Pre-Announcement Risk

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Abstract

I propose and test a new explanation for the pre-FOMC announcement drift puzzle. I show that such a drift arises in a model where investors interpret a given FOMC action differently based on recent news. If recent news has been good, FOMC announcements are seen as signals about economic conditions; if recent news has been poor, they are seen as signals about the Fed's own policy stance. Consistent with the model, I demonstrate that the market return prior to the announcement—a proxy for recent news—predicts the interpretation of Fed action. In the model, the pre-FOMC drift represents a risk premium associated with the resolution of uncertainty about announcement type. The model does not require informational leaks or biased beliefs and can account for the seasonality of aggregate returns over the FOMC calendar.

1 Introduction

Recent work by Lucca and Moench (2015) establishes a striking pattern of upward drift in the aggregate equity market in anticipation of Federal Open Market Committee (FOMC) announcements. From 1994 to 2019, an investor would have seen an average return of 176 bps per year by holding the equity market in the intraday trading before the eight annually scheduled FOMC announcements. This is puzzling because risk premia should be earned when uncertainty is resolved.

In this paper I propose and test a model that attributes these elevated returns to a risk premium. Specifically, I show that a pre-announcement risk premium arises if Fed action is interpreted by market participants based on news learned in the run-up to the announcement. The model does not rely on leaked information and investors have, on average, correct expectations about announcement content.

The key element of the model is that the Fed can affect asset prices via at least two distinct channels. Apart from the traditional policy channel, a number of recent papers have demonstrated

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the existence of an informational channel.[1] This informational channel of Fed action affects asset prices via expectations of growth rates going forward, or by changing investors' risk perceptions. In direct contrast to the standard mechanism, a surprise funds rate increase tends to bring about higher market valuations via the informational effect. Any Fed pronouncement, then, is a mixture of the two distinct types of information. The same action by the Fed—say a surprise cut in the funds rate—can have a dissimilar impact on asset prices, depending on the news in the run-up to the announcement.

I build on this literature and show that the manner in which a given announcement is interpreted is predictable with information learned in the run-up to the announcement. Namely, if recent news has been good, the Fed announcement tends to be interpreted as a reflection of the Fed's belief about growth rates going forward. If recent news has been poor, the Fed announcement tends to be interpreted as a reflection of its own policy stance. Put differently, Fed action is interpreted as a traditional policy shock precisely in bad times.

From an asset pricing perspective, this feature of the announcements gives rise to a risk premium earned in the run-up to the announcement. Consider an investor with Epstein-Zin preferences who is anticipating a Fed announcement in a terminal period. The Fed statement can be interpreted in one of two ways, as described above. In the periods leading up to the announcement the investor learns about the value of a state variable that governs the interpretation of the Fed announcement. As long as the announcement commands a different risk premium under the two interpretations, any resolution of uncertainty about announcement type will affect the continuation value of the investor's value function. Innovations to the state variable that govern the announcement type therefore constitute a priced risk in the pre-announcement period.

In the model uncertainty about the announcement is resolved only when the news release is made—there are no informational leaks. In contrast, the state variable that determines the announcement interpretation follows a mean-reverting process. Because of the mean reversion, uncertainty about its value at a fixed future date declines at an increasing rate in the run-up to the scheduled event. As a result, valuations grow at an increasing rate as the Fed meeting approaches. This explanation does not require any news leakage about the announcement itself during the pre-announcement drift window, but it is vital that there is some uncertainty regarding the action the Fed will take. The model of pre-announcement spells out the conditions under which an announcement risk premium gives rise to a pre-announcement risk premium: the key requirement is that the two announcement interpretations command a different risk premium. In practice, I find that the risk premium associated with traditional policy announcements is considerably higher than that of the informational announcements.

