary policy announcement premium by focusing on interest rate risk and heterogeneity in asset duration. The monetary policy announcement premium refers to the empirical pattern that average asset returns are elevated on announcement days (Savor and Wilson, 2013).[1] Prior to announcements, investors face greater risk than they do in normal periods and demand higher expected returns to hold assets. This paper provides evidence on the specific type of risk investors face and the assets that are more affected by it. The main findings are as follows: (i) the resolution of interest rate risk leads to higher returns, and (ii) asset duration is a key determinant of cross-sectional heterogeneity in risk exposures.

First, this paper highlights interest rate risk as a key factor, whereas the literature primarily emphasizes cash-flow risk as the main risk resolved by announcements (Ai and Bansal, 2018; Wachter and Zhu, 2022). Monetary policy announcements convey information about future interest rates, resulting in a reduction in interest rate risk around announcements, as measured by option-implied volatility of interest rates (Bauer, Lakdawala, and Mueller, 2022).

Second, assets with different durations exhibit different exposures to interest rate risk. When interest rates rise unexpectedly, long-duration assets decline in value more than short-duration assets, as future cash flows are discounted at higher discount rates. Conversely, an interest rate reduction leads to larger gains for long-duration assets. Prior to announcements, investors who prefer early resolution of uncertainty assign lower valuations to long-duration assets. Short-duration assets are less sensitive to interest rate changes due to their near-term cash flows.

We develop a tractable asset pricing model in which a representative investor with recursive preferences allocates wealth between short- and long-duration assets under uncertainty. The model features two sources of risk: cash-flow risk and discount rate risk. Long-duration assets are more exposed to discount rate risk because cash flows in the distant future are sensitive to discount rates. Short-duration assets are more sensitive to cash-flow risk, as monetary policy affects short-term cash flows through the monetary transmission mechanism, but monetary policy is neutral in the long run. Both risks are resolved upon announcements.

We derive two theoretical predictions: one for assets without cash-flow risk (bonds) and one for assets with cash-flow risk (equities). The first prediction concerns average returns on announcement days. For bonds, long-duration bonds are expected to yield higher average returns than short-duration bonds on announcement days because they provide claims on more distant future consumption and are more sensitive to discount rate risk.

The relative expected returns of short- and long-duration equities are theoretically ambiguous

[1] Savor and Wilson (2013) find that the return on the S&P 500 Index is higher on FOMC days (25.5 basis points) than on non-FOMC days (2.7 basis points).

due to the uncertainty about equity cash flows. Short-duration equities are more exposed to cash-flow risk from monetary policy announcements, which are non-neutral in the short run but neutral in the long run. This greater sensitivity to cash-flow risk may offset their lower exposure to discount rate risk compared to long-duration equities.

The second theoretical prediction concerns the contemporaneous relationship between changes in interest rate risk and asset returns on announcement days. Specifically, returns on long-duration assets are more sensitive to changes in interest rate risk than those on short-duration assets. The intuition is as follows: consider two announcements that generate different changes in interest rate risk. When monetary policy announcements resolve interest rate risk, the prices of long-duration assets, which are more sensitive to interest rates, increase. When interest rate risk does not increase or decrease, long-duration asset prices remain unchanged. In contrast, short-duration assets, which are less sensitive to interest rate risk, exhibit much smaller price movements in both cases.

We empirically test the theoretical predictions using measures of asset duration and interest rate risk. The analysis focuses on U.S. Treasury bonds and publicly traded U.S. firms. Bond analysis uses zero-coupon U.S. Treasury data (Liu and Wu, 2021). Equity duration is estimated from firm-level cash flows (Weber, 2018) or is proxied by the book-to-market ratio (Hansen, Heaton, and Li, 2008). Interest rate risk is measured by the option-implied volatility of Eurodollar futures (Bauer, Lakdawala, and Mueller, 2022).

First, we test the theoretical predictions for average returns and find that longer-duration bonds have higher average returns than short-duration bonds. For example, five-year Treasury bonds yield 4.8 basis points on average on monetary policy announcement days, while twenty-year bonds yield 10.0 basis points. This supports the prediction that the returns of long-duration bonds are more sensitive to discount rate risk.

In contrast to bonds, equities exhibit no positive relationship between duration and average returns. For example, equities with durations of 13 and 22 years have average returns of 17.5 and 17.3 basis points, respectively, indicating no statistically significant difference. This flat term structure of returns contrasts with prior literature, which finds a downward-sloping term structure of average monthly equity returns (Lettau and Wachter, 2011; Weber, 2018), where long-duration equities yield *lower* average monthly returns than short-duration equities. The return on the longest-duration portfolio is 55 basis points, while that on the shortest-duration portfolio is 233 basis points.

To assess the importance of interest rate risk, we compare average returns across two subsamples where interest rate risk either increases or decreases beyond a threshold. For bonds, the long-minus-short-duration portfolio yields 33.9 basis points when interest rate risk decreases and -32.3 basis points when it increases. For equities, the corresponding strategy yields 17.5 and -32.3 basis points, respectively. These results indicate that a downward-sloping term structure emerges when interest rate risk increases.

In the second empirical exercise, we demonstrate that the elasticity of returns to changes in interest rate risk increases with duration for both bonds and equities. For example, when interest rate risk decreases by 1% on FOMC days, the return on 10-year bonds increases by 6.8 basis points, while the return on 5-year bonds increases by 4.1 basis points.

As a comparison, we examine the elasticity of returns to changes in the VIX across durations. A 1% decrease in the VIX increases returns by 0.1 basis points for 10-year bonds and 0.9 basis points for 5-year bonds. Both estimates are statistically indistinguishable from zero. This suggests that interest rate risk is a more significant driver of the announcement premium for long-duration bonds than aggregate market volatility as measured by the VIX.

For equities with a duration of 25 years, the elasticity of returns to interest rate risk is 12, implying that returns increase by 12 basis points when interest rate risk decreases by 1% on announcement days. For equities with a duration of 7 years, the elasticity is lower, at 8, indicating a weaker response compared to long-duration equities. This greater sensitivity of long-duration equities to interest rate risk highlights a contrast between unconditional and conditional return patterns across maturities. On average, long-duration equities do not earn higher returns than short-duration equities on announcement days. However, conditional on a decline in interest rate risk, long-duration equities exhibit a stronger response than short-duration equities.

The paper is organized as follows. Section 2 highlights the cross-sectional heterogeneity in exposure to monetary policy announcements. Section 3 presents a simple theory and outlines the testable theoretical predictions. Section 4 describes the data and variable construction. Section 5 empirically tests the theoretical predictions for bonds, while Section 6 conducts the corresponding analysis for equities. Section 7 concludes the paper.

Related Literature This paper fills a gap in the literature by providing evidence on the specific type of risk investors face and the assets that are more affected by it. First, this paper contributes to the literature on the macroeconomic announcement premium. Savor and Wilson (2013) document that excess returns on stocks and bonds are elevated on macro announcement days, a phenomenon that has been examined extensively in the empirical literature.[2] On the theoretical side, models have been developed to explain the macroeconomic announcement premium. Ai and Bansal (2018) provide a revealed preference theory for the announcement premium. Wachter and Zhu (2022) develop a framework based on rare disasters and the ability of the CAPM to explain announcement-day returns. Ai et al. (2022) develop a model in which risk compensation is required because

[2] Lucca and Moench (2015) show that, for FOMC announcements, much of this excess return is concentrated in a pre-announcement drift. Related empirical contributions include Brusa, Savor, and Wilson (2020); Neuhierl and Weber (2018); Cieslak, Morse, and Vissing-Jorgensen (2019); Mueller, Tahbaz-Salehi, and Vedolin (2017); Indriawan, Jiao, and Tse (2021); Wachter and Zhu (2022).

FOMC announcements reveal the Fed's private information about its interest rate target and future economic growth rate.

This paper highlights interest rate risk as an important driver of the monetary policy announcement premium. While much of the existing literature emphasizes cash-flow risk, this paper focuses on interest rate risk as an additional mechanism underlying the premium. Empirically, Lucca and Moench (2015) and Hu et al. (2022) show that excess returns are higher when aggregate uncertainty, commonly proxied by the VIX, falls more substantially on FOMC announcement days, and Zhang and Zhao (2023) examines the contemporaneous relationship between reductions in the VIX and the announcement premium. On the theoretical side, models such as Wachter and Zhu (2022) and Ai et al. (2022) primarily attribute the announcement premium to cash-flow risk. By introducing a framework that jointly incorporates both interest rate risk and cash-flow risk, this paper provides a complementary perspective on the risks resolved by monetary policy announcements.

In addition to interest rate risk, this paper highlights duration as a key source of cross-sectional heterogeneity in exposure to monetary policy announcements. Prior empirical studies have often tested risk-based hypotheses by examining cross-sectional variation in asset sensitivities, such as the relationship between market beta and expected returns (Savor and Wilson, 2014; Wachter and Zhu, 2022), or the predictive power of option-implied variance reductions for excess returns (Ai et al., 2022). Theoretically, prior work has generally treated cross-sectional heterogeneity in sensitivity as exogenous and has not directly addressed its sources (Wachter and Zhu, 2022). This paper instead provides an interpretation of the underlying determinants of such heterogeneity, demonstrating that variation in exposure to monetary policy announcements is systematically driven by differences in asset duration.

Second, this paper contributes to the literature that emphasizes the role of monetary policy uncertainty in determining asset prices. While the effects of uncertainty have been extensively studied, prior research has primarily focused on aggregate variables such as term premia and asset prices, with limited attention to cross-sectional heterogeneity.[3] This paper addresses this gap by focusing on cross-sectional heterogeneity in asset duration.

Third, this paper contributes to the literature on the term structure of asset returns. Lettau and Wachter (2011), Van Binsbergen and Koijen (2017), and Weber (2018) document a downward-sloping term structure of monthly average equity returns. This paper extends that evidence by examining the term structure specifically on monetary policy announcement days rather than using monthly averages. The results show that the term structure on announcement days differs markedly

[3] Bundick, Herriford, and Smith (2017) estimate that changes in short-term uncertainty positively impact the term premium on announcement days. Bauer, Lakdawala, and Mueller (2022) highlight that reductions in uncertainty influence asset prices in ways distinct from conventional policy surprises. Lakdawala, Moreland, and Schaffer (2021) demonstrate that changes in uncertainty affect spillovers to global bond yields. Similarly, Kroencke, Schmeling, and Schrimpf (2021) identify shifts in risk appetite on FOMC announcement days, showing a correlation with stock returns.

Table 1: Cross-sectional Heterogeneity in Average Daily Returns on FOMC and Non-FOMC Days.

	S&P 500	Group				
	Index	1	2	3	4	5
Mean on FOMC	25.5	6.7	19.4	28.5	39.7	64.1
Mean on Non-FOMC	2.7	5.2	5.4	5.5	6.0	7.2
SD on FOMC	108	194	204	234	263	329
SD on Non-FOMC	109	192	206	230	253	297

Note: Table 1 shows the cross-sectional heterogeneity in average returns for S&P 500 firms. Firms are sorted into five groups based on their time-series average returns on FOMC days. The average daily returns on FOMC and non-FOMC days are calculated for each group. "Mean on FOMC" represents the time-series average return for each group on FOMC days. "Mean on Non-FOMC" represents the corresponding return on non-FOMC days. "SD" denotes the standard deviation. "S&P 500 Index" represents the mean and standard deviation of the S&P 500 Index. Returns are expressed in basis points. Groups "1" through "5" denote portfolios from low to high. The sample period is from January 1990 to December 2019.

from the pattern observed in monthly average returns. Within the theoretical framework, we provide an interpretation of this empirical finding.

2 Heterogeneous Exposure to Monetary Policy Announcements

This section examines the cross-sectional heterogeneity in exposure to monetary policy announcements among S&P 500 firms. We calculate the time-series average daily returns on FOMC days for each firm over the sample period (January 1990–December 2019). Firms are then sorted into five groups, from the lowest to the highest average returns. Table 1 reports the mean and standard deviation of daily returns on both FOMC and non-FOMC days for each group. The results reveal substantial variation in FOMC day returns across the five groups, with the highest group averaging 64.1 basis points and the lowest group averaging 6.7 basis points. In contrast, returns on non-FOMC days are similar across all groups.

Savor and Wilson (2013) find that returns on the S&P 500 Index are higher on FOMC days (25.5 basis points) than on non-FOMC days (2.7 basis points). While much of the literature focuses on aggregate stock returns, Table 1 shows that these elevated returns are concentrated in a subset of firms rather than being uniformly distributed.

3 Theory

This section develops a model to derive testable predictions about risk factors and expected returns on announcement days. The framework builds on Ai and Bansal (2018) and introduces two key extensions: (i) investors face discount factor risk in addition to the cash-flow risk studied by Ai and Bansal (2018), and (ii) the model incorporates cross-sectional heterogeneity by allowing for variation in asset duration.

There is a representative investor operating in a four-period model. Periods 1 and 2 are designated as trading periods, while periods 2, 3, and 4 serve as consumption periods. Period 2 functions as both a trading and consumption period. The investor can trade two types of assets: short-duration assets, which provide claims to consumption in period 3, and long-duration assets, which provide claims to consumption in period 4.

An investor in period 1 faces two sources of risk: discount factor risk and short-duration cash-flow risk. The economy can be in one of four states. The discount rate is high and cash flow is high with probability p_1 (state s_1), the discount rate is high and cash flow is low with probability p_2 (state s_2), the discount rate is low and cash flow is high with probability p_3 (state s_3), and the discount rate is low and cash flow is low with probability p_4 (state s_4). At the start of period 2, an announcement reveals the true state, which is then known to agents in periods 2, 3, and 4.

In period 1, the asset market opens, with short-duration assets traded at price P_1^S and long-duration assets at P_1^L. After the announcement in period 2 resolves uncertainty, a second asset market opens. In periods 3 and 4, the investor consumes the returns from these assets; consumption is financed solely by asset holdings. Aggregate consumption is exogenously given and does not depend on the realized state s.

The investor derives utility from consumption in periods 2, 3, and 4 and maximizes expected utility:

$$\max_{\theta_1^S,\theta_1^L,S_1,\{\theta_2^S(s),\theta_2^L(s)\}_s} \left\{ E_1\left[\left(C_2(s)^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta(s)^2 C_4(s)^{1-\frac{1}{\psi}} \right)^{\frac{1-\gamma}{1-\frac{1}{\psi}}} \right] \right\}^{\frac{1}{1-\gamma}},$$

subject to

$$\begin{aligned} e &= P_1^S\theta_1^S + P_1^L\theta_1^L + S_1, \\ S_1 &= C_2(s) + P_2^S(s)\theta_2^S(s) + P_2^L(s)\theta_2^L(s), \quad s \in \{s_1, s_2, s_3, s_4\}, \\ C_3(s) &= X_3(s)\big(\theta_1^S + \theta_2^S(s)\big), \\ C_4(s) &= X_4(s)\big(\theta_1^L + \theta_2^L(s)\big), \end{aligned}$$

where $C_t(s)$ denotes consumption in period t conditional on state s, e is the initial endowment, and S_1 denotes savings from period 1 to period 2. The variables θ_1^S and θ_1^L represent the investor's holdings of short- and long-duration assets chosen in period 1. After the revelation of the state at the beginning of period 2, the investor selects state-contingent holdings $\theta_2^S(s)$ and $\theta_2^L(s)$. The payoffs $X_3(s)$ and $X_4(s)$ denote the cash flows of the short- and long-duration assets in periods 3 and 4, respectively.

In states s_1 and s_2, the discount factor is high, $\beta(s) = \beta^h$. In states s_3 and s_4, the discount factor is low, $\beta(s) = \beta^l$. In states s_1 and s_3, the cash flow of short-duration assets is high, $X_3(s) = X_3^h$. In states s_2 and s_4, the cash flow of short-duration assets is low, $X_3(s) = X_3^l$. The cash flow of long-duration assets is assumed to be invariant across states, $X_4(s) = X_4$.

There are two considerations. First, the investor faces uncertainty about the discount rate in period 1, reflecting uncertainty about the risk-free short-term interest rate before a monetary policy announcement. Because the risk-free rate discounts future cash flows, investors are uncertain about how to value these cash flows prior to the announcement.

Second, it is assumed that only uncertainty about the return on short-duration assets is resolved by the announcement, while information about the cash flows of long-duration assets remains unrevealed. This does not imply that long-term cash flows are invariant in reality, but rather that monetary policy announcements do not provide information about distant future cash flows. This assumption is motivated by empirical evidence that the effect of monetary policy is typically transitory (Christiano, Eichenbaum, and Evans, 2005; Ramey, 2016).

3.1 Bonds as a Case without Cash-Flow Uncertainty

This section derives theoretical predictions for assets without cash-flow uncertainty, which correspond to bonds, since their cash flows are invariant across economic states, at least in nominal terms. In the model, this is represented by setting $p_1 > 0$, $p_2 > 0$, and $p_3 = p_4 = 0$, so that the cash flow in period 3 is invariant across all possible states with positive probability. Proposition 1 provides an analytical solution for the difference in average announcement premia between short- and long-duration bonds.

Proposition 1. *The average announcement premium of a short-duration bond is lower than that of a long-duration bond:*

$$E_1\left[\frac{P_2^S(s)}{P_1^S}\right] < E_1\left[\frac{P_2^L(s)}{P_1^L}\right]$$

if and only if

$$(V(s_1) - V(s_2))\left(\beta^h C_3(s_2)^{-\frac{1}{\psi}} C_4(s)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} C_4(s)^{-\frac{1}{\psi}}\right) < 0,$$

where $V(s_i)$ is defined as

$$V(s_i) \equiv \left[C_2^{1-\frac{1}{\psi}} + \beta(s_i)C_3(s_i)^{1-\frac{1}{\psi}} + \beta^2(s_i)C_4(s)^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}}.$$

Proof. See Appendix A.1. □

These necessary and sufficient conditions for determining the average returns of short- and long-duration bonds can be further simplified when investors face minimal uncertainty about aggregate consumption $(C_3(s_1) \approx C_3(s_2))$. In this case, the condition reduces to a comparison between risk aversion and the intertemporal elasticity of substitution:

Corollary 1. *When $C_3(s_1) \approx C_3(s_2)$, the average return of long-duration bonds is higher than that of short-duration bonds:*

$$E_1\left[\frac{P_2^L(s)}{P_1^L}\right] > E_1\left[\frac{P_2^S(s)}{P_1^S}\right]$$

if and only if $\gamma < \frac{1}{\psi}$.

Proof. See Appendix A.1.1. □

Intuitively, for bonds, the discount factor is the sole source of uncertainty. Long-duration bonds are therefore more sensitive to monetary policy announcements, as their returns are more exposed to discount rate risk. When $\gamma < \frac{1}{\psi}$, the investor places greater weight on unfavorable states and less weight on favorable states. Consequently, the resolution of uncertainty raises the prices of long-duration bonds more than those of short-duration bonds.

3.2 Equity as a Cash-Flow Uncertainty Case

This section presents theoretical predictions for equities characterized by $p_3 > 0$ and $p_4 > 0$. In this setting, a central bank announcement conveys information about future cash flows. Unlike the bond case, the expected return on short-duration equities exceeds that on long-duration equities when the dispersion of cash flows between high and low states is sufficiently large.

Proposition 2. *If*

$$X_3^h - X_3^l > \overline{\sigma},$$

then the expected return on short-duration assets exceeds that on long-duration assets:

$$E_1\left[\frac{P_2^S(s)}{P_1^S}\right] > E_1\left[\frac{P_2^L(s)}{P_1^L}\right].$$

Here, $\overline{\sigma}$ is defined in Appendix A.2.

Proof. See Appendix A.2. □

Short-duration assets are exposed to cash-flow risk. When the dispersion of cash flows is large, the resolution of cash-flow uncertainty leads to a larger price increase for short-duration equities, as they are more sensitive to cash-flow risk. In contrast, long-duration equities are less affected by cash-flow risk. If cash-flow dispersion is small, discount factor risk dominates, and the expected return on long-duration assets exceeds that of short-duration assets, as in the bond case. The relative importance of these risks is examined empirically in Section 6.

3.3 The Elasticity of Returns to the Resolution of Discount Rate Risk

The last theoretical prediction concerns the sensitivity of asset returns to the resolution of discount rate risk. When monetary policy announcements resolve a greater degree of discount rate risk, the returns of long-duration assets increase more than those of short-duration assets. This prediction holds for both bonds and equities.

Proposition 3. *When discount rate risk is resolved to a greater extent by monetary policy announcements, the returns of long-duration assets increase more than those of short-duration assets. This is expressed as:*

$$\frac{\partial E_1\left[\frac{P_2^L(s)}{P_1^L}\right]}{\partial \sigma^\beta} > \frac{\partial E_1\left[\frac{P_2^S(s)}{P_1^S}\right]}{\partial \sigma^\beta},$$

where

$$\sigma^\beta \equiv \frac{\beta^h - \beta^l}{2}.$$

Proof. See Appendix A.3. □

Note that this prediction applies to both equities and bonds. Even though equities are subject to cash-flow uncertainty and bonds are not, the resolution of discount rate risk affects both asset classes. This is because when uncertainty about the discount rate is resolved, it leads to a more pronounced increase in the expected returns of long-duration assets compared to short-duration assets.

4 Data

This section details the construction of the main variables: bond and equity returns, equity duration, and interest rate risk. Bond returns are calculated using data on U.S. Treasury bonds. The equity sample consists of firms incorporated in the United States and listed on the NYSE, Amex, or Nasdaq, excluding those in the financial sector. Balance sheet information is obtained from the Compustat database. Appendix B provides a detailed description of all data sources. The sample period runs from the first quarter of 1990 to the fourth quarter of 2019, when data on interest rate risk are available.

4.1 Equity and Bond Returns

The daily return of an asset on announcement days is calculated as $\frac{p_t - p_{t-1}}{p_{t-1}}$, where p_t denotes the closing price on the announcement day and p_{t-1} denotes the closing price on the previous day. For equities, daily closing price data are obtained from CRSP.

For Treasury bonds, returns are constructed using data from Liu and Wu (2021). This dataset provides daily zero-coupon yields on U.S. Treasury bonds for various maturities, $Y_t(n)$. The price of a bond with maturity n years, $p_t(n)$, is given by $p_t(n) = \frac{1}{(1+Y_t(n))^n}$, where $Y_t(n)$ is the annualized yield on a bond with maturity n years at time t.

4.2 The Duration of Assets

To analyze heterogeneous exposure across assets with different durations, we first measure asset duration. For zero-coupon bonds, duration equals years to maturity; thus, a bond with n years to maturity has duration n.

For equities, duration is not directly observable. Following Weber (2018), equity duration is constructed based on the timing of expected cash flows, analogous to the Macaulay duration used for bonds. This approach reflects the weighted average time to maturity of cash flows, where the weights are determined by the ratio of discounted future cash flows to the current price:

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{\infty} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}},$$

where $\text{Duration}_{i,t}$ is the duration of firm i at time t, $\text{CF}_{i,t+s}$ is the cash flow at time $t+s$, $P_{i,t}$ is the current equity price, and r is the constant discount rate. In contrast to bonds, equities lack observable finite maturities and predetermined cash flows. To account for this feature, the duration formula is decomposed into two components: a finite-horizon term of length T, and a residual term that captures the infinite-horizon component:

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{T} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}} + \left(T + \frac{1+r}{r}\right) \frac{P_{i,t} - \sum_{s=1}^{T} \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}}. \quad (1)$$

Appendix B.2 provides the derivation. Future cash flows are forecast using the projected return on equity and growth in book equity, based on clean surplus accounting:

$$\begin{aligned} \text{CF}_{i,t+s} &= \text{E}_{i,t+s} - (\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}) \\ &= \text{BV}_{i,t+s-1} \left[\frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}} - \frac{\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}} \right]. \end{aligned} \quad (2)$$

Return on equity, defined as $\text{E}_{i,t+s}/\text{BV}_{i,t+s-1}$, is the ratio of income before extraordinary items to lagged book equity. Both return on equity and growth in book equity are modeled as autoregressive processes, with parameters estimated using pooled data from CRSP-Compustat firms. Additional details on the estimation procedure are provided in Appendix B.1.

Table 2 presents summary statistics for key firm characteristics in Panel A. The average duration implied by stock prices is 18.0 years, with a standard deviation of 4.1 years, reflecting substantial heterogeneity across firms. On average, the public (19.8 years) and transportation (18.0 years) industries have longer durations, while the utilities (16.3 years) and wholesale (16.8 years) industries have shorter durations.

Panel B reports the cross-sectional correlations among key firm characteristics. The book-to-market ratio is defined as the ratio of book equity to market equity, where book equity is calculated as total stockholders' equity plus deferred taxes and investment tax credits, minus the book value of preferred stock, and market equity is measured as total market capitalization.

Panel B shows a strong negative correlation between duration and the book-to-market ratio, with a correlation coefficient of -0.66. As shown in Appendix B.3, the theory implies a negative linear relationship between cash-flow duration and the book-to-market ratio. The close alignment between this theoretical prediction and the data suggests that our measure of cash-flow duration provides validation for our duration measure.

Following the literature that employs it as an alternative proxy for duration (Lettau and Wachter, 2011; Hansen, Heaton, and Li, 2008), we use the book-to-market ratio in robustness checks, and

Table 2: Summary Statistics and Correlations for Firm Characteristics.

	Dur	BM	Size	Prof	Lev	Sales	ME
	Panel A. Means and Standard Deviations						
Mean	18.0	0.78	5.8	0.01	0.21	1.66	2337
SD	4.1	1.0	2.1	0.05	0.22	20.6	9628
	Panel B. Correlations						
Dur		-0.66	-0.02	-0.09	-0.04	0.01	0.13
BM			-0.00	-0.08	-0.09	-0.05	-0.12
Size				0.19	0.24	-0.00	0.42
Prof					0.08	0.16	0.12
Lev						-0.00	0.06
Sales							0.00

Note: Table 2 reports time-series averages of quarterly cross-sectional means and standard deviations for firm characteristics in Panel A and correlations among these variables in Panel B. "Dur" is cash-flow duration in years; "BM" is the book-to-market ratio; "Size" is the log of assets; "Prof" is profit divided by assets; "Lev" is the leverage ratio. "Sales" is percentage sales growth. "ME" is market capitalization in millions. Financial statement data come from quarterly Compustat. The sample period is 1990Q1–2019Q4.

the results remain consistent.

4.3 Interest Rate Risk Data

The measure of interest rate risk is constructed using the market-based conditional volatility of the future short-term interest rate, as proposed by Bauer, Lakdawala, and Mueller (2022). Specifically, Bauer, Lakdawala, and Mueller (2022) compute the standard deviation of one-year-ahead Eurodollar (ED) futures, conditional on current information, denoted as $\text{IRU}_t \equiv \sqrt{\text{Var}(\text{ED}_{t+\tau} \mid I_t)}$. This approach yields a model-free estimate of the conditional standard deviation using information embedded in futures and options prices.

Figure 1 presents a histogram of the two-day change in interest rate risk surrounding FOMC announcement days, measured as $\log(\text{IRU}_{t+1}) - \log(\text{IRU}_{t-1})$ where t denotes the FOMC day. The sample spans 1990 to 2019 and includes eight scheduled FOMC announcements per year, yielding 240 observations. The average change in the uncertainty measure is -0.021, with a t-statistic of -7.12, indicating that monetary policy announcements reduce the standard deviation of future interest rates by an average of 2.1%.

The standard deviation of the changes in interest rate risk is 0.047. The variation in the resolution of interest rate risk is often related to changes in the Federal Reserve's forward guidance (Lakdawala, Moreland, and Schaffer, 2021).[4] In the subsequent analysis, we exploit the variation in

[4]For example, the largest decrease occurred in August 2011; monetary policy uncertainty decreased by 29%, shown

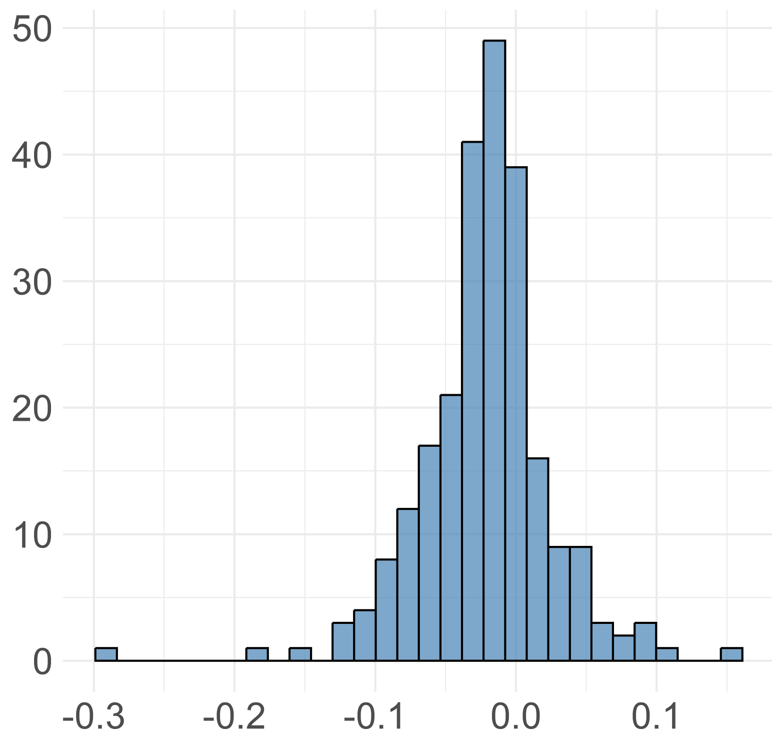


Figure 1: Histogram of Changes in Interest Rate Risk on FOMC Days.

Note: Figure 1 shows a histogram of the two-day change in interest rate risk on FOMC days. Interest rate risk is measured using the risk-neutral standard deviation of the three-month interest rate at a one-year horizon, estimated from Eurodollar futures and options. The two-day change is calculated as the log of uncertainty at $t+1$ minus the log of uncertainty at $t-1$, where t represents a FOMC announcement day. The sample period spans from January 1990 to December 2019, including 240 announcements. Data are obtained from Bauer, Lakdawala, and Mueller (2022).

changes in interest rate risk to estimate the elasticity of asset returns with respect to these changes. Conceptually, the empirical approach compares asset returns across announcement days that differ in the magnitude of the change in interest rate risk.

in the left tail of the histogram in Figure 1. Before the meeting, the FOMC stated that interest rates would be kept low "... for an extended period". At the August meeting, the FOMC explicitly signaled that rates would remain low "at least through mid-2013". The market was able to interpret the statement with less uncertainty about future interest rates. The central bank's guidance played a crucial role in reducing interest rate risk.

5 Empirical Analysis of Bonds

5.1 Average Return on FOMC Days

This subsection empirically evaluates the theoretical prediction regarding average bond returns on FOMC days. Proposition 1 predicts that long-duration bonds should exhibit higher returns than short-duration bonds. Figure 2(a) presents the average returns on FOMC days across maturities (in years) from 1990 to 2019, with 95% confidence intervals based on Newey-West standard errors. The results show a monotonic increase in returns with duration. For example, the average return on a one-year Treasury bond is 0.62 basis points, while that on a twenty-nine-year Treasury bond is 10.22 basis points. These findings are consistent with Proposition 1.

Long-duration bonds exhibit larger standard errors. This follows from the bond price formula, $p_t(n) = \frac{1}{(1+Y_t(n))^n}$, which implies that a given change in $Y_t(n)$ results in greater price variability for longer-maturity bonds. Consequently, the standard errors of returns increase with duration. This pattern is consistent with Wachter and Zhu (2022).

Since this paper examines the relationship between bond returns and interest rate risk, Figure 2(b) presents average returns for two subsamples defined by changes in interest rate risk. Specifically, observations are sorted by the change in interest rate risk, and the top and bottom quintiles are selected. The red line represents the top quintile, and the blue line represents the bottom quintile.

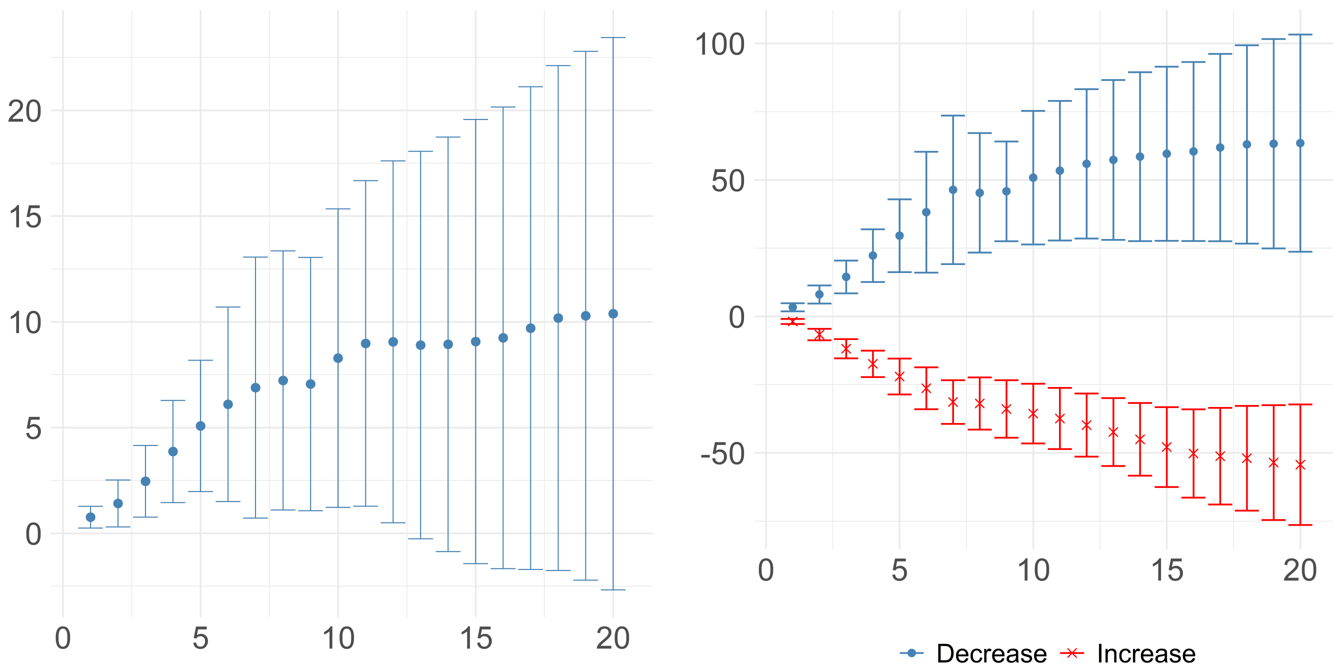
Figure 2(b) shows a clear difference in the term structure of returns between the two subsamples. When interest rate risk declines substantially, five-year bonds earn returns of 29.5 basis points, and twenty-year bonds return 63.4 basis points. When interest rate risk declines by a smaller amount in absolute value, or instead increases, five-year and twenty-year bond returns are -22.0 and -54.3 basis points, respectively. These results highlight that the magnitude of changes in interest rate risk is crucial for the term structure of bond returns on FOMC days.

We also regress the returns of Treasury bonds with different maturities on risk factors. The empirical specification is

$$y_t^m = \alpha^m + \beta_s^m X_{s,t} + \epsilon_t^m, \tag{3}$$

where y_t^m denotes the return on bonds with maturity m at time t; α^m is the pricing error; β_s^m is the time-series loading on risk factors s; and $X_{s,t}$ is the risk factor. Bond returns and market excess returns are expressed in basis points.

Table 3 reports the average returns on FOMC and non-FOMC days for Treasury bonds with maturities of 1, 5, 10, 15, and 20 years. Panel A presents the results for FOMC days. On average, a long-short portfolio earns 9.6 basis points on FOMC announcement days. The table also reports CAPM alphas and betas; X^s denotes the market excess return. Risk-adjusted returns, as measured by CAPM alphas, increase monotonically with maturity, from 0.7 for one-year bonds to 11.1 for



(a) All FOMC days

(b) Conditional on Changes in Interest Rate Risk

Figure 2: Average Returns on Treasury Bonds on FOMC Days.

Note: Figure 2 shows average returns on Treasury bonds with different maturities on FOMC days. The vertical axis represents bond returns, expressed in basis points, and the horizontal axis represents bond duration in years. Panel (a) includes all FOMC days from 1990 to 2019. Panel (b) conditions on changes in interest rate risk, with the red line representing the top 20% of changes and the blue line representing the bottom 20%. The 95% confidence intervals are calculated using Newey–West standard errors.

twenty-year bonds.