Put differently, the model demonstrates how predictable announcement type combined with differences in risk premia at announcement time give rise to a pre-announcement drift. To demonstrate the quantitative relevance of the proposed mechanism, I pick an asset pricing model that can ac-

[1]Examples include Gurkaynak et al. (2005), Matheson and Stavrev (2014), Boyarchenko et al. (2017), Kroencke et al. (2019), Cieslak and Schrimpf (2019), Jarociński and Karadi (2020), Leombroni et al. (2020), Nakamura and Steinsson (2018), and Paul (2019).

count for the announcement time risk return trade-off and demonstrate it is able to match the pre-announcement evidence. The model is silent on the ultimate source of the ability of monetary policy to impact asset markets. Instead, it shows how a successful calibration to fundamentals can also account for the pre-announcement evidence.

Let me contrast the proposed explanation of the pre-announcement drift with existing literature, notably the account in Cieslak et al. (2019). These authors establish that the pre-FOMC announcement drift is part of a broader cyclical pattern—expected returns are high on even weeks following the FOMC announcement. They argue these periodic high expected returns stem from a combination of two factors: (potentially informal) communications from the Fed that tend to be concentrated on even weeks of the FOMC calendar, and a persistent underestimation by market participants of the amount of accommodation the Fed is willing or able to provide. The model proposed here attributes the high even week returns to a risk premium effect that arises under investor beliefs that are, on average, correct. Because Fed announcements are interpreted conditional on the state of economy at announcement time, the times leading up to communications from the Fed are riskier from investors' perspective. The discrete timing of announcements induces a seasonality in market expected returns, even if fundamentals have a constant volatility.

Regardless of the reasons behind the cyclicality in market returns over the FOMC calendar, the high returns in the last days before Fed announcements are hard to square with leaks or biased expectations. If the drift is caused by leaked information, the realized pre-announcement return should predict with a positive sign the market response to the announcement, which is not true in the data. Likewise, if the drift is caused by a bias in investor expectations, the same bias should be evident in Fed funds futures market, which is also not true in the data. The model presented here can rationalize pre-announcement returns in the absence of any corresponding changes in funds futures prices. The existing work that attributes the pre-announcement drift to a leak, such as Cieslak et al. (2019) mentioned above, as well as Ai and Bansal (2018), has difficulty accounting for the lack of positive autocorrelation between pre- and post-announcement returns.

To provide empirical support for the model proposed here I build on recent work by Cieslak and Schrimpf (2019) and Jarociński and Karadi (2020) to classify Fed announcements based on the realized stock-bond covariance immediately following an announcement. These authors show that a traditional monetary policy shock is associated with positive stock-bond return covariance, while a shock to growth rate expectations is associated with a negative stock-bond covariance. Extending their work, I demonstrate that the type of announcement can be predicted using pre-announcement returns: poor market returns in the run-up tend to be followed by an announcement with positive stock-bond covariance; good returns tend to be followed by negative stock-bond covariance. Put differently, the inter-meeting market return informs investors' interpretation of the Fed action. Similarly to Rigobon and Sack (2003) and Cieslak and Vissing-Jorgensen (forthcoming), I argue that market returns contain information about Fed announcements, but I find it is the *type* of announcement that can be gleaned from pre-announcement market behavior. In line with model assumption, I confirm that the two announcement types command a different risk premium: tradi-

tional monetary policy shocks see a positive risk premium, while the informational announcements see a negative risk premium on announcement. The model predicts a pre-announcement drift whenever the associated risk premia are different, irrespective of the absolute sizes or signs. That the two announcement types see opposite sign risk premia helps rationalize the fact that the average post-announcement return is roughly zero.

This predictability of announcement type is evident at short horizons: intraday return on the announcement day predicts the announcement type. In other words, the way an announcement is interpreted by the market depends on very short-lived signals. Calibrating the model allows me to quantify this statement: the state variable that governs announcement type has an autocorrelation of .8 in the daily data. Underlying this dependence on late-breaking developments could be a tendency of the Fed to focus on recent news, a belief on the part of market participants that the Fed behaves this way, or a feedback effect as described in Stein and Sunderam (2018). This isn't to say that the Fed is never responding to news that occurs more than a couple of days before scheduled meetings. Predictable moves at announcement time are by that point priced in and do not contribute to return innovations in the pre-announcement window. Rather, substantial news that happens to arrive just before the Fed announcement tends to have a strong impact on how the surprise component of the announcement is interpreted. Indeed, it is the case empirically that the pre-announcement drift is stronger when the residual uncertainty about the policy move is higher.