In contrast, returns on non-FOMC days are lower than those on FOMC days. For example, the average return for a one-year maturity bond is 0.06 basis points on non-FOMC days, compared to 0.7 basis points on FOMC days. This is consistent with the view that interest rate risk is not substantially resolved on non-FOMC days. Moreover, the difference in average returns between short- and long-duration bonds is minimal on non-FOMC days, with a long-short portfolio earning only 1.7 basis points.

5.2 Interest Rate Risk and Contemporaneous Regression

This section empirically demonstrates that the returns on bonds with longer durations are more responsive to changes in interest rate risk than those with shorter durations. This hypothesis is

Table 3: Average Returns on Treasury Bonds by Duration.

	Maturity				
	1	5	10	15	20
	Panel A: FOMC days				
Average Return	0.7	5.0	8.2	9.0	10.3
	(0.26)	(1.60)	(3.64)	(5.41)	(6.73)
α_{CAPM}	0.7	4.4	7.7	8.8	11.1
	(0.34)	(1.91)	(3.55)	(5.16)	(7.15)
β_{CAPM}	0.00	0.02	0.02	0.01	-0.03
	(0.006)	(0.03)	(0.06)	(0.07)	(0.09)
	Panel B: Non-FOMC days				
Average Return	0.06	0.3	0.7	1.3	1.8
	(0.05)	(0.33)	(0.62)	(0.90)	(1.14)
α_{CAPM}	0.07	0.4	1.0	1.7	2.3
	(0.06)	(0.34)	(0.64)	(0.93)	(1.15)
β_{CAPM}	-0.01	-0.06	-0.11	-0.16	-0.20
	(0.002)	(0.008)	(0.016)	(0.023)	(0.032)

Note: Table 3 reports the returns of Treasury bonds on FOMC days, time-series factor loadings (β), and pricing errors (α) for different maturities. The return on a Treasury bond is defined as $\frac{p_t(n)-p_{t-1}(n)}{p_{t-1}(n)}$, where $p_t(n)$ is the daily price of a Treasury bond with maturity n. Returns are stated in basis points. α_{CAPM} and β_{CAPM} are from the CAPM model. Newey–West standard errors are shown in parentheses. Maturity is in years.

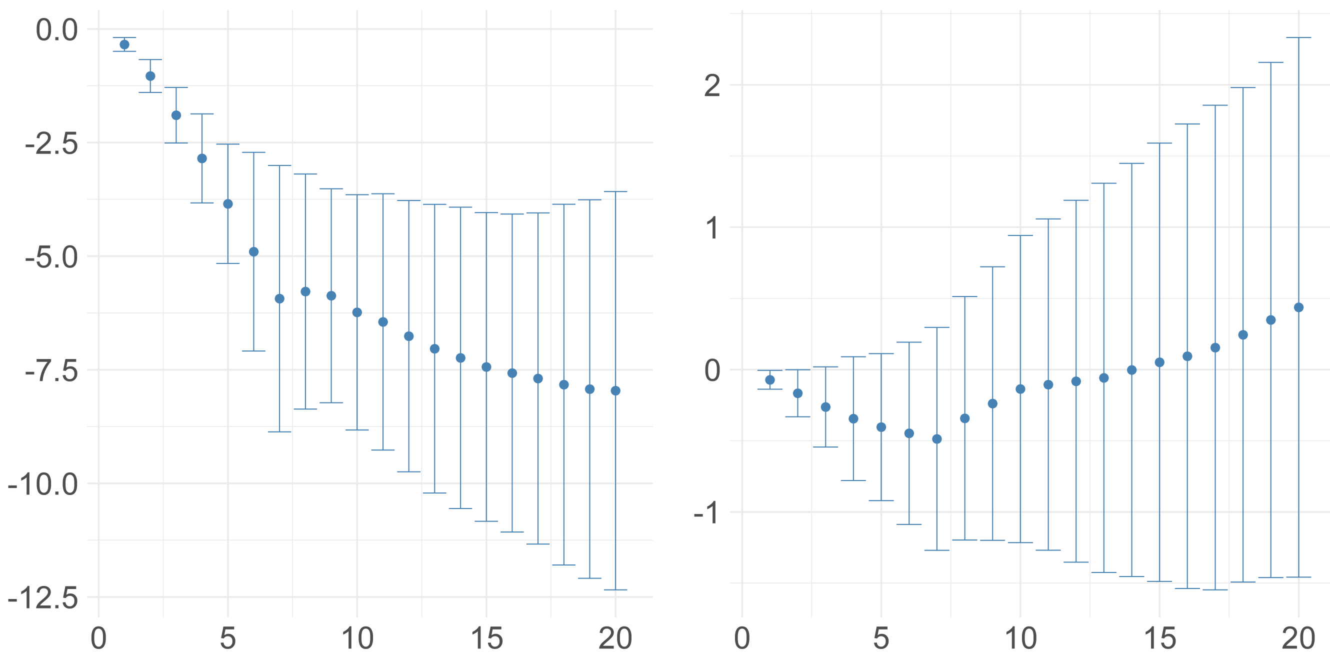
derived from Proposition 3. We separately estimate the time-series regression

$$y_t^m = \beta_{iru}^m \Delta\text{IRU}_t + \epsilon_t^m, \tag{4}$$

where t indexes the t-th FOMC announcement, and y_t^m is the return on Treasury bonds with duration m, expressed in percentage points. ΔIRU_t is the log difference between next day's and the previous day's interest rate risk, when today is the t-th FOMC day. The coefficients β_{iru}^m are estimated separately using data on bonds with maturity m.

Figure 3(a) shows the estimated values of β_{iru}^m plotted against maturity, with 95% confidence intervals based on Newey–West standard errors. The coefficient decreases monotonically with duration, indicating that longer-duration bonds are more sensitive to changes in interest rate risk. For example, for a 10-year bond, β_{iru}^m is -6.8, implying that a 1% decrease in implied interest rate volatility increases the return by 6.8 basis points, while for a 5-year bond, the coefficient is -4.1. These results are consistent with Proposition 3.

In contrast to the interest rate risk emphasized in this paper, much of the literature focuses on stock market uncertainty, often proxied by the VIX (Lucca and Moench, 2015; Hu et al., 2022). To assess whether elevated bond returns are more closely associated with changes in interest rate



(a) Interest Rate Risk

(b) VIX

Figure 3: The Elasticity of Returns to Changes in Uncertainty by Duration.

Note: Figure 3 shows the sensitivity of returns to changes in (a) interest rate risk and (b) the VIX for different maturities. The figure plots coefficients from regressions of Treasury returns on changes in the uncertainty measure:

$$y_t^m = \beta^m \Delta \text{UNC}_t + \epsilon_t^m,$$

where ΔUNC_t represents changes in interest rate risk in Panel (a) and changes in the VIX in Panel (b). The vertical axis plots the coefficients β^m for each maturity m, along with their 95% confidence intervals.

risk than with aggregate cash-flow uncertainty, we also examine the contemporaneous relationship between the VIX and Treasury bond returns. Specifically, we estimate

$$y_t^m = \beta_{vix}^m \Delta \text{VIX}_t + \epsilon_t^m, \tag{5}$$

where ΔVIX_t is defined as the logarithmic change in the VIX from the day before to the day after the t-th FOMC announcement.

Figure 3(b) shows that the estimated values of β_{vix}^m are not statistically different from zero and do not exhibit a clear pattern with duration. For example, the coefficient is -0.9 for a 5-year bond and -0.1 for a 10-year bond. This suggests that Treasury bonds are not significantly exposed to VIX-related risks; instead, interest rate risk is an important driver of bond returns.

To test whether returns on longer-duration bonds respond more strongly to the resolution of interest rate risk, we regress bond returns of varying durations on changes in interest rate risk. The empirical specification is given by

$$\text{Return}_{n,t} = \beta_1 \Delta\text{UNC}_t + \beta_2 \text{Duration}_{n,t} + \beta_3 \Delta\text{UNC}_t \times \text{Duration}_{n,t} + \gamma X_{n,t} + \epsilon_{n,t}, \tag{6}$$

where $\text{Return}_{n,t}$ is the return on bonds with duration n years at the t-th FOMC, expressed in basis points, ΔUNC_t is the measured change in IRU_t at the t-th FOMC, and $\text{Duration}_{n,t}$ equals n, the bond's maturity (in years). We use bonds with maturities ranging from one year to twenty-nine years, in one-year increments.

Control variables, $X_{n,t}$, include the two-day change in the VIX, monetary policy shocks (measured by high-frequency changes in federal funds futures; see Bernanke and Kuttner (2005)), and their interactions with duration. These controls account for the possibility that changes in interest rate risk may be correlated with changes in aggregate uncertainty or with the first moment of monetary policy, both of which could influence the sensitivity of returns across durations. The inclusion of the VIX reflects its widespread use as a proxy for uncertainty in the literature.

Table 4 presents the results. Column (1) excludes control variables, while column (2) includes them. The coefficient of interest, β_3, is estimated to be -0.24 in column (1) and -0.26 in column (2). The negative coefficient on the interaction term indicates that a 1% increase in interest rate risk reduces the return of bonds by 0.24–0.26 basis points more for each additional year of duration, relative to bonds with one year shorter duration.

We also conduct sensitivity analyses using alternative measures of interest rate risk for ΔUNC_t in equation (6). In the baseline analysis, discount factor risk is proxied by the standard deviation of one-year-ahead Eurodollar futures. Since discount factor risk is not directly observable, we also use basis point volatility (BP vol)—the product of Black implied volatility and the futures price, calculated using at-the-money Eurodollar options—and the MOVE index, a weighted average of basis point volatility for one-month Treasury options across maturities.

Table 4 presents the results using alternative uncertainty measures. Columns (3) and (4) use BP vol, while columns (5) and (6) use MOVE. The estimate of β_3 is significantly negative across all specifications. For example, in column (3), a 1% increase in BP vol reduces bond returns by 0.17 basis points more for each additional year of duration. This confirms that return sensitivity increases with duration, consistent with earlier findings. The results are robust to the choice of uncertainty measure, and columns (4) and (6) indicate that these effects are not driven by changes in the VIX or monetary policy shocks.

As an additional robustness check, we conduct subsample analyses for the pre-crisis and post-crisis periods, employ an alternative dataset of zero-coupon Treasury returns from Gürkaynak, Sack, and Wright (2007), and estimate results using subsets of maturities rather than the full range

Table 4: Elasticity of Returns to Changes in Uncertainty by Duration.

	(1)	(2)	(3)	(4)	(5)	(6)
IRU	-2.800***	-1.887***				
	(0.5495)	(0.5277)				
Duration × IRU	-0.2449**	-0.2675***				
	(0.1022)	(0.0850)				
BP vol			-2.045***	-1.422***		
			(0.4064)	(0.3988)		
Duration × BP vol			-0.1759**	-0.1852***		
			(0.0701)	(0.0623)		
MOVE					-1.470***	-0.8990*
					(0.4502)	(0.4596)
Duration × MOVE					-0.1256	-0.1605**
					(0.0856)	(0.0796)
Controls		✓		✓		✓
R^2	0.10061	0.15016	0.08712	0.14093	0.04576	0.11597
Observations	7,047	7,018	7,047	7,018	7,047	7,018

Note: Table 4 reports results from pooled regressions of Treasury bond returns (in basis points) from 1990 to 2019. The main explanatory variables are the change in interest rate risk, duration, and their interaction. Standard errors are clustered by time. Columns (1) and (2) use interest rate risk, columns (3) and (4) use BP vol, and columns (5) and (6) use MOVE as uncertainty measures. Control variables include the two-day change in the VIX, monetary policy shocks, and their interactions with duration. The regression equation is

$$\text{Return}_{n,t} = \beta_1 \Delta\text{UNC}_t + \beta_2 \text{Duration}_{n,t} + \beta_3 \Delta\text{UNC}_t \times \text{Duration}_{n,t} + \gamma X_{n,t} + \epsilon_{n,t},$$

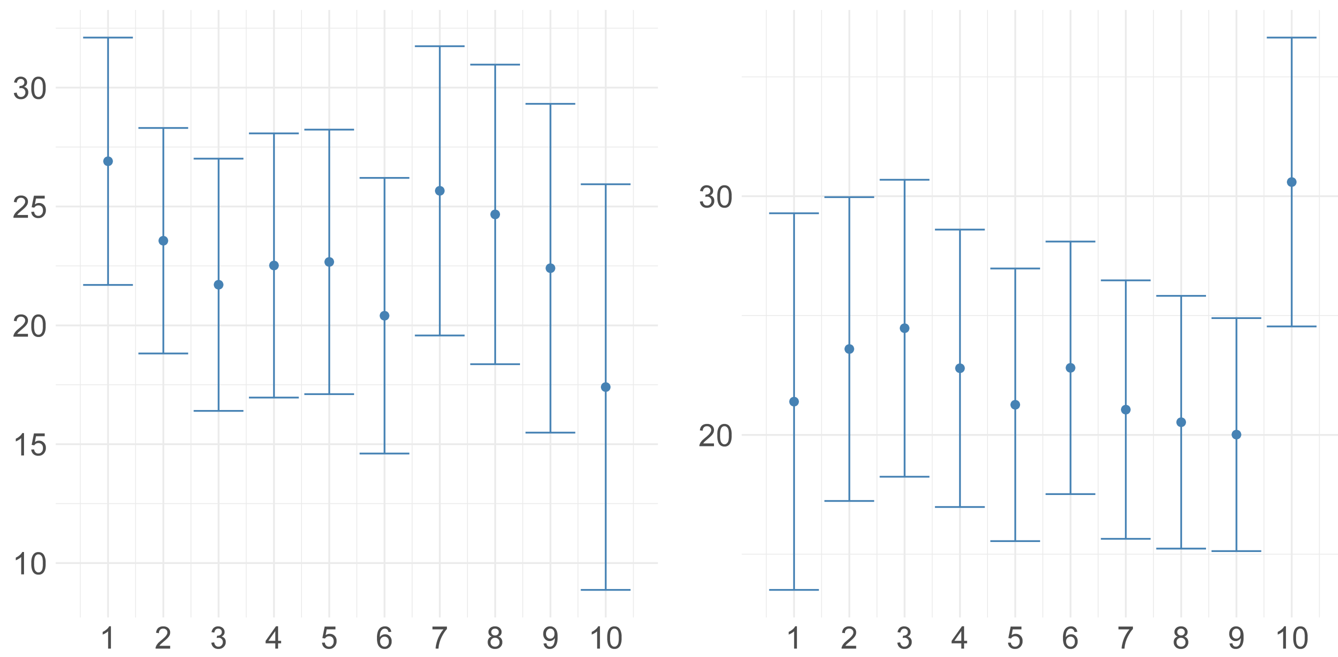
where $\text{Return}_{n,t}$ is the return on bonds with duration n years at the t-th FOMC, ΔUNC_t is the change in uncertainty at the t-th FOMC, and $\text{Duration}_{n,t}$ equals n, where bonds mature in n years. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

from one to twenty-nine years. The results of these sensitivity analyses are reported in Appendix C.

6 Empirical Analysis of Equities

6.1 Average Return on FOMC Days

In this section, we empirically examine whether short- or long-duration equities exhibit higher returns on announcement days. Proposition 2 implies that short-duration equities will exhibit higher returns than long-duration equities when the resolution of cash-flow uncertainty is substantial. Conversely, if discount rate uncertainty is the primary risk resolved, the pattern is consistent with



(a) Cash-Flow Duration

(b) Book-to-Market Ratio

Figure 4: Average Returns Conditional on Duration.

Note: Figure 4 plots average portfolio returns on FOMC days. The horizontal axis represents portfolio duration, ranging from one (short duration) to ten (long duration). The vertical axis shows the average return for each portfolio. Equities are sorted into ten portfolios based on duration and rebalanced quarterly. Panel (a) presents portfolios sorted on cash-flow duration as defined by Weber (2018), while Panel (b) uses the book-to-market ratio. Confidence intervals are based on Newey-West standard errors.

the bond case: long-duration equities will exhibit higher returns than short-duration equities.

Equities are sorted into ten deciles based on cash-flow duration from the previous quarter, with portfolios rebalanced quarterly. Figure 4(a) presents average portfolio returns, in basis points, with 95% confidence intervals based on Newey-West standard errors, as a function of cash-flow duration. The results indicate that average returns on short- and long-duration equities are statistically indistinguishable. Specifically, the shortest-duration portfolio has an average return of 26.9 basis points, the second-shortest duration portfolio has 22.4 basis points, and the longest-duration portfolio has 17.4 basis points. This empirical pattern stands in contrast to Treasury bonds, for which long-duration bonds exhibit higher returns.

Since cash-flow duration is not directly observable, we conduct a sensitivity analysis using the book-to-market ratio as an alternative proxy for duration, following Lettau and Wachter (2007) and Hansen, Heaton, and Li (2008). Figure 4(b) presents the average returns on portfolios sorted by the book-to-market ratio, with portfolios rebalanced quarterly. The results indicate that returns on low- and high-book-to-market ratio portfolios are not statistically distinguishable.

The term structure of average returns on FOMC days stands in sharp contrast to that of average monthly returns. Weber (2018) documents a downward-sloping term structure for monthly equity returns. Figure 5 (a) corroborates this finding and shows that monthly average returns for portfolios sorted by cash-flow duration decrease with duration: the shortest-duration portfolio yields 11.3 basis points, while the longest-duration portfolio yields only 0.3 basis points.[5]

Figure 5 (b) presents the monthly average returns of portfolios sorted by the book-to-market ratio, further demonstrating the downward-sloping term structure documented by Lettau and Wachter (2007). The shortest-duration portfolio yields 10.6 basis points, while the longest-duration portfolio yields 2.5 basis points. Given that the book-to-market ratio is negatively correlated with duration, this finding aligns with the results based on cash-flow duration.

While the term structure of average monthly returns is downward-sloping, this pattern does not persist for returns on FOMC days. The results suggest that average returns on long-duration equities are higher on FOMC days than on non-FOMC days, consistent with an upward-sloping term structure. This pattern arises because the resolution of interest rate risk through monetary policy announcements disproportionately benefits long-duration equities.

To further investigate the relationship between average returns and interest rate risk, we conduct a subsample analysis focusing on announcements where the increase in interest rate risk exceeds a predetermined threshold. This threshold is set at the 80th percentile of the distribution of changes in interest rate risk.[6] For these selected announcements, we compute the time-series average of portfolio returns.