It is evident from transcripts of FOMC meetings that policymakers pay close attention to market and non-market news arriving just before the decision is made. I highlight a number of quotes from FOMC meeting transcripts where late-breaking news is put forth as pivotal with respect to the policy decision. Of the 160 scheduled FOMC meetings from 1994 to 2013, the transcripts of 87 contain mention of macroeconomic news announcements that happened in the morning of the meeting. Many others contain discussion of stock-, bond-, or Funds futures market behavior during the meeting. (In the 1990s FOMC transcripts sometimes note the use of "electronic market monitors" by committee members to follow asset market developments during the meeting.) In order to provide more systematic evidence, I count phrases like "this morning" and "this week" in the FOMC transcripts and show that the frequency of such phrases is positively correlated with the strength of the pre-announcement drift.

Other empirical facts are consistent with the model of pre-announcement drift proposed here. In the time series, I show that the strength of the upward drift is predictable using measures of stock market volatility or monetary policy uncertainty. In the cross-section, I show that the CAPM beta predicts drift strength across asset classes, consistent with the model claim that the drift represents a reduction in the risk premium. This observation rationalizes the behavior of Treasury and FX prices in the pre-announcement window. Lucca and Moench (2015) find no pre-announcement drift in Treasury prices, while Karnaukh (2020) and Borisenko and Pozdeev (2017) find substantial predictability in currency returns around FOMC announcements. I show that accounting for the time-variation in FX and Treasury portfolios' respective market betas, the pre-announcement returns are consistent with contemporaneous stock market returns. Finally, I carry

out a calibration to demonstrate that the model can quantitatively match the pre-announcement returns with standard assumptions about preference parameters and volatility of fundamentals.

Why would the Fed condition its statements on recent information? I provide a framework under which the Fed finds it optimal to operate in this manner. The underlying mechanism is the same that makes the investors demand high expected returns prior to the announcement: the Fed actions impact markets via a direct effect, as well as via an informational effect. Recognizing a trade-off between the optimal policy choice with respect to the direct and informational impact, the Fed adopts an announcement strategy under which it conditions its policy objective on announcement time market conditions. In effect, the Fed uses recent news to better signal its intent. The model implicitly assumes that the full disclosure of the Fed's private information is a non-viable strategy. Much of the existing literature on Fed's communications recognizes that such a restriction arises as a result of a time-consistency problem inherent in Fed policy making (examples include Barro and Gordon (1983) and Stein (1989)).

Combining the model of pre-announcement risk with the model of Fed behavior provides a rationale for the striking cyclicality of expected returns over the FOMC calendar documented by Cieslak et al. (2019). On the one hand, the Fed optimally adopts a conditional announcement policy to make its announcements more informative. On the other hand, by making its announcements conditional on recent news, the Fed creates more risk that is resolved in the run-up. The benefits of Fed action—lower expected returns—accrue at a constant rate over time. The costs of Fed action—high required returns pre-announcement—accrue predominantly right before the announcement. As a result, market returns display a notable seasonality over the FOMC calendar. According to the model, should the Fed decide to do less to counter aggregate fluctuations, the pre-announcement drift would be lower, but expected returns in other times would increase. The fact that pre-FOMC returns are high does not necessarily imply that in a world without the Fed average returns would be lower.

My results have applications outside the topic of monetary policy transmission. The mechanism I use to account for the pre-FOMC drift predicts a pre-announcement drift in any situation featuring time-varying risk loadings and discrete arrival of news. Indeed, I find evidence of a market-level pre-announcement drift before important macroeconomic news announcements (MNAs). As already reported in Frazzini and Lamont (2007) and Hartzmark and Solomon (2013), there is a pre-announcement drift before scheduled earnings and dividend announcements. Consistent with the model here, I demonstrate that such drift is particularly strong for high CAPM beta stocks.

In the final section of the paper, I discuss alternative explanations of the pre-announcement drift, particularly the hypothesis that attributes these returns to informational leaks from the Fed. I demonstrate that the leaks hypothesis is inconsistent with a key prediction: realized returns in the pre-announcement window should predict the market response to the announcement itself. I conclude with a discussion of other related literature.

2 Model

The model separately studies the two sides of the Fed announcement. Firstly, I will show that investors demand a pre-announcement risk premium because of the dependence of announcement interpretation on pre-announcement news. Secondly, I will write down a model in which the Fed finds it constrained optimal to communicate in this manner.

Underlying both parts of the model is the observation that Fed announcements affect financial markets at least via two distinct channels. A number of recent papers have provided theoretical and empirical support to this effect. Broadly speaking, the surprise component of a Fed announcement might represent a change in the expected path of real rates, or it might correspond to news about the Fed's expectation of economic growth going forward. Examples of papers studying the separate channels include Gurkaynak et al. (2005), Matheson and Stavrev (2014), Boyarchenko et al. (2017), Kroencke et al. (2019), Cieslak and Schrimpf (2019), Jarociński and Karadi (2020), Leombroni et al. (2020), Nakamura and Steinsson (2018), and Paul (2019).

The presence of multiple types of information in a given announcement is evident in short window event studies. On average, stock prices tend to rise in response to a surprise cut in the funds rate, consistent with textbook models of monetary policy transmission. However, looking at the data meeting-by-meeting, stock prices often drop in response to a surprise cut (the literature sometimes calls such meetings "wrong-signed.") In the empirical section, I use the methodology of Cieslak and Schrimpf (2019) and Jarociński and Karadi (2020) of high-frequency stock-bond covariance to infer the time-varying relative importance of the two channels.

The goal of the model is to demonstrate that this newly documented feature of Fed announcements can also rationalize the high pre-announcement expected returns. Two additional conditions have to be met. One, the two types of announcements have to command a different risk premium. Empirically, I will show that shocks to the path of real rates command a higher risk premium than shocks to expected growth. Two, it has to be the case that Fed communications that commands a higher risk premium are more likely after bad news in the pre-announcement period.

The model specifies Epstein and Zin (1989) recursive preferences. In addition to providing a convenient way to capture the model insight, Epstein-Zin preferences are likely necessary to match the empirical magnitude of the pre-announcement risk premium. For instance, Savor and Wilson (2013) calibrate a version of the Bansal and Yaron (2004) model to match the empirical fact that market expected returns are higher on days of significant macroeconomic announcements.[2] In Appendix B.1 I combine the model of pre-announcement risk presented here with the calibrated model of time-varying disaster risk in Wachter (2013) to demonstrate that it can account for the magnitude of pre-announcement risk premium.

Magnitudes aside, the existence of a pre-announcement risk does not crucially rely on the specific functional form of Epstein-Zin or on the preference for early resolution of uncertainty. Indeed, I show in Appendix B.2 that the model of pre-announcement risk is consistent with CRRA utility,

[2]While FOMC announcements are part of their sample, Savor and Wilson (2013) do not separately address the pre-announcement evidence—their paper was likely completed before Lucca and Moench (2015) was first circulated.

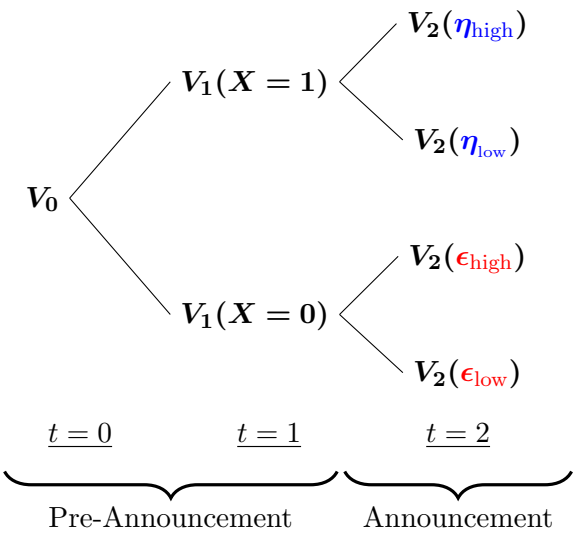

Figure 1: Resolution of Uncertainty. In the first period, investors learn the type of the announcement to be made. In the second period, the announcement of ϵ or η is made. The figure shows two values for ϵ and η although these variables follow a normal distribution in the model.

as well as a host of other preference specifications.