Figure 6 presents the average returns of portfolios on FOMC days for the full sample of announcements (blue) and for a subsample in which the increase in interest rate risk exceeds a predetermined threshold (red). The difference in the term structure between the two samples is pronounced: when interest rate risk rises, the term structure becomes downward sloping. This pattern reflects the greater sensitivity of long-duration equities to discount factor uncertainty, causing investors to devalue these assets more when uncertainty increases. Overall, Figure 6 provides evidence that the resolution of interest rate risk is a key determinant of the term structure of equity returns on FOMC days.

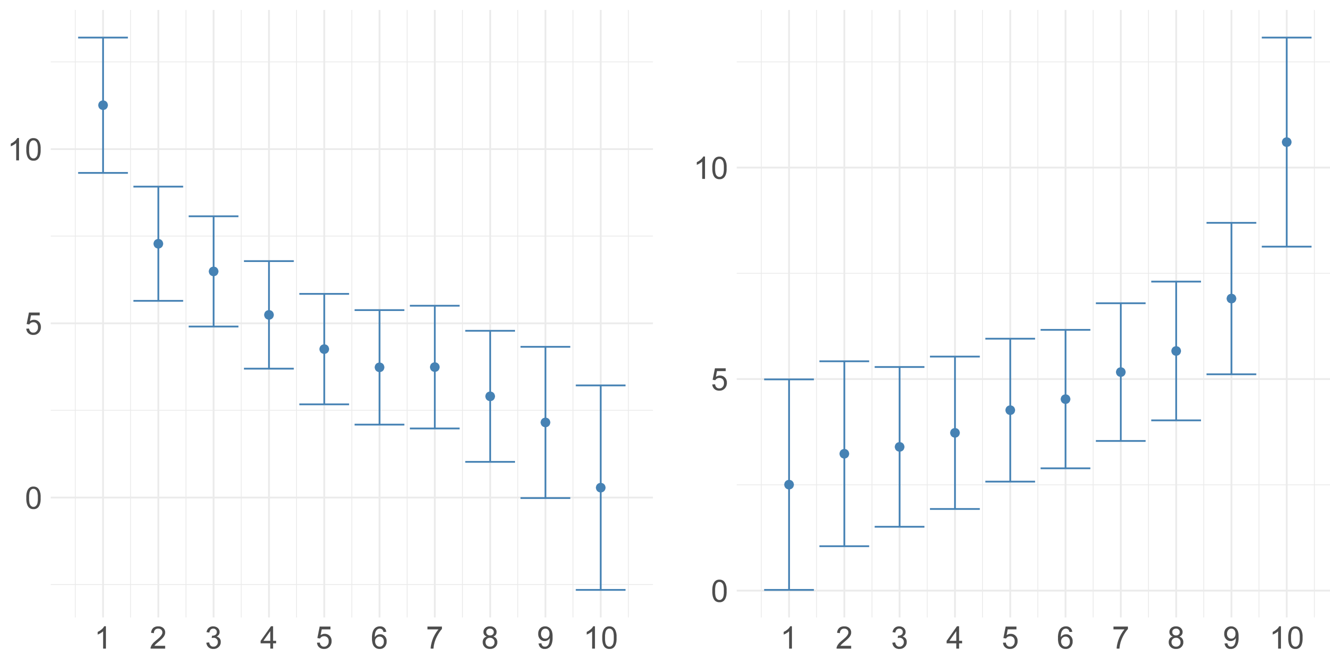
We estimate portfolio-level excess returns using risk factor regressions. The empirical specification is

$$y_t^m = \alpha^m + \beta_s^m X_{s,t} + \epsilon_t^m, \tag{7}$$

where y_t^m denotes the excess return of portfolio m at time t, with $m \in \{1, \ldots, 10\}$ indexing

[5]Monthly returns are calculated as the price difference between the beginning and end of the month, converted to daily returns by dividing the monthly return by the number of business days. Portfolios are formed by sorting equities into ten deciles based on duration from the previous quarter.

[6]The 80th percentile of $\log(\text{IRU}_{t+1}) - \log(\text{IRU}_{t-1})$ in the full sample is 0.004. Accordingly, we analyze 48 announcements (20% of 240) with changes in interest rate risk greater than 0.4%.



(a) Cash-Flow Duration (b) Book-to-Market Ratio

Figure 5: Monthly Average Returns Conditional on Duration.

Note: Figure 5 plots the time-series average of monthly returns for each portfolio. The horizontal axis represents portfolio rank. The vertical axis represents the average monthly return for each portfolio, expressed in basis points. Returns are converted from monthly to daily returns by dividing the monthly returns by the number of business days in the month. Equities are sorted into ten groups based on (a) cash-flow duration and (b) book-to-market ratio. The average return within each group is calculated. Standard errors are Newey–West standard errors. 95% confidence intervals are shown. The portfolios are rebalanced every quarter.

portfolios sorted by duration. α^m is the model-specific pricing error, and β_s^m is the factor loading on the risk factors $X_{s,t}$. The risk factors are the Fama–French three factors.

Panel A of Table 5 reports mean excess returns (OLS estimates) and pricing errors from the three–factor model. The results do not reveal a clear upward or downward term structure. The three-factor model provides limited explanatory power for returns on FOMC days, as the average returns and pricing errors are similar across portfolios.

Panel B of Table 5 reports average monthly returns and pricing errors from the three–factor model. The results show that average monthly returns decrease monotonically with duration. The third row in Panel B indicates a strong positive relationship between duration and CAPM beta: high-duration stocks have a CAPM beta of 2.6, while low-duration stocks have a beta of 1.4. Consequently, pricing errors are negatively related to duration.

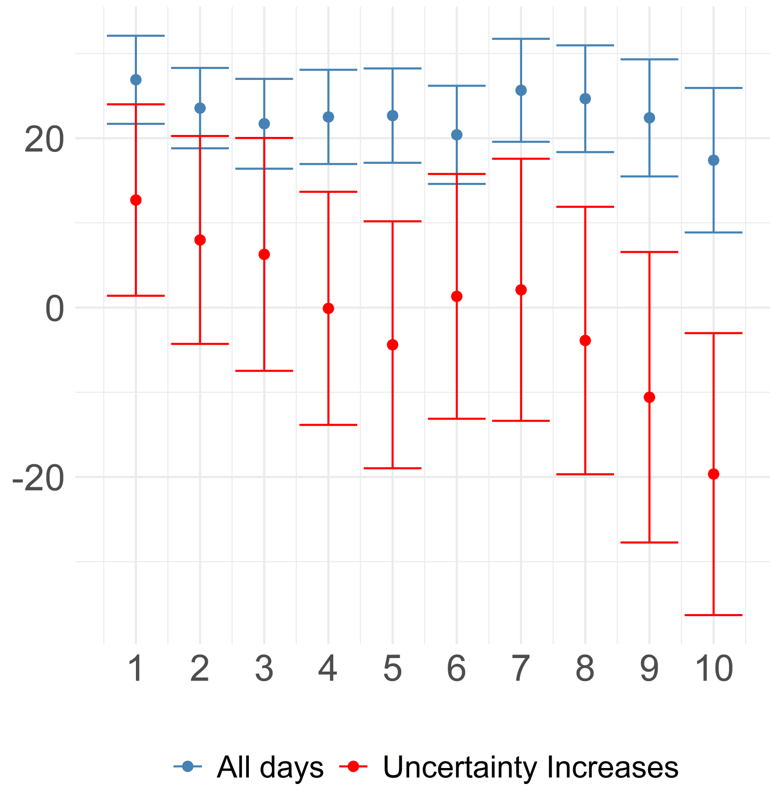


Figure 6: Average Returns Conditional on Duration and an Increase in Uncertainty.

Note: Figure 6 plots the time-series average of portfolio returns for all announcements and for a subsample. The blue points represent the average returns for all announcements from 1990 to 2019, while the red points represent the average returns for the subset of announcements where the change in interest rate risk $(\log(\text{IRU}_{t+1}) - \log(\text{IRU}_{t-1}))$ exceeds 0.004. The 80th percentile of the change in interest rate risk over the entire sample period is 0.004. The horizontal axis represents portfolio duration, ranging from short (one) to long (ten). The vertical axis represents the average return on FOMC days for each portfolio. The 95% confidence intervals, based on Newey–West standard errors, are shown. Portfolios are rebalanced every quarter.

Sensitivity Analysis The cash-flow duration measure described in Section 4.2 is determined by six parameters: the persistence of return on equity (ROE) and sales growth, the long-run growth rates of sales and ROE, the discount rate, and the forecasting horizon. To assess the robustness of the results to these parameter choices, we conduct a sensitivity analysis by systematically varying each parameter, as detailed in Appendix D.2. The findings indicate that the results are robust to alternative parameter specifications.

6.2 Interest Rate Risk and Contemporaneous Regression

This section estimates the elasticity of returns to changes in interest rate risk across durations, testing the prediction from Proposition 3 that long-duration equities are more sensitive to interest

Table 5: Average Returns of Portfolios Sorted by Duration.

Portfolio	1	2	3	4	5	6	7	8	9	10
	Panel A: FOMC days									
Average returns	26.9	23.6	21.7	22.5	22.7	20.4	25.7	24.7	22.4	17.4
	(2.6)	(2.4)	(2.7)	(2.8)	(2.8)	(2.9)	(3.1)	(3.2)	(3.5)	(4.4)
CAPM α	26.1	22.5	20.1	20.9	20.4	17.6	22.5	21.5	18.1	11.9
	(2.7)	(2.5)	(2.8)	(2.9)	(2.9)	(3.0)	(3.1)	(3.2)	(3.5)	(3.4)
CAPM β	0.2	0.28	0.42	0.41	0.57	0.70	0.80	0.80	1.05	1.29
	(0.14)	(0.14)	(0.15)	(0.16)	(0.16)	(0.16)	(0.17)	(0.16)	(0.17)	(0.29)
FF3 α	26.0	20.8	19.6	20.6	19.9	18.1	23.1	22.5	19.1	13.3
	(2.6)	(2.5)	(2.7)	(2.8)	(2.8)	(2.8)	(3.0)	(3.1)	(3.4)	(3.0)
	Panel B: Average Monthly Returns									
Average returns	11.4	7.2	6.4	5.2	4.3	3.7	3.8	2.9	2.2	0.3
	(1.0)	(0.8)	(0.8)	(0.8)	(0.8)	(0.8)	(0.9)	(1.0)	(1.1)	(1.5)
CAPM α	10.5	6.4	5.6	4.4	3.4	2.7	2.6	1.6	0.5	-1.7
	(1.0)	(0.8)	(0.8)	(0.7)	(0.7)	(0.8)	(0.8)	(0.9)	(1.0)	(1.3)
CAPM β	1.4	1.4	1.3	1.3	1.5	1.6	1.8	2.1	2.6	3.0
	(0.25)	(0.23)	(0.22)	(0.21)	(0.21)	(0.21)	(0.23)	(0.23)	(0.27)	(0.37)
FF3 α	9.4	5.3	4.5	3.4	2.5	1.9	2.0	1.3	0.6	-1.2
	(1.0)	(0.8)	(0.8)	(0.8)	(0.8)	(0.8)	(0.9)	(0.9)	(1.0)	(1.4)
	Panel C: Properties of Portfolios									
Duration	9.5	14.3	16.1	17.3	18.2	19.1	19.9	20.8	21.7	23.6

Note: The table shows the time-series average of the portfolio returns. "Average returns" refers to the average returns on the portfolios, expressed in basis points. "FF3 α" reports alphas from the three-factor model of Fama and French (1993). "1"-"10" represent the portfolios ordered from short to long duration. Panel A uses daily returns on FOMC days. Panel B uses monthly portfolio returns. In Panel B, returns are converted to a daily frequency by dividing monthly returns by the number of business days in the month. Panel C shows the average cash-flow duration of the portfolios in years. Standard errors in parentheses are Newey–West standard errors. The sample period is 1990/1–2019/12.

rate risk than short-duration equities.

We estimate the following regression separately for each portfolio to examine the sensitivity of returns to changes in interest rate risk:

$$y_t^m = \beta_{iru}^m \Delta\text{IRU}_t + \epsilon_t^m,$$

where y_t^m is the return of portfolio m at time t expressed in basis points, and ΔIRU_t is the change in interest rate risk at time t. Portfolios are indexed by $m \in \{1, \dots, 10\}$ and are constructed by sorting stocks into ten deciles based on cash-flow duration in the previous quarter.

Figure 7(a) presents the estimated coefficients β_{iru}^m plotted against portfolio duration m, along with 95% confidence intervals based on OLS standard errors. The coefficients decrease monotonically with duration: for the shortest-duration portfolio, the estimate is -5.3, while for the longest-duration portfolio, it is -9.85. This indicates that return sensitivity to interest rate risk increases in absolute value with duration, consistent with the theoretical prediction.

Figure 7(b) presents the estimated coefficients β^m_{iru} for portfolios sorted by the book-to-market ratio. The coefficients increase monotonically with the book-to-market ratio: the lowest book-to-market portfolio has an estimate of -9.2, while the highest has -6.5.

This monotonic relationship between the elasticity of returns to uncertainty and duration holds for both equities and bonds. Intuitively, conditional on the resolution of interest rate risk, assets with longer duration—regardless of cash-flow risk—are more responsive. However, despite similar return sensitivities, the term structure of *average* returns differs: long-duration bonds have higher average returns than short-duration bonds, while for equities, average returns do not increase with duration. This difference reflects the presence of cash-flow risk in equities but not in bonds.

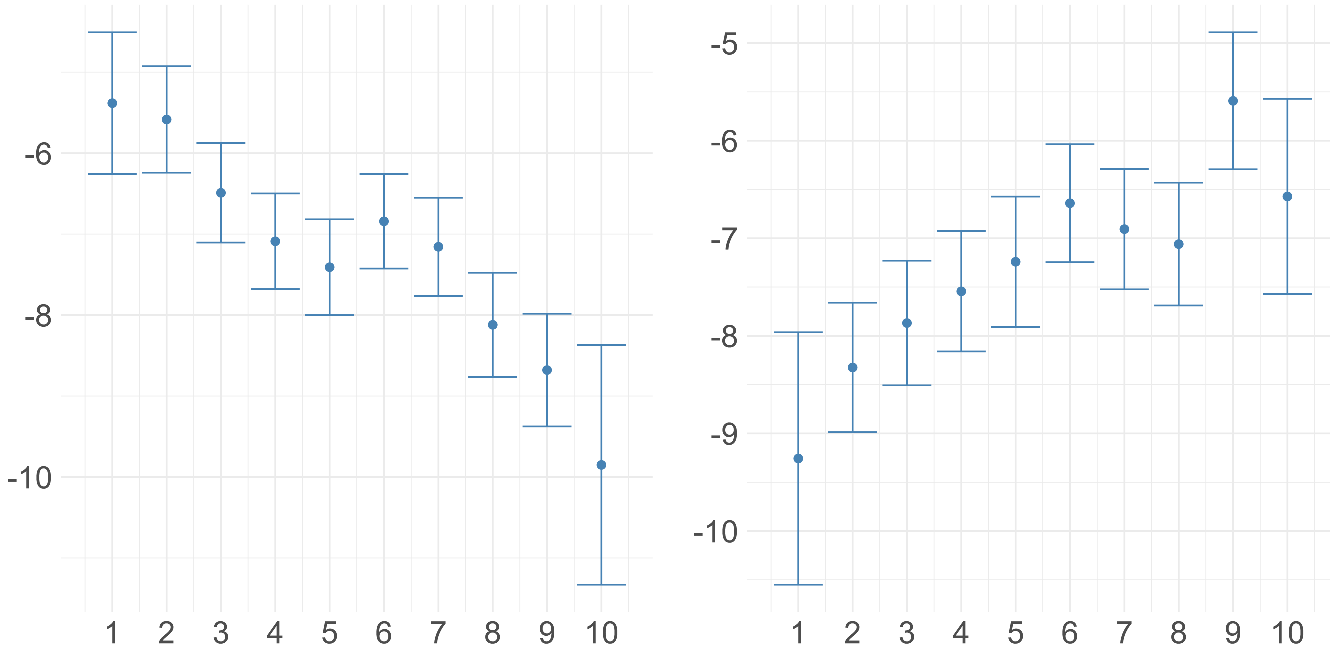
We estimate the following regression to assess whether returns on longer-duration equities are more sensitive to the resolution of interest rate risk:

$$\text{Return}_{i,t} = \beta_1 \Delta\text{IRU}_t + \beta_2 \text{Duration}_{i,t} + \beta_3 \Delta\text{IRU}_t \times \text{Duration}_{i,t} + \gamma X_{i,t} + \epsilon_{i,t}, \tag{8}$$

where i indexes firms, t indexes t-th FOMC, $\text{Return}_{i,t}$ denotes the stock return of firm i on the t-th FOMC day (in basis points), ΔIRU_t is the change in interest rate risk associated with the t-th FOMC, and $\text{Duration}_{i,t}$ is the duration of firm i at time t. $X_{i,t}$ denotes a vector of control variables, including (i) firm and year fixed effects, (ii) firm characteristics such as size, profitability, leverage, and sales growth, and (iii) interactions between these characteristics and ΔIRU_t. All balance sheet variables are measured using information from the previous quarter. Robust standard errors are clustered at the firm level.

Table 6 presents the regression results. Column (1) excludes control variables and fixed effects; column (2) includes control variables; and column (3) adds firm fixed effects. The coefficient of interest, β_3, is statistically significantly negative across all specifications (e.g., -0.3 in column (1)), indicating that a one-year increase in equity duration is associated with a 0.3 percentage point greater sensitivity of returns to changes in interest rate risk. Thus, the elasticity of returns with respect to interest rate risk increases in absolute value with duration.

Sensitivity Analysis Table 7 reports the results of the sensitivity analysis using alternative measures of interest rate risk. Specifically, basis point volatility (BP vol) and the MOVE index are employed as alternative proxies, as described in the previous section. Across all specifications, the estimated coefficients for the interaction between duration and the uncertainty measure remain significantly negative. The magnitude of these coefficients is consistent with previous estimates,



(a) Cash-Flow Duration

(b) Book-to-Market Ratio

Figure 7: The Elasticity of Returns to Interest Rate Risk Conditional on Duration.