2.1 Investors' Problem

2.1.1 Set-up

Consider the following two-period set-up. There is a scheduled Fed announcement to be made at time $t = 2$. The announcement can be either of two types: an announcement about the path of real interest rates, or an announcement about the Fed's beliefs about long-term economic growth. Both announcements are made by changing the funds rate, and investors interpret the announcement conditional on a state variable X, capturing economic conditions.

At $t = 0$ investors don't know the type of the announcement, nor do they know the content of the announcement. At $t = 1$ both the Fed and market participants observe the state variable X, capturing aggregate economic conditions and governing the announcement type to be made. For ease of exposition, suppose there are only to aggregate states, good ($X = 1$) and bad ($X = 0$)[3].

By observing the evolution of the state variable from $t = 0$ to $t = 1$ investors learn the *type* of announcement the Fed will make—whether it will be about monetary policy stance, or about long-term growth expectations. In good times the Fed makes an announcement about growth expectations—an η shock. In bad times the Fed makes a statement about monetary policy stance—an ϵ shock. Denote the announcement time change in the Fed Funds rate, relative to expectations,

[3]No results depend on the binary nature of X. Section 2.1.5 relaxes the assumption about binary realization of X to study the timing of the pre-announcement risk premium.

by $\phi \sim N(0,1)$. The corresponding ϵ and η shocks are backed out according to

$$\begin{aligned} \eta &= X\phi \\ \epsilon &= (1-X)\phi. \end{aligned} \tag{1}$$

Investors have Epstein-Zin recursive preferences with risk aversion γ and elasticity of intertemporal substitution (EIS) of 1. The investor value function at time t is given by

$$V_t = C_t^{1-\beta} \mathcal{I}_t(V_{t+1})^{\beta} \tag{2}$$

$$\mathcal{I}_t(V_{t+1}) = \left(\mathrm{E}_t \left[V_{t+1}^{1-\gamma} \right] \right)^{\frac{1}{1-\gamma}}, \quad \gamma > 1. \tag{3}$$

Let me start by directly specifying the continuation value and consumption amount in the terminal time period $t = 2$, and then work backward to find the value function in earlier periods. The time $t = 2$ continuation value depends both on the surprise change in the Fed funds rate ϕ, and the economic conditions X

$$\mathcal{I}_2(V_3(X,\phi))^{\beta} = \exp\{\lambda_\epsilon \epsilon - .5\lambda_\epsilon^2 \sigma_\epsilon^2 + \lambda_\eta \eta - .5\lambda_\eta^2 \sigma_\eta^2\}. \tag{4}$$

The key assumption I make is that the continuation value at $t = 2$ is more sensitive to news about the path of real rates than to news regarding long-term growth prospects, captured by $\lambda_\epsilon > \lambda_\eta$. This assumption doesn't mean that the rate shocks are generically more important than growth shocks, but rather that the rate information contained in Fed announcements tends to move investor value functions more than the growth information contained in Fed announcements. Note too that there is no requirement that λ_η is non-zero.

For simplicity let me assume $C_2(X = 1, \phi) = C_2(X = 0, \phi)$, meaning there is no consumption innovation in period $t = 2$. The value function at time $t = 2$ is then given by

$$\begin{aligned} V_2(X,\phi) =& C_2^{1-\beta} \mathcal{I}_2(V_3(X,\phi))^{\beta} \\ =& C_2^{1-\beta} \exp\left\{\lambda_\epsilon \epsilon - .5\lambda_\epsilon^2 \sigma_\epsilon^2 + \lambda_\eta \eta - .5\lambda_\eta^2 \sigma_\eta^2\right\}. \end{aligned} \tag{5}$$