Note: Figure 7 shows the sensitivity of equity returns to changes in interest rate risk. We separately regress the return of portfolios on changes in the uncertainty measure:

$$y_t^m = \beta^m \Delta \text{IRU}_t + \epsilon_t^m,$$

where y_t^m is the return of portfolio m at time t expressed in basis points, and ΔIRU_t is the change in interest rate risk. Portfolios are indexed by $m \in \{1, \ldots, 10\}$. The portfolios are sorted based on cash-flow duration in Figure (a) and on the book-to-market ratio in Figure (b). Interest rate risk data are taken from Bauer, Lakdawala, and Mueller (2022). The figure plots the coefficients β^m for each portfolio m, along with their two-standard-error bands.

ranging from -0.35 to -0.2.

As discussed in Section 6.1, the cash-flow duration measure depends on several parameter choices. Appendix D.2 presents a sensitivity analysis of these parameters. The results demonstrate that the main findings are robust to alternative parameter specifications.

7 Conclusion

This paper provides empirical evidence and a theoretical framework for understanding cross-sectional asset returns on FOMC announcement days. Specifically, it investigates the types of uncertainty resolved by FOMC announcements and the factors underlying the heterogeneity in stock

Table 6: The Elasticity of Returns to Interest Rate Risk Conditional on Duration.

	(1)	(2)	(3)
Duration $\times$ IRU	-0.3194***	-0.3674***	-0.3908***
	(0.0570)	(0.0573)	(0.0549)
Profit $\times$ IRU		20.30*	13.52
		(11.47)	(10.15)
Leverage $\times$ IRU		1.009	-0.3120
		(0.9006)	(0.8878)
Sales growth $\times$ IRU		-1.538**	-1.652**
		(0.7683)	(0.7817)
IRU	-1.591*	5.210***	5.205***
	(0.9639)	(0.9060)	(0.9119)
R^2	0.00473	0.00547	0.02777
Observations	775,506	698,297	698,297
Controls		✓	✓
Firm fixed effects			✓
Year fixed effects			✓

Note: Table 6 reports the coefficient estimates from the pooled regression of equity returns over 240 FOMC event days. The explanatory variables include the change in the uncertainty measure, duration, their interaction, and control variables. Control variables consist of (i) firm and year fixed effects, (ii) size, profitability, leverage, and sales growth, and (iii) interactions between the variables in (ii) and the change in interest rate risk. Standard errors are clustered at the firm level. The dependent variable is equity returns measured in basis points. Column (2) includes the control variables in (ii) and (iii), while Column (3) adds firm and year fixed effects. The regression equation is

$$\text{Return}_{i,t} = \beta_1 \Delta\text{IRU}_t + \beta_2 \text{Duration}_{i,t} + \beta_3 \Delta\text{IRU}_t \times \text{Duration}_{i,t} + \gamma X_{i,t} + \epsilon_{i,t},$$

where i indexes firms, t is the t-th FOMC, $\text{Return}_{i,t}$ is the stock return of firm i at the t-th FOMC, ΔIRU_t is the measured change in uncertainty caused by the t-th FOMC, and $\text{Duration}_{i,t}$ is the measured duration of firm i at the t-th FOMC. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

returns. The findings are consistent with the literature emphasizing risk-based explanations for the elevated excess returns observed on announcement days. In contrast to prior work focusing on cash-flow uncertainty, this analysis underscores the central role of interest rate risk in explaining these returns. To evaluate the importance of interest rate risk, the paper develops theoretical predictions relating announcement returns to asset duration and presents empirical results supporting these predictions.

Table 7: The Elasticity of Returns to Interest Rate Risk Conditional on Duration.

	(1)	(2)	(3)	(4)	(5)	(6)
Duration × BP vol	-0.2308***	-0.2597***	-0.2867***			
	(0.0521)	(0.0510)	(0.0495)			
Duration × MOVE				-0.2976***	-0.3338***	-0.3528***
				(0.0476)	(0.0450)	(0.0443)
Duration	-1.654***	-1.685***	-3.044***	-1.613***	-1.639***	-2.744***
	(0.1621)	(0.1681)	(0.2623)	(0.1683)	(0.1721)	(0.2787)
BP vol	-1.900**	2.368***	2.945***			
	(0.8656)	(0.6556)	(0.6661)			
MOVE				0.1215	3.620***	4.198***
				(0.7960)	(0.6268)	(0.6309)
R^2	0.00601	0.00653	0.02930	0.00504	0.00540	0.02837
Observations	775,506	698,297	698,297	775,506	698,297	698,297
Controls		✓	✓		✓	✓
Firm fixed effects			✓			✓
Year fixed effects			✓			✓

Note: Table 7 reports the coefficient estimates from pooled regressions of equity returns over 240 FOMC event days. Explanatory variables include the change in the uncertainty measure, duration, their interaction, and control variables. Basis point volatility (BP vol) is the product of Black IV and the futures price. MOVE is a weighted average of basis point volatility for one-month Treasury options across maturities. Control variables include (i) firm and year fixed effects, (ii) size, profitability, leverage, and sales growth, and (iii) interactions between (ii) and the change in interest rate risk. Standard errors are clustered at the firm level. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

References

Ai, Hengjie and Ravi Bansal. 2018. "Risk preferences and the macroeconomic announcement premium." *Econometrica* 86 (4):1383–1430.

Ai, Hengjie, Leyla Jianyu Han, Xuhui Nick Pan, and Lai Xu. 2022. "The cross section of the monetary policy announcement premium." *Journal of Financial Economics* 143 (1):247–276.

Bauer, Michael D, Aeimit Lakdawala, and Philippe Mueller. 2022. "Market-based monetary policy uncertainty." *The Economic Journal* 132 (644):1290–1308.

Bernanke, Ben S and Kenneth N Kuttner. 2005. "What explains the stock market's reaction to Federal Reserve policy?" *The Journal of finance* 60 (3):1221–1257.

Brusa, Francesca, Pavel Savor, and Mungo Wilson. 2020. "One central bank to rule them all." *Review of Finance* 24 (2):263–304.

Bundick, Brent, Trenton Herriford, and Andrew Smith. 2017. "Forward guidance, monetary policy uncertainty, and the term premium." *Monetary Policy Uncertainty, and the Term Premium (July 2017)* .

Christiano, Lawrence J, Martin Eichenbaum, and Charles L Evans. 2005. "Nominal rigidities and the dynamic effects of a shock to monetary policy." *Journal of political Economy* 113 (1):1–45.

Cieslak, Anna, Adair Morse, and Annette Vissing-Jorgensen. 2019. "Stock returns over the FOMC cycle." *The Journal of Finance* 74 (5):2201–2248.

Dechow, Patricia M, Richard G Sloan, and Mark T Soliman. 2004. "Implied equity duration: A new measure of equity risk." *Review of Accounting Studies* 9 (2):197–228.

Fama, Eugene F and Kenneth R French. 1993. "Common risk factors in the returns on stocks and bonds." *Journal of financial economics* 33 (1):3–56.

Gürkaynak, Refet S, Brian Sack, and Jonathan H Wright. 2007. "The US Treasury yield curve: 1961 to the present." *Journal of monetary Economics* 54 (8):2291–2304.

Hansen, Lars Peter, John C Heaton, and Nan Li. 2008. "Consumption strikes back? Measuring long-run risk." *Journal of Political economy* 116 (2):260–302.

Hu, Grace Xing, Jun Pan, Jiang Wang, and Haoxiang Zhu. 2022. "Premium for heightened uncertainty: Explaining pre-announcement market returns." *Journal of Financial Economics* 145 (3):909–936.

Indriawan, Ivan, Feng Jiao, and Yiuman Tse. 2021. "The FOMC announcement returns on long-term US and German bond futures." *Journal of Banking & Finance* 123:106027.

Kroencke, Tim A, Maik Schmeling, and Andreas Schrimpf. 2021. "The FOMC risk shift." *Journal of Monetary Economics* 120:21–39.

Lakdawala, Aeimit, Timothy Moreland, and Matthew Schaffer. 2021. "The international spillover effects of us monetary policy uncertainty." *Journal of International Economics* 133:103525.

Lettau, Martin and Jessica A Wachter. 2007. "Why is long-horizon equity less risky? A duration-based explanation of the value premium." *The Journal of Finance* 62 (1):55–92.

———. 2011. "The term structures of equity and interest rates." *Journal of Financial Economics* 101 (1):90–113.

Liu, Yan and Jing Cynthia Wu. 2021. "Reconstructing the yield curve." *Journal of Financial Economics* 142 (3):1395–1425.

Lucca, David O and Emanuel Moench. 2015. "The pre-FOMC announcement drift." *The Journal of finance* 70 (1):329–371.

Mueller, Philippe, Alireza Tahbaz-Salehi, and Andrea Vedolin. 2017. "Exchange rates and monetary policy uncertainty." *The Journal of Finance* 72 (3):1213–1252.

Neuhierl, Andreas and Michael Weber. 2018. "Monetary momentum." Tech. rep., National Bureau of Economic Research.

Ramey, Valerie A. 2016. "Macroeconomic shocks and their propagation." *Handbook of macroeconomics* 2:71–162.

Savor, Pavel and Mungo Wilson. 2013. "How much do investors care about macroeconomic risk? Evidence from scheduled economic announcements." *Journal of Financial and Quantitative Analysis* 48 (2):343–375.

———. 2014. "Asset pricing: A tale of two days." *Journal of Financial Economics* 113 (2):171–201.

Van Binsbergen, Jules H and Ralph SJ Koijen. 2017. "The term structure of returns: Facts and theory." *Journal of financial economics* 124 (1):1–21.

Wachter, Jessica A and Yicheng Zhu. 2022. "A model of two days: Discrete news and asset prices." *The Review of Financial Studies* 35 (5):2246–2307.

Weber, Michael. 2018. “Cash flow duration and the term structure of equity returns.” *Journal of Financial Economics* 128 (3):486–503.

Zhang, Chu and Shen Zhao. 2023. “The Macroeconomic Announcement Premium and Information Environment.” *Journal of Monetary Economics* .

Appendix A Proof

A.1 Proposition 1

For bonds, the discount factor is high (β^h) with probability p (state s_1) and low (β^l) with probability $1-p$ (state s_2). Bond cash flows, $X_3(s)$, do not depend on the state of the economy (s).

The announcement premium of long-maturity bonds and short-maturity bonds is given by

$$\begin{aligned}
& E_1\left[\frac{P_2^S(s)}{P_1^S}\right] - E_1\left[\frac{P_2^L(s)}{P_1^L}\right] \\
&= \frac{E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}}\right] E\left[\beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right]}{E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right]} \\
&- \frac{E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}}\right] E\left[\beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right]}{E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right]}.
\end{aligned} \tag{9}$$

When (9) is positive, the expected return on short-duration assets exceeds that on long-duration assets. Conversely, when (9) is negative, the expected return on short-duration assets falls below that on long-duration assets. The sign of (9) is equal to

$$\begin{aligned}
& E\left[\beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right] E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right] \\
& - E\left[\beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right] E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right].
\end{aligned} \tag{10}$$

To simplify the notation,

$$V(s_i) \equiv \left[C_2^{1-\frac{1}{\psi}} + \beta(s_i) C_3(s_i)^{1-\frac{1}{\psi}} + \beta^2(s_i) C_4^{1-\frac{1}{\psi}} \right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}}. \tag{11}$$

Equation (10) can be written as

$$\begin{aligned}
&\left(p\beta^h C_3(s_1)^{-\frac{1}{\psi}} X_3 + (1-p)\beta^l C_3(s_2)^{-\frac{1}{\psi}} X_3 \right) \\
&\times \left(pV(s_1)(\beta^h)^2 C_4^{-\frac{1}{\psi}} X_4 + (1-p)V(s_2)(\beta^l)^2 C_4^{-\frac{1}{\psi}} X_4 \right) \\
&- \left(p\beta^h C_4^{-\frac{1}{\psi}} X_4 + (1-p)\beta^l C_4^{-\frac{1}{\psi}} X_4 \right) \\
&\times \left(pV(s_1)(\beta^h)^2 C_3(s_1)^{-\frac{1}{\psi}} X_3 + (1-p)V(s_2)(\beta^l)^2 C_3(s_2)^{-\frac{1}{\psi}} X_3 \right) \\
&= p(1-p)\beta^h\beta^l X_3 X_4 \left(V(s_1) - V(s_2) \right) \left(\beta^h C_3(s_2)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} \right).
\end{aligned} \tag{12}$$

Here, $p(1-p)\beta^h\beta^l X_3 X_4$ in equation (12) is positive. Therefore, the sign of the difference in average returns between short- and long-duration bonds is given by

$$\left(V(s_1) - V(s_2) \right) \left(\beta^h C_3(s_2)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} \right).$$

□

A.1.1 Corollary 1

From Proposition 1, the difference between the average returns of short and long-duration bonds is determined by

$$\left(V(s_1) - V(s_2) \right) \left(\beta^h C_3(s_2)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} \right). \tag{13}$$

Under the assumption that consumption is approximately the same across the states ($C_3(s_1) \approx C_3(s_2)$), the second term

$$\beta^h C_3(s_2)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} C_4^{-\frac{1}{\psi}}$$

is positive when $\beta^h > \beta^l$. Moreover, the first term in (13),

$$
\begin{aligned}
&V(s_1) - V(s_2) \\
&= \left[C_2^{1-\frac{1}{\psi}} + \beta^h C_3(s_1)^{1-\frac{1}{\psi}} + (\beta^h)^2 C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} - \left[C_2^{1-\frac{1}{\psi}} + \beta^l C_3(s_2)^{1-\frac{1}{\psi}} + (\beta^l)^2 C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}},
\end{aligned}
$$

is negative if and only if $\frac{1}{\psi} < \gamma$ holds. Therefore, the average return of long-duration bonds is higher than that of short-duration bonds if and only if $\frac{1}{\psi} < \gamma$.

□

A.2 Proposition 2

The sign of the difference in expected returns between short- and long-duration bonds is given by

$$
\begin{aligned}
&E\left[\beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right] E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right] \\
&- E\left[\beta^2(s)C_4^{-\frac{1}{\psi}}X_4\right] E\left[\left[C_2^{1-\frac{1}{\psi}} + \beta(s)C_3(s)^{1-\frac{1}{\psi}} + \beta^2(s)C_4^{1-\frac{1}{\psi}}\right]^{\frac{\frac{1}{\psi}-\gamma}{1-\frac{1}{\psi}}} \beta(s)C_3(s)^{-\frac{1}{\psi}}X_3(s)\right] \\
&= (X_3^h C_3(s_1)^{-\frac{1}{\psi}} - X_3^l C_3(s_2)^{-\frac{1}{\psi}})p_1p_2(\beta^h)^3 C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_1)) \\
&+ (X_3^h C_3(s_3)^{-\frac{1}{\psi}} - X_3^l C_3(s_4)^{-\frac{1}{\psi}})p_3p_4(\beta^l)^3 C_4^{-\frac{1}{\psi}}(V(s_4) - V(s_3)) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})p_1p_3X_3^h\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_1) - V(s_3)) \\
&+ (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}})p_2p_4X_3^l\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_4)) \\
&+ p_1p_4\beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} - \beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\
&+ p_2p_3\beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h X_3^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l X_3^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_3)). \qquad (14)
\end{aligned}
$$

The cash flows of short-duration equities in the high and low states are defined as

$$
X_3^h \equiv \overline{X} + \sigma,
$$

$$
X_3^l \equiv \overline{X} - \sigma,
$$

where σ is the dispersion of cash flows.

Equation (14) can be written as

$$
\begin{aligned}
&((\overline{X}+\sigma)C_3(s_1)^{-\frac{1}{\psi}} - (\overline{X}-\sigma)C_3(s_2)^{-\frac{1}{\psi}})p_1p_2(\beta^h)^3C_4^{-\frac{1}{\psi}}(V(s_2)-V(s_1))\\
&+((\overline{X}+\sigma)C_3(s_3)^{-\frac{1}{\psi}} - (\overline{X}-\sigma)C_3(s_4)^{-\frac{1}{\psi}})p_3p_4(\beta^l)^3C_4^{-\frac{1}{\psi}}(V(s_4)-V(s_3))\\
&+(\beta^hC_3(s_3)^{-\frac{1}{\psi}} - \beta^lC_3(s_1)^{-\frac{1}{\psi}})p_1p_3(\overline{X}+\sigma)\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_1)-V(s_3))\\
&+(\beta^hC_3(s_4)^{-\frac{1}{\psi}} - \beta^lC_3(s_2)^{-\frac{1}{\psi}})p_2p_4(\overline{X}-\sigma)\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_2)-V(s_4))\\
&+p_1p_4\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^h(\overline{X}-\sigma)C_3(s_4)^{-\frac{1}{\psi}} - \beta^l(\overline{X}+\sigma)C_3(s_1)^{-\frac{1}{\psi}})(V(s_1)-V(s_4))\\
&+p_2p_3\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^h(\overline{X}+\sigma)C_3(s_3)^{-\frac{1}{\psi}} - \beta^l(\overline{X}-\sigma)C_3(s_2)^{-\frac{1}{\psi}})(V(s_2)-V(s_3))\\
&=\frac{1}{16}\sigma\Big[(C_3(s_1)^{-\frac{1}{\psi}} + C_3(s_2)^{-\frac{1}{\psi}})(\beta^h)^3C_4^{-\frac{1}{\psi}}(V(s_2)-V(s_1))\\
&+(C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_4)^{-\frac{1}{\psi}})(\beta^l)^3C_4^{-\frac{1}{\psi}}(V(s_4)-V(s_3))\\
&+(\beta^hC_3(s_3)^{-\frac{1}{\psi}} - \beta^lC_3(s_1)^{-\frac{1}{\psi}})\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_1)-V(s_3))\\
&-(\beta^hC_3(s_4)^{-\frac{1}{\psi}} - \beta^lC_3(s_2)^{-\frac{1}{\psi}})\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_2)-V(s_4))\\
&-\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^hC_3(s_4)^{-\frac{1}{\psi}} - \beta^lC_3(s_1)^{-\frac{1}{\psi}})(V(s_1)-V(s_4))\\
&+\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^hC_3(s_3)^{-\frac{1}{\psi}} - \beta^lC_3(s_2)^{-\frac{1}{\psi}})(V(s_2)-V(s_3))\Big]\\
&+t.i.p.
\end{aligned}
\tag{15}
$$

To abbreviate the notation, we define terms independent of the parameter σ in equation (15).

$$
\begin{aligned}
t.i.p. \equiv\ &(\overline{X}C_3(s_1)^{-\frac{1}{\psi}} - \overline{X}C_3(s_2)^{-\frac{1}{\psi}})p_1p_2(\beta^h)^3C_4^{-\frac{1}{\psi}}(V(s_2)-V(s_1))\\
&+(\overline{X}C_3(s_3)^{-\frac{1}{\psi}} - \overline{X}C_3(s_4)^{-\frac{1}{\psi}})p_3p_4(\beta^l)^3C_4^{-\frac{1}{\psi}}(V(s_4)-V(s_3))\\
&+(\beta^hC_3(s_3)^{-\frac{1}{\psi}} - \beta^lC_3(s_1)^{-\frac{1}{\psi}})p_1p_3\overline{X}\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_1)-V(s_3))\\
&+(\beta^hC_3(s_4)^{-\frac{1}{\psi}} - \beta^lC_3(s_2)^{-\frac{1}{\psi}})p_2p_4\overline{X}\beta^h\beta^lC_4^{-\frac{1}{\psi}}(V(s_2)-V(s_4))\\
&+p_1p_4\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^h\overline{X}C_3(s_4)^{-\frac{1}{\psi}} + \beta^l\overline{X}C_3(s_1)^{-\frac{1}{\psi}})(V(s_1)-V(s_4))\\
&+p_2p_3\beta^h\beta^lC_4^{-\frac{1}{\psi}}(\beta^h\overline{X}C_3(s_3)^{-\frac{1}{\psi}} + \beta^l\overline{X}C_3(s_2)^{-\frac{1}{\psi}})(V(s_2)-V(s_3)).
\end{aligned}
\tag{16}
$$

It is assumed that

$$C(s_2) = C(s_4) < C(s_1) = C(s_3).$$

This assumption implies that aggregate consumption is high when the cash flow of short-term equities is high. In contrast, the aggregate consumption is not affected by the discount rate.

Then, the order of $V(s_i)$ is determined.

$$V(s_1) < V(s_2),$$
$$V(s_3) < V(s_4).$$

In the equation (15), the coefficient on σ, denoted by α^σ, is

$$\begin{aligned}\alpha^\sigma \equiv& \frac{1}{16}\Big[(C_3(s_1)^{-\frac{1}{\psi}} + C_3(s_2)^{-\frac{1}{\psi}})(\beta^h)^3 C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_1)) \\ &+ (C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_4)^{-\frac{1}{\psi}})(\beta^l)^3 C_4^{-\frac{1}{\psi}}(V(s_4) - V(s_3)) \\ &+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})p_1 p_3 \beta^h \beta^l C_4^{-\frac{1}{\psi}}(V(s_1) - V(s_3)) \\ &- (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}})p_2 p_4 \beta^h \beta^l C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_4)) \\ &- \beta^h \beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\ &+ \beta^h \beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_3))\Big]. \end{aligned} \tag{17}$$

In Lemma 1, it is shown that α^σ is positive. Therefore, when

$$\sigma = \frac{X^h - X^l}{2} > \frac{-t.i.p}{\alpha^\sigma},$$

the expected return on short-duration equities minus that on long-duration equities is positive.

In Proposition 2, $\overline{\sigma}$ is

$$\overline{\sigma} \equiv 2\frac{-t.i.p}{\alpha^\sigma}. \tag{18}$$

□

A.2.1 Lemma 1

Lemma 1. *The coefficient on* σ*,*

$$
\begin{aligned}
&(C_3(s_1)^{-\frac{1}{\psi}} + C_3(s_2)^{-\frac{1}{\psi}})(\beta^h)^3 C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_1)) \\
&+ (C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_4)^{-\frac{1}{\psi}})(\beta^l)^3 C_4^{-\frac{1}{\psi}}(V(s_4) - V(s_3)) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_1) - V(s_3)) \\
&- (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_4)) \\
&- \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\
&+ \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_3)),
\end{aligned}
\tag{19}
$$

is positive.

Proof. Since $V(s_1) < V(s_2)$ and $V(s_3) < V(s_4)$ hold, the first two terms in (19) are positive:

$$
\begin{aligned}
&(C_3(s_1)^{-\frac{1}{\psi}} + C_3(s_2)^{-\frac{1}{\psi}})(\beta^h)^3 C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_1)) > 0 \\
&+ (C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_4)^{-\frac{1}{\psi}})(\beta^l)^3 C_4^{-\frac{1}{\psi}}(V(s_4) - V(s_3)) > 0.
\end{aligned}
$$

The remaining term (the sum of the third to sixth terms in (19)) is

$$
\begin{aligned}
&(\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_1) - V(s_3)) \\
&- (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_4)) \\
&- \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\
&+ \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_3)) \\
&\geq (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_1) - V(s_4)) \\
&- (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}})\beta^h\beta^l C_4^{-\frac{1}{\psi}}(V(s_2) - V(s_4)) \\
&- \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\
&+ \beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_4))
\end{aligned}
$$

$$
\begin{aligned}
&= \beta^h\beta^l(V(s_1)-V(s_4))\left((\beta^h-\beta^l)C_3(s_1)^{-\frac{1}{\psi}} - (\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})\right) \\
&+ \beta^h\beta^l(V(s_2)-V(s_4))\left(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}} - (\beta^h-\beta^l)C_3(s_2)^{-\frac{1}{\psi}}\right) \\
&= \beta^h\beta^l(V(s_1)-V(s_4))\left(-(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})\right) \\
&+ \beta^h\beta^l(V(s_2)-V(s_4))\left(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}}\right) \\
&+ \beta^h\beta^l(V(s_1)-V(s_4))\left((\beta^h-\beta^l)C_3(s_1)^{-\frac{1}{\psi}}\right) \\
&+ \beta^h\beta^l(V(s_2)-V(s_4))\left(-(\beta^h-\beta^l)C_3(s_2)^{-\frac{1}{\psi}}\right).
\end{aligned}
\tag{20}
$$

Here, the sum of the first and second terms in (20) is nonnegative:

$$
\begin{aligned}
&\beta^h\beta^l(V(s_1)-V(s_4))\left(-(\beta^h C_3(s_4)^{-\frac{1}{\psi}} + \beta^l C_3(s_1)^{-\frac{1}{\psi}})\right) \\
&+ \beta^h\beta^l(V(s_2)-V(s_4))\left(\beta^h C_3(s_3)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}}\right) \\
&\geq \beta^h\beta^l(V(s_1)-V(s_4)) \\
&\times \left(-\beta^h C_3(s_2)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}} + \beta^h C_3(s_1)^{-\frac{1}{\psi}} + \beta^l C_3(s_2)^{-\frac{1}{\psi}}\right) \\
&= \beta^h\beta^l(V(s_1)-V(s_4))(\beta^h-\beta^l)(C_3(s_1)^{-\frac{1}{\psi}} - C_3(s_2)^{-\frac{1}{\psi}}) \\
&\geq 0.
\end{aligned}
\tag{21}
$$

The sum of the third and fourth terms in (20) is nonnegative:

$$
\begin{aligned}
&\beta^h\beta^l(V(s_1)-V(s_4))\left((\beta^h-\beta^l)C_3(s_1)^{-\frac{1}{\psi}}\right) \\
&+ \beta^h\beta^l(V(s_2)-V(s_4))\left(-(\beta^h-\beta^l)C_3(s_2)^{-\frac{1}{\psi}}\right) \\
&\geq \beta^h\beta^l(V(s_1)-V(s_4))(\beta^h-\beta^l)(C_3(s_1)^{-\frac{1}{\psi}} - C_3(s_2)^{-\frac{1}{\psi}}) \\
&\geq 0.
\end{aligned}
\tag{22}
$$

$\square$

A.3 Proposition 3

As shown in equation (14), the difference in expected returns between short- and long-duration assets is given by

$$
\begin{aligned}
&(X_3^h C_3(s_1)^{-\frac{1}{\psi}} - X_3^l C_3(s_2)^{-\frac{1}{\psi}}) p_1 p_2 (\beta^h)^3 C_4^{-\frac{1}{\psi}} (V(s_2) - V(s_1)) \\
&+ (X_3^h C_3(s_3)^{-\frac{1}{\psi}} - X_3^l C_3(s_4)^{-\frac{1}{\psi}}) p_3 p_4 (\beta^l)^3 C_4^{-\frac{1}{\psi}} (V(s_4) - V(s_3)) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}}) p_1 p_3 X_3^h \beta^h \beta^l C_4^{-\frac{1}{\psi}} (V(s_1) - V(s_3)) \\
&+ (\beta^h C_3(s_4)^{-\frac{1}{\psi}} - \beta^l C_3(s_2)^{-\frac{1}{\psi}}) p_2 p_4 X_3^l \beta^h \beta^l C_4^{-\frac{1}{\psi}} (V(s_2) - V(s_4)) \\
&+ p_1 p_4 \beta^h \beta^l C_4^{-\frac{1}{\psi}} (\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} - \beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4)) \\
&+ p_2 p_3 \beta^h \beta^l C_4^{-\frac{1}{\psi}} (\beta^h X_3^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l X_3^l C_3(s_2)^{-\frac{1}{\psi}})(V(s_2) - V(s_3)).
\end{aligned}
\tag{23}
$$

The dispersion of the discount rate in high and low states is given by

$$
\begin{aligned}
\beta^h &= \beta + \sigma^\beta, \\
\beta^l &= \beta - \sigma^\beta.
\end{aligned}
$$

It remains to show that the derivative of equation (23) is negative.

In the case of $C(s_1) \approx C(s_2)$ and $C(s_3) \approx C(s_4)$, $V(s_1) \approx V(s_2)$ and $V(s_3) \approx V(s_4)$. The sum of the first and second terms in equation (23) is approximately equal to zero.

The derivative of the third term with respect to σ^β is given by

$$
\begin{aligned}
&(C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_1)^{-\frac{1}{\psi}}) p_1 p_3 X_3^h (\beta^2 - (\sigma^\beta)^2) C_4^{-\frac{1}{\psi}} (V(s_1) - V(s_3)) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}}) p_1 p_3 X_3^h (\beta^2 - (\sigma^\beta)^2) C_4^{-\frac{1}{\psi}} \left(\frac{\partial V(s_1)}{\partial \sigma^\beta} - \frac{\partial V(s_3)}{\partial \sigma^\beta} \right) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}}) p_1 p_3 X_3^h (-2\sigma^\beta) C_4^{-\frac{1}{\psi}} (V(s_1) - V(s_3)) \\
&\approx p_1 p_3 X_3^h C_4^{-\frac{1}{\psi}} (V(s_1) - V(s_3)) \left((C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_1)^{-\frac{1}{\psi}}) \beta^2 + (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})(-2\sigma^\beta) \right) \\
&+ (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}}) p_1 p_3 X_3^h (\beta^2) C_4^{-\frac{1}{\psi}} \left(\frac{\partial V(s_1)}{\partial \sigma^\beta} - \frac{\partial V(s_3)}{\partial \sigma^\beta} \right).
\end{aligned}
\tag{24}
$$

The approximation follows from the assumption that $(\sigma^\beta)^2 \approx 0$. Also, when $\sigma^\beta \ll \beta$,

$$(C_3(s_3)^{-\frac{1}{\psi}} + C_3(s_1)^{-\frac{1}{\psi}})\beta^2 + (\beta^h C_3(s_3)^{-\frac{1}{\psi}} - \beta^l C_3(s_1)^{-\frac{1}{\psi}})(-2\sigma^\beta) > 0. \tag{25}$$

Here,

$$\begin{aligned}
&V(s_1) - V(s_3) < 0,\\
&\frac{\partial V(s_1)}{\partial \sigma^\beta} < 0,\\
&\frac{\partial V(s_3)}{\partial \sigma^\beta} > 0.
\end{aligned}$$

Therefore, (24) is negative.
Similarly, the derivative of the fourth term with respect to σ^β is negative because

$$\begin{aligned}
&V(s_2) - V(s_4) < 0,\\
&\frac{\partial V(s_2)}{\partial \sigma^\beta} < 0,\\
&\frac{\partial V(s_4)}{\partial \sigma^\beta} > 0.
\end{aligned}$$

The derivative of the fifth term with respect to σ^β is given by

$$\begin{aligned}
&p_1p_4(-2\sigma^\beta)C_4^{-\frac{1}{\psi}}(\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} - \beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4))\\
&+ p_1p_4\beta^h\beta^l C_4^{-\frac{1}{\psi}}(X_3^l C_3(s_4)^{-\frac{1}{\psi}} + X_3^h C_3(s_1)^{-\frac{1}{\psi}})(V(s_1) - V(s_4))\\
&+ p_1p_4\beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} - \beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})\left(\frac{\partial V(s_1)}{\partial \sigma^\beta} - \frac{\partial V(s_4)}{\partial \sigma^\beta}\right)\\
&= p_1p_4(V(s_1) - V(s_4))C_4^{-\frac{1}{\psi}}\\
&\times(-2\sigma^\beta\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} + 2\sigma^\beta\beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}} + \beta^h\beta^l X_3^l C_3(s_4)^{-\frac{1}{\psi}} + \beta^h\beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})\\
&+ p_1p_4\beta^h\beta^l C_4^{-\frac{1}{\psi}}(\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} - \beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}})\left(\frac{\partial V(s_1)}{\partial \sigma^\beta} - \frac{\partial V(s_4)}{\partial \sigma^\beta}\right).
\end{aligned} \tag{26}$$

When $\sigma^\beta \ll \beta$, we have

$$-2\sigma^\beta\beta^h X_3^l C_3(s_4)^{-\frac{1}{\psi}} + 2\sigma^\beta\beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}} + \beta^h\beta^l X_3^l C_3(s_4)^{-\frac{1}{\psi}} + \beta^h\beta^l X_3^h C_3(s_1)^{-\frac{1}{\psi}} > 0.$$

Also,

$$V(s_1) < V(s_4),$$

so (26) is negative. Similarly, the derivative of sixth term with respect to σ^β is negative. Therefore, the derivative of equation (23) is negative.

□

Appendix B Data Sources and Descriptions

1. FOMC announcement dates are obtained from the website of the Board of Governors of the Federal Reserve System.

2. Daily returns of the S&P 500 Index are obtained from CRSP.

3. VIX data are obtained from the Chicago Board Options Exchange.

4. The monetary policy uncertainty measure is based on daily market data from Bauer, Lakdawala, and Mueller (2022) and is obtained from the author's website.

5. Firm-level characteristics are obtained from Compustat.

6. Daily U.S. Treasury data are based on Liu and Wu (2021) and are obtained from the author's website.

B.1 Construction of Duration Measure

This subsection outlines the procedure for constructing cash-flow duration, following the methodologies of Dechow, Sloan, and Soliman (2004) and Weber (2018). This measure represents the weighted average time to cash flow realization:

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{T} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}},$$

where $\text{Duration}_{i,t}$ is the duration of firm i at time t, $\text{CF}_{i,t+s}$ is the cash flow at time $t+s$, $P_{i,t}$ is the equity price, and r is the risk-free rate, which is assumed to be common across time and firms.

Equities do not have a well-defined finite maturity (T). Therefore, the duration formula is decomposed into a finite-period component and an infinite-horizon terminal value:

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{T} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}} + (T + \frac{1+r}{r}) \times \frac{P_{i,t} - \sum_{s=1}^{T} \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}}. \quad (27)$$

Future cash flows are decomposed into two terms and are approximated using an AR(1) process:

$$\begin{aligned} \text{CF}_{i,t+s} &= \text{E}_{i,t+s} - (\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}) \\ &= \text{BV}_{i,t+s-1}\left[\frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}} - \frac{\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}}\right]. \end{aligned} \quad (28)$$

Future return on equity $\left(\frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}}\right)$ and growth in book equity $\left(\frac{\text{BV}_{i,t+s}-\text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}}\right)$ follow an AR(1) process with mean reversion.

$$\begin{aligned} \frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}} &= (1-\rho_1)\overline{\frac{\text{E}}{\text{BV}}} + \rho_1 \frac{\text{E}_{i,t+s-1}}{\text{BV}_{i,t+s-2}}, \\ \frac{\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}} &= (1-\rho_2)\overline{\text{BVG}} + \rho_2 \frac{\text{BV}_{i,t+s-1} - \text{BV}_{i,t+s-2}}{\text{BV}_{i,t+s-2}}, \end{aligned}$$

where $\overline{\frac{\text{E}}{\text{BV}}}$ denotes the average return on equity, and $\overline{\text{BVG}}$ denotes the average growth in book equity.[7] After estimating each equation, the return on equity has an AR(1) coefficient of 0.67, while the growth in book equity has an AR(1) coefficient of 0.18.

Given these parameters, the procedure to calculate one-period-ahead cash flow is as follows:

1. Compute $\frac{\text{BV}_{i,t+s+1}-\text{BV}_{i,t+s}}{\text{BV}_{i,t+s}}$ with AR(1) process.
2. Compute $\frac{\text{E}_{i,t+s+1}}{\text{BV}_{i,t+s}}$ with an AR(1) process.
3. Compute $\text{CF}_{i,t+1}$ using equation (28).
4. Update $\text{BV}_{i,t+1}$ with

$$\text{BV}_{i,t+1} = \left(1 + \frac{\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}}\right)\text{BV}_{i,t+s-1}.$$

[7] These are set to 0.03 and 0.015, respectively, with the risk-free rate fixed at 0.03 and the terminal period T set to 60 quarters, as specified in Weber (2018).

This is a recursive procedure in which n-period-ahead cash flows are calculated in the same manner. Duration is then measured using these future cash flows and equation (27).

B.2 Derivation of Equation (1)

This subsection derives the equation (1). The cash-flow duration is given by

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{\infty} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}}.$$

This equation is decomposed into a finite term and an infinite term:

$$\begin{aligned}\text{Duration}_{i,t} = & \frac{\sum_{s=t}^{T} s \times \text{CF}_{i,t+s}/(1+r)^s}{\sum_{s=t}^{T} \text{CF}_{i,t+s}/(1+r)^s} \frac{\sum_{s=t}^{T} \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}} \\ & + \frac{\sum_{s=T+1}^{\infty} s \times \text{CF}_{i,t+s}/(1+r)^s}{\sum_{s=T+1}^{\infty} \text{CF}_{i,t+s}/(1+r)^s} \frac{\sum_{s=T+1}^{\infty} \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}}. \end{aligned} \tag{29}$$

It is assumed that the terminal cash flow stream is equal to the difference between the observed market value implied by the stock price and the present discounted value of cash flows over the finite period,

$$\sum_{s=T+1}^{\infty} \text{CF}_{i,t+s}/(1+r)^s = P_{i,t} - \sum_{s=t}^{\infty} \text{CF}_{i,t+s}/(1+r)^s. \tag{30}$$

It is also assumed that after $t = T$ the cash flow is constant over time. Then,

$$\frac{\sum_{s=T+1}^{\infty} s \times \text{CF}_{i,t+s}/(1+r)^s}{\sum_{s=T+1}^{\infty} \text{CF}_{i,t+s}/(1+r)^s} = T + \frac{1+r}{r}.$$

By substituting this and equation (30) into equation (29), we obtain the equation (1).

B.3 Negative relationship between cash-flow duration and book-to-market

Section 6.2 uses the book-to-market ratio as an alternative measure of duration for robustness checks. In this subsection, a linear relationship between cash-flow duration and the book-to-market ratio is derived under certain assumptions.

The cash-flow duration is defined as

$$\text{Duration}_{i,t} = \frac{\sum_{s=1}^{T} s \times \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}} + (T + \frac{1+r}{r}) \times \frac{P_{i,t} - \sum_{s=1}^{T} \text{CF}_{i,t+s}/(1+r)^s}{P_{i,t}},$$

and with the accounting identity, net cash distribution is given by

$$\text{CF}_{i,t+s} = \text{BV}_{i,t+s-1} \left[\frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}} - \frac{\text{BV}_{i,t+s} - \text{BV}_{i,t+s-1}}{\text{BV}_{i,t+s-1}} \right].$$

If we assume that the growth in the book value of equity is zero for all finite periods ($\text{BV}_{i,t+s-1} = \text{BV}_{i,t+s}$) and the return on equity is constant over the periods $\left(\frac{\text{E}_{i,t+s}}{\text{BV}_{i,t+s-1}} = \frac{\text{E}_{i,t}}{\text{BV}_{i,t-1}} \right)$, then $\text{CF}_{i,t+s} = \text{E}_{i,t}$ holds.

Under this assumption, cash-flow duration can be written as

$$\text{Duration}_{i,t} = T + \frac{1+r}{r} - T \frac{\text{E}_{i,t}}{r P_{i,t}}.$$

Also assume that the return on equity is always equal to the cost of capital, $\frac{E_{i,t}}{BV_{i,t-1}} = r$. Then, duration can be written as

$$\text{Duration}_{i,t} = T + \frac{1+r}{r} - T \frac{\text{BV}_{i,t}}{P_{i,t}}.$$

In this special case, duration is negatively and linearly related to the book-to-market ratio.

Appendix C Sensitivity Analysis for Bonds

This section presents a sensitivity analysis for bond returns.

Alternative Measure for Zero-Coupon Bonds In the baseline analysis, Treasury bond returns are taken from Liu and Wu (2021), in which the yield curve is estimated using a nonparametric kernel-smoothing method. We also incorporate an alternative dataset on zero-coupon Treasury bonds from Gürkaynak, Sack, and Wright (2007), which estimates the forward rate using a parametric approach.

The empirical specification is given in equation (6), and the results are reported in Table 8. The uncertainty measure is IRU in the first and second columns, BP vol in the third and fourth columns, and MOVE in the fifth and sixth columns. The findings are consistent with the baseline results, showing a significantly negative interaction between duration and the uncertainty measure across all specifications. Moreover, the estimated values, ranging from -0.14 to -0.21, are comparable to the baseline.

Table 8: The Elasticity of Returns to Changes in Uncertainty Conditional on Duration: Alternative Measure for Zero-Coupon Bonds.

	(1)	(2)	(3)	(4)	(5)	(6)
IRU	-3.052***	-2.069***				
	(0.5141)	(0.4990)				
Duration × IRU	-0.1484*	-0.2114**				
	(0.0875)	(0.0819)				
BP vol			-2.303***	-1.638***		
			(0.3868)	(0.3702)		
Duration × BP vol			-0.1198**	-0.1578***		
			(0.0498)	(0.0489)		
MOVE					-1.556***	-0.9002*
					(0.4642)	(0.4857)
Duration × MOVE					-0.0867	-0.1460*
					(0.0808)	(0.0784)
Controls		✓		✓		✓
R^2	0.07344	0.10340	0.07359	0.10399	0.03637	0.07745
Observations	7,047	7,018	7,047	7,018	7,047	7,018

Note: Table 8 reports the coefficient estimates from the pooled regression of Treasury bond returns. The explanatory variables include the change in interest rate risk, duration, and their interaction. Standard errors are clustered by time. The dependent variables are Treasury bond returns of different maturities, expressed in basis points. Columns (2) and (4) additionally include the two-day change in VIX, the monetary policy shock, the interaction between the change in VIX and duration, and the interaction between the monetary policy shock and duration. The regression equation is

$$\text{Return}_{n,t} = \beta_1 \Delta IRU_t + \beta_2 \text{Duration}_{n,t} + \beta_3 \Delta IRU_t \times \text{Duration}_{n,t} + \gamma X_{n,t} + \epsilon_{n,t},$$

where $\text{Return}_{n,t}$ is the return on bonds with duration of n years at the t-th FOMC meeting, ΔIRU_t is the change in interest rate risk at the t-th FOMC meeting, and $\text{Duration}_{n,t} = n$, since the bonds mature in n years. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Different Time Subsample We also conduct a subsample analysis by dividing the sample period into the pre-crisis (1990–2007) and post-crisis (2008–2019) periods. The empirical specification follows equation (6), with the uncertainty measure given by the benchmark interest rate risk variable, IRU_t. The results are reported in Table 9. Columns (1) and (2) use the pre-crisis period, while columns (3) and (4) use the post-crisis period. The results are consistent across the subsamples: the interaction term between duration and the uncertainty measure is significantly negative. Overall, the findings are robust to the choice of uncertainty measure and subsample period.

Quantitatively, the coefficients for the post-crisis period are smaller in absolute value. During this period, the nominal interest rate is close to zero, and investors face less uncertainty about future interest rates. As a result, the resolution of interest rate risk is less significant, and the response of returns to this resolution is smaller in the post-crisis period.

Table 9: Bond Return Sensitivity to Interest Rate Risk: Different Time Subsample.

	(1)	(2)	(3)	(4)
IRU	-2.149***	-1.010**	-3.190***	-2.350***
	(0.5889)	(0.4584)	(0.8077)	(0.7801)
Duration × IRU	-0.3196***	-0.3139***	-0.2115	-0.2840***
	(0.1146)	(0.1161)	(0.1474)	(0.0996)
Controls		✓		✓
R^2	0.10815	0.13756	0.10013	0.24261
Observations	4,321	4,292	2,726	2,726

Note: Table 9 reports the coefficient estimates from the pooled regression of Treasury bond returns for the 1990–2019 subsample analysis. The explanatory variables include the change in interest rate risk, duration, and their interaction. Standard errors are clustered by time. The dependent variables are Treasury bond returns of different maturities, expressed in basis points. Columns (1) and (2) use the pre-crisis period (1990–2007), while columns (3) and (4) use the post-crisis period (2008–2019). Columns (2) and (4) additionally include the two-day change in VIX, the monetary policy shock, the interaction between the change in VIX and duration, and the interaction between the monetary policy shock and duration. The regression equation is

$$\text{Return}_{n,t} = \beta_1 \Delta IRU_t + \beta_2 \text{Duration}_{n,t} + \beta_3 \Delta IRU_t \times \text{Duration}_{n,t} + \gamma X_{n,t} + \epsilon_{n,t},$$

where $\text{Return}_{n,t}$ is the return on bonds with duration of n years at the t-th FOMC meeting, ΔIRU_t is the measured change in interest rate risk at the t-th FOMC meeting, and $\text{Duration}_{n,t} = n$, since the bonds mature in n years. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Different Bond Maturities In the baseline analysis, we use bonds with maturities ranging from one to twenty-nine years, in one-year increments. This section examines the sensitivity of the results to the choice of maturity range. We analyze three alternative datasets: maturities from one to five years, from one to ten years, and from eleven to twenty-one years, all in one-year increments. The empirical specification follows equation (6), with the uncertainty measure given by the benchmark interest rate risk variable, IRU_t. The results are reported in Table 10. Columns (1) and (2) use maturities from one to five years, columns (3) and (4) use maturities from one to ten years, and columns (5) and (6) use maturities from eleven to twenty-one years.

The results are consistent across maturities, showing a significantly negative interaction term between duration and the uncertainty measure. The estimated coefficients are larger in absolute value for shorter-maturity bonds (columns (1) and (2)) and smaller for longer-maturity bonds (columns (5) and (6)). This suggests that monetary policy has a stronger influence on discount factors for shorter maturities, with the effect diminishing for longer ones. For example, when investors discount a consumption claim twenty years into the future, the discount factor is much less affected by monetary policy announcements.

Table 10: The Elasticity of Returns to Changes in Uncertainty Conditional on Duration: Different Bond Maturities.

	(1)	(2)	(3)	(4)	(5)	(6)
IRU	0.5630***	0.6244***	0.0160	0.4067**	-4.834***	-3.414***
	(0.1384)	(0.1507)	(0.2061)	(0.1974)	(1.190)	(1.182)
Duration × IRU	-0.8382***	-0.6620***	-0.7066***	-0.6426***	-0.1649*	-0.2113**
	(0.1430)	(0.1367)	(0.1484)	(0.1366)	(0.0986)	(0.0887)
Controls		✓		✓		✓
R^2	0.20908	0.40314	0.21159	0.31556	0.13206	0.19064
Observations	972	968	2,430	2,420	2,430	2,420

Note: Table 10 reports the coefficient estimates from the pooled regression of Treasury bond returns. The explanatory variables include the change in interest rate risk, duration, their interaction, and control variables. Standard errors are clustered by time. The dependent variables are Treasury bond returns of different maturities, expressed in basis points. Columns (1) and (2) use maturities from one to five years, columns (3) and (4) use maturities from one to ten years, and columns (5) and (6) use maturities from eleven to twenty-one years. The regression equation is

$$\text{Return}_{n,t} = \beta_1 \Delta IRU_t + \beta_2 \text{Duration}_{n,t} + \beta_3 \Delta IRU_t \times \text{Duration}_{n,t} + \gamma X_{n,t} + \epsilon_{n,t},$$

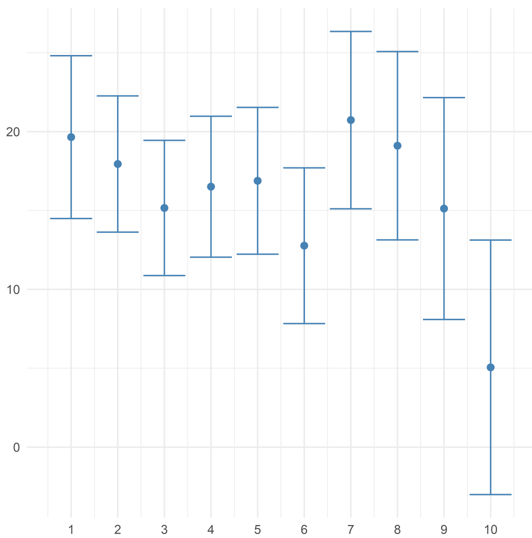
where $\text{Return}_{n,t}$ is the return on bonds with a duration of n years at the t-th FOMC meeting, ΔIRU_t is the measured change in interest rate risk at the t-th FOMC meeting, and $\text{Duration}_{n,t} = n$, since the bonds mature in n years. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

Appendix D Sensitivity Analysis for Equities

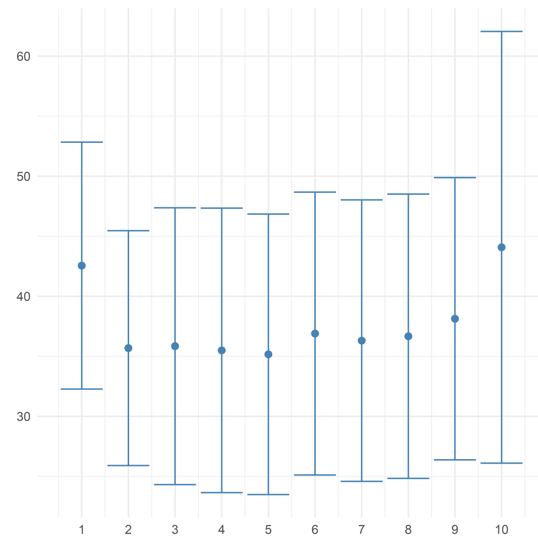
D.1 Sensitivity to Alternative Time Subsamples

D.1.1 Average Returns on Equities

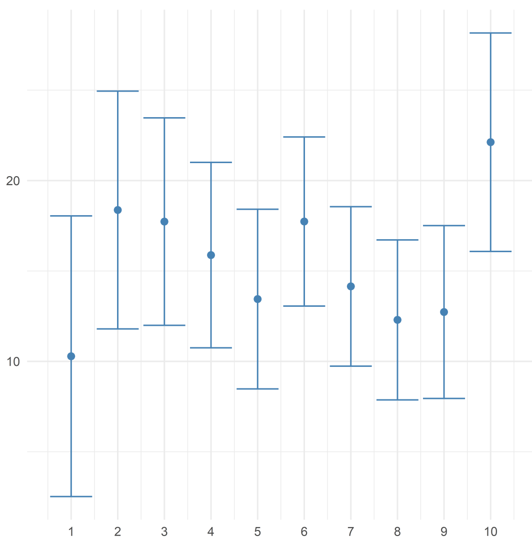
Figure 8 presents the average returns of portfolios sorted by cash-flow duration. Panels (a) and (c) use the sample from 1990–2007, while panels (b) and (d) use the sample from 2007–2019. In panels (a) and (b), portfolios are sorted by cash-flow duration, whereas in panels (c) and (d), portfolios are sorted by the book-to-market ratio. The average returns of short- and long-duration portfolios are indistinguishable in both the pre- and post-crisis periods.



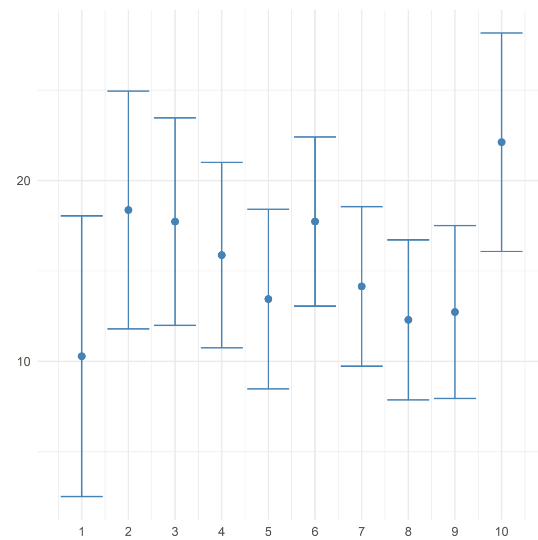
(a) Before 2009



(b) After 2008



(c) Before 2009 and by Book-to-Market



(d) After 2008 and by Book-to-Market

Figure 8: Average Returns Conditional on Duration: Different Time Subsamples.

Note: Figure 8 plots the time-series average of portfolio returns on FOMC days. The horizontal axis represents portfolio duration, ranging from short (one) to long (ten). The vertical axis represents the average return on FOMC days for each portfolio. Equities are sorted into ten groups based on duration, and the average return within each group is calculated. Portfolios are rebalanced every quarter. Panels (a) and (c) use the 1990–2007 sample, while panels (b) and (d) use the 2007–2019 sample. Panels (a) and (b) sort portfolios by cash-flow duration, whereas panels (c) and (d) sort portfolios by the book-to-market ratio.

D.1.2 The Elasticity of Returns to Interest Rate Risk

Table 11 estimates a regression of the form (8) using different time subsamples. Columns (1) and (2) use the 1990–2007 sample, while columns (3) and (4) use the 2007–2019 sample. The results are similar across the two periods: the interaction term between interest rate risk and duration is negative and significant in both samples.

Table 11: The Elasticity of Returns to Interest Rate Risk Conditional on Duration.

	(1)	(2)	(3)	(4)
Duration × IRU	-0.2303***	-0.2379***	-0.6256***	-0.6582***
	(0.0451)	(0.0484)	(0.1279)	(0.0989)
Profit × IRU		10.21**		1.810
		(4.750)		(19.73)
Leverage × IRU		0.1842		-5.376***
		(1.002)		(1.636)
Sales growth × IRU		-0.3396		-4.742**
		(0.7310)		(1.915)
IRU	0.7087	1.618	-2.987	6.362***
	(0.8280)	(1.067)	(2.054)	(1.577)
R^2	0.00120	0.02392	0.01521	0.06516
Observations	530,068	466,974	245,438	231,323
Controls		✓		✓
Firm fixed effects		✓		✓
Year fixed effects		✓		✓

Note: Table 11 reports the coefficient estimates from the pooled regression of equity returns across 240 FOMC event days. The explanatory variables include the change in the uncertainty measure, duration, their interaction, and control variables. Control variables include (i) firm and year fixed effects and (ii) the interaction of firm characteristics with the change in interest rate risk. Standard errors are clustered at the firm level. Columns (1) and (2) use the 1990–2007 sample, while columns (3) and (4) use the 2007–2019 sample. Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

D.2 Sensitivity to Parameters in Cash-Flow Duration

To construct the cash-flow duration, the required parameters include the persistence in ROE (ρ_1), the persistence in sales growth (ρ_2), the long-run growth rate in sales ($\overline{\text{BVG}}$), the long-run growth rate in ROE $\left(\overline{\frac{E}{BV}}\right)$, the discount rate ($r$), and the forecasting horizon (T). All variables are defined in Appendix B.1.

We conduct a sensitivity analysis by varying the parameters. The baseline case is set as $\rho_1 = 0.67$, $\rho_2 = 0.18$, $\overline{\text{BVG}} = 0.015$, $\overline{\frac{E}{BV}} = 0.03$, $r = 0.03$, and $T = 60$ quarters (15 years). One parameter is changed at a time while the others are held constant. Specifically, the persistence in ROE is set to 0.55 and 0.75 (baseline 0.67); the persistence in sales growth to 0.1 and 0.3 (baseline 0.18); the long-run growth rate in sales to 0.01 and 0.02 (baseline 0.015); the long-run growth rate in ROE to 0.02 and 0.04 (baseline 0.03); the discount rate to 0.025 and 0.035 (baseline 0.03); and the forecasting horizon to 12 years and 18 years (baseline 15 years).

D.2.1 Average Returns on FOMC Days

We calculate the cash-flow duration for each firm under twelve different parameter values. Firms are then sorted by duration, and we estimate the average returns on FOMC days for each portfolio. Figures 9 and 10 plot the average return against cash-flow duration under twelve different parameter values. In each figure, one parameter is varied while the others are held fixed at their baseline values.

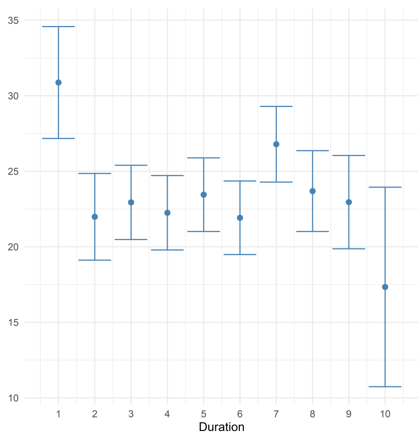
D.2.2 Interest Rate Uncertainty and the Contemporaneous Relationship

This subsection presents a sensitivity analysis of the elasticity of equity returns to interest rate risk. After calculating cash-flow duration under different parameter values and sorting firms by duration, we regress portfolio returns on changes in interest rate risk. The equation is

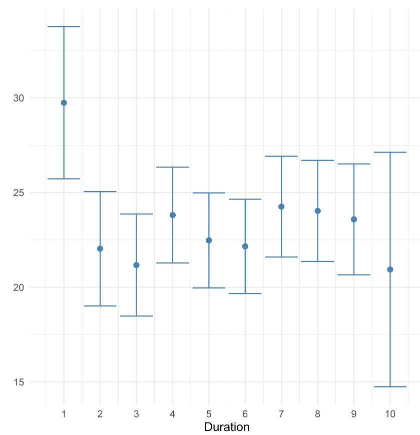
$$y_t^m = \beta^m \Delta \mathrm{IRU}_t + \epsilon_t^m, \tag{31}$$

where $\Delta\mathrm{IRU}_t$ is the change in interest rate risk, and portfolios are indexed by $m \in \{1, \cdots, 10\}$.

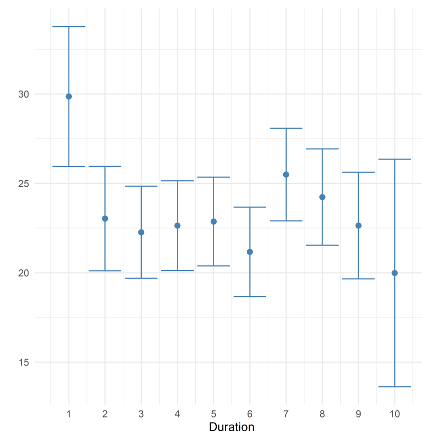
Figure 11 and 12 show the coefficients β^m for each portfolio m along with their two standard error bands. The figures demonstrate that the elasticity of equity returns to interest rate risk increases with duration in absolute value. This result does not depend on the parameter values assumed when calculating cash-flow duration.



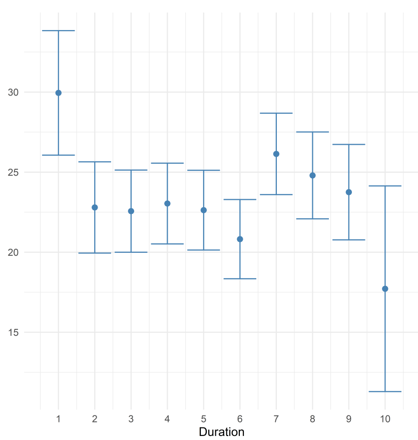
(a) $\rho_1 = 0.75$



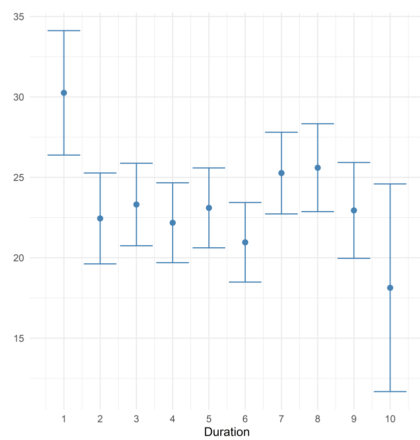
(b) $\rho_1 = 0.55$



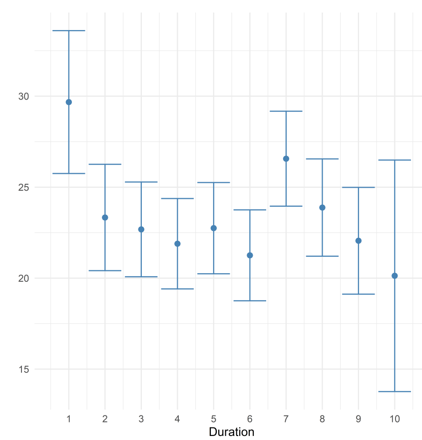
(c) $\rho_2 = 0.3$



(d) $\rho_2 = 0.1$



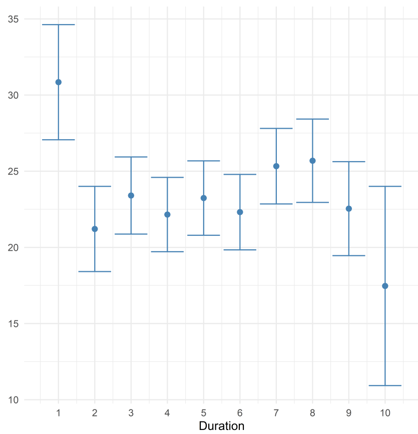
(e) $r = 0.02$



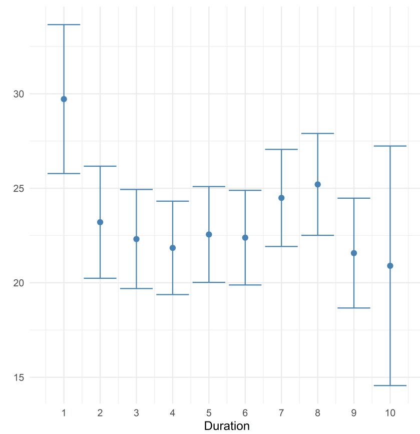
(f) $r = 0.01$

Figure 9: Sensitivity Analysis for Average Returns.

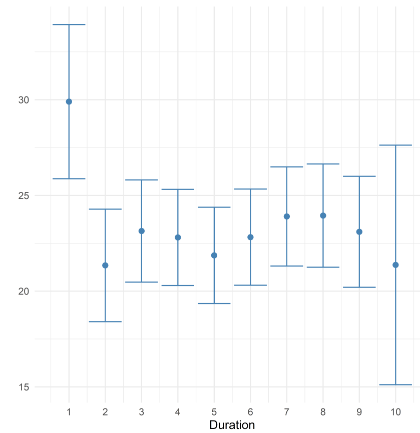
Note: Figure 9 plots the time-series average of portfolio returns on FOMC days under different parameter values. The horizontal axis represents portfolio duration, ranging from short (one) to long (ten). The vertical axis represents the average return on FOMC days for each portfolio. Equities are sorted into ten groups, from low to high, based on duration, and the average return within each group is calculated. Each panel varies one parameter at a time while holding the others constant.



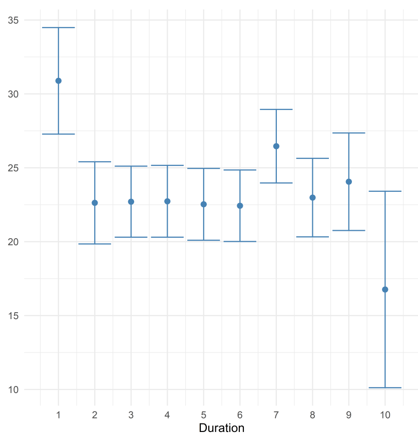
(a) $\overline{BVG} = 0.02$



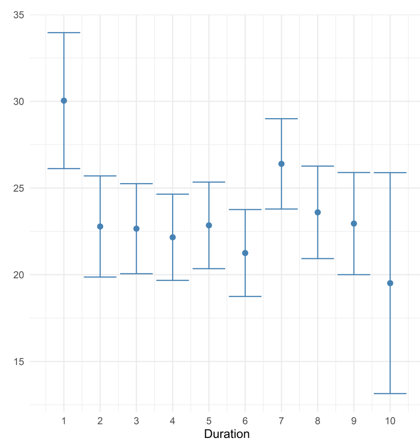
(b) $\overline{BVG} = 0.01$



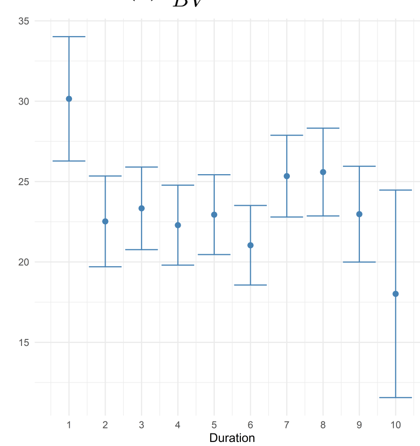
(c) $\overline{\frac{E}{BV}} = 0.04$



(d) $\overline{\frac{E}{BV}} = 0.02$



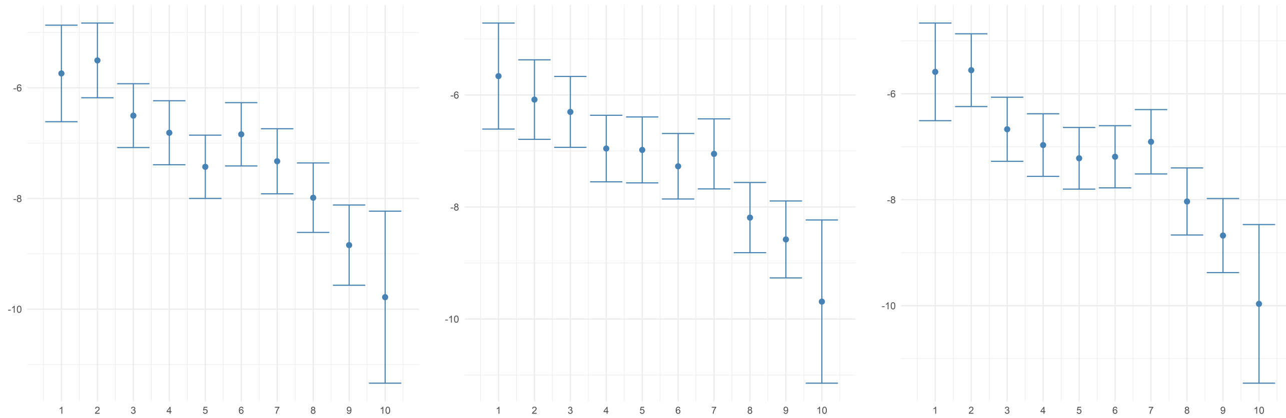
(e) $T = 18$ years



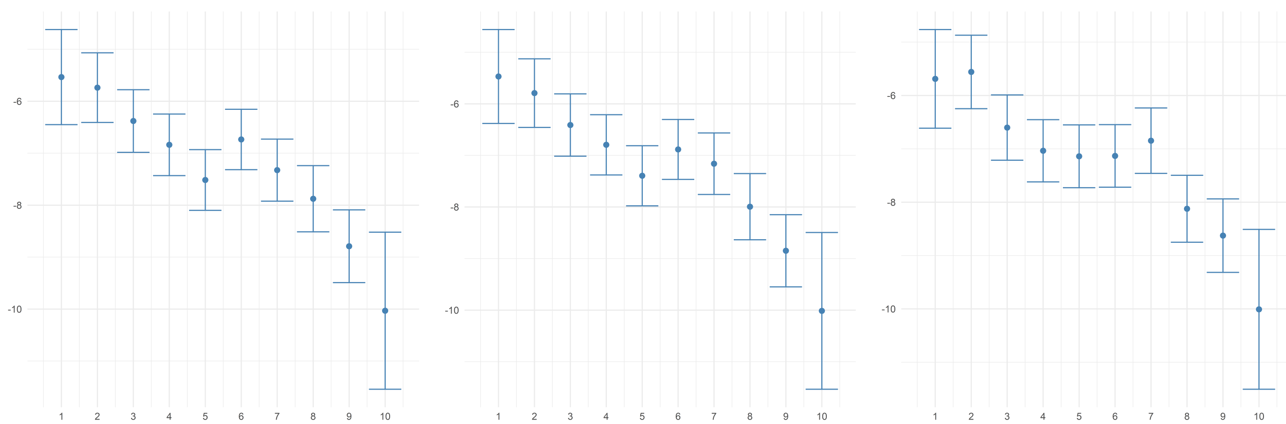
(f) $T = 12$ years

Figure 10: Sensitivity Analysis for Average Returns.

Note: Figure 10 plots the time-series average of portfolio returns on FOMC days under different parameter values. The horizontal axis represents portfolio duration, ranging from short (one) to long (ten). The vertical axis represents the average return on FOMC days for each portfolio. Equities are sorted into ten groups, from low to high, based on duration, and the average return within each group is calculated. Each panel varies one parameter at a time while holding the others constant.



(a) $\rho_1 = 0.75$ (b) $\rho_1 = 0.55$ (c) $\rho_2 = 0.3$



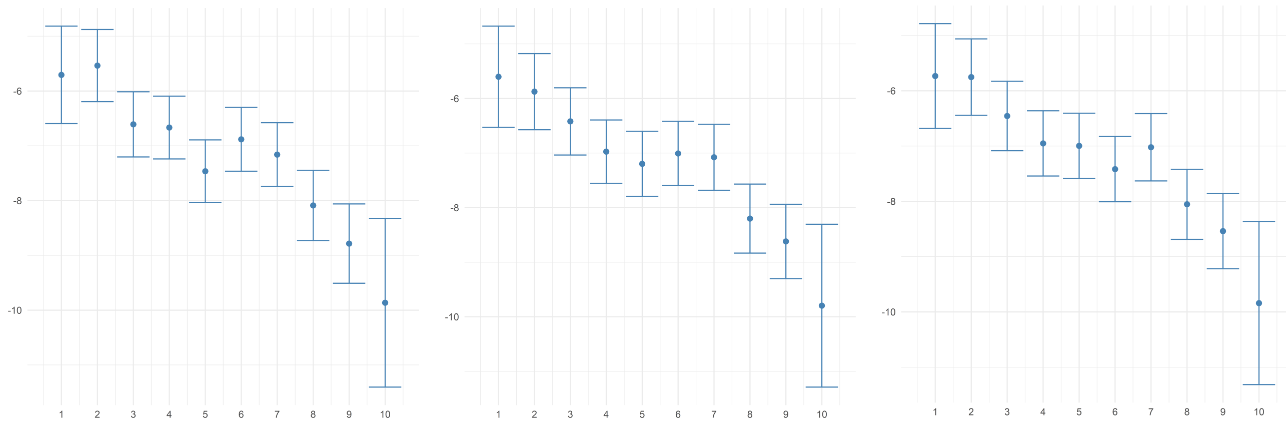
(d) $\rho_2 = 0.1$ (e) $r = 0.02$ (f) $r = 0.01$

Figure 11: Sensitivity Analysis for the Elasticity to Interest Rate Risk.

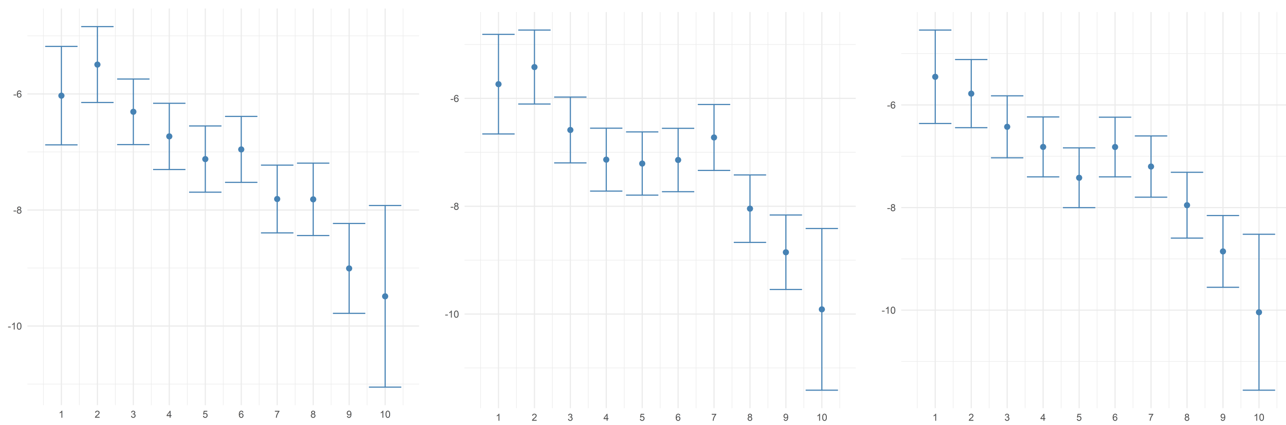
Note: Figure 11 shows the sensitivity of equity returns to changes in interest rate risk. We separately regress portfolio returns on changes in the uncertainty measure,

$$y_t^m = \beta^m \Delta \text{IRU}_t + \epsilon_t^m, \tag{32}$$

where ΔIRU_t is the change in interest rate risk and portfolios are indexed by $m \in \{1, \cdots, 10\}$. The interest rate risk measure is taken from Bauer, Lakdawala, and Mueller (2022). The vertical axis plots the coefficients β^m for each portfolio m along with their two standard error bands. In each panel, one parameter is varied while the others are held constant.



(a) $\overline{BVG} = 0.02$ (b) $\overline{BVG} = 0.01$ (c) $\overline{\frac{E}{BV}} = 0.04$



(d) $\overline{\frac{E}{BV}} = 0.02$ (e) $T = 18$ years (f) $T = 12$ years

Figure 12: Sensitivity Analysis for the Elasticity to Interest Rate Risk.

Note: Figure 12 shows the sensitivity of equity returns to changes in interest rate risk. We separately regress portfolio returns on changes in the uncertainty measure,

$$y_t^m = \beta^m \Delta \text{IRU}_t + \epsilon_t^m, \tag{33}$$

where ΔIRU_t is the change in interest rate risk and portfolios are indexed by $m \in \{1, \cdots, 10\}$. The interest rate risk measure is taken from Bauer, Lakdawala, and Mueller (2022). The vertical axis plots the coefficients β^m for each portfolio m along with their two standard error bands. Each panel varies one parameter at a time while holding the others constant.