At time $t = 1$, let me again assume that $C_1(X = 1) = C_1(X = 0)$ and so the value function is given by

$$V_1(X) = C_1^{1-\beta} \mathcal{I}_1(V_2(X,\phi))^{\beta}. \tag{6}$$

Because I have assumed $\lambda_\epsilon > \lambda_\eta$ it follows from Equation 5

$$\mathcal{I}_1[V_2(X = 1, \phi)] > \mathcal{I}_1[V_2(X = 0, \phi)]. \tag{7}$$

In words, the $t = 2$ value function certainty equivalent at time $t = 1$ is higher in the good state ($X = 1$) than in the bad state ($X = 0$). Importantly, this result obtains even though the realization

of ϕ is not known at $t = 1$. As I have abstracted from consumption innovations the respective value functions at time $t = 1$ satisfy

$$V_1(X = 1) = C_1(X)^{1-\beta}\mathcal{I}_1[V_2(X = 1, \phi)]^\beta > C_1(X)^{1-\beta}\mathcal{I}_1[V_2(X = 0, \phi)]^\beta = V_1(X = 0). \tag{8}$$

The investor value function is higher in state $X = 1$ because the subsequent announcement is less risky and the continuation value part of the utility function is higher.

2.1.2 Pre-and Post-Announcement Risk Premium

Let's me turn to calculating asset prices in the model. Consider the final period (log) payoff of asset i that loads on ϵ and η shocks, as well as the state variable X

$$d_2^i = \bar{d}^i + \kappa_\epsilon^i \epsilon + \kappa_\eta^i \eta + \kappa_X^i X. \tag{9}$$

The innovation in log SDF in all periods is standard for Epstein-Zin preferences specified above

$$m_{t,t+1} - \mathrm{E}_t[m_{t,t+1}] = -\left(c_{t+1} - \mathrm{E}_t[c_{t+1}]\right) + (1-\gamma)\left(v_{t+1} - \mathrm{E}_t[v_{t+1}]\right), \tag{10}$$

where the lowercase c_{t+1} and v_{t+1} refer to the log consumption and value function, respectively.

Under the assumed second period value function, the second period log risk premium on asset i is

$$RP_{1,2}^i(X) = (\gamma - 1)\kappa_\epsilon^i \lambda_\epsilon (1 - X) + (\gamma - 1)\kappa_\eta^i \lambda_\eta X. \tag{11}$$

Note that X is known at time $t = 1$, so it doesn't contribute to the risk premium from $t = 1$ to $t = 2$ except by determining whether an ϵ or η shock is realized.

We are now in position to find the pre-announcement risk premium, meaning the expected returns from time $t = 0$ to $t = 1$. The price of asset i at time $t = 1$ is given by

$$p_1^i = \bar{d}^i + \kappa_X^i X - r^f - RP_{1,2}^i(X). \tag{12}$$

The only unknown in the price is X, so we can write the total return as

$$r_{0,1}^i = \mu + \sigma_d^i \left(X - \mathrm{E}_0[X]\right). \tag{13}$$

The SDF that discounts payoffs of $t = 1$ back to $t = 0$ takes the familiar form

$$m_{0,1} - \mathrm{E}_t[m_{0,1}] = -\left(c_1 - \mathrm{E}_0[c_1]\right) + (1-\gamma)\left(v_1 - \mathrm{E}_0[v_1(X)]\right). \tag{14}$$

We have already seen how the $t = 1$ value function $V_1(X)$ depends on the realization of the state

variable X because of the continuation value component. Consequently, the discount factor depends on the realization of X at least via the continuation value component. The risk premium on the asset i is given by

$$RP^i_{0,1} = (\gamma - 1)\,\mathrm{Cov}\left(v_1(X) - E_0[v_1(X)], \sigma^i_d\,(X - \mathrm{E}_0[X])\right). \tag{15}$$

Any asset, then, with a payoff that depends on the state variable X will earn a risk premium in the pre-announcement period.

The crucial assumption is that $\lambda_\epsilon > \lambda_\eta$ which ensures that the $t = 0$ to $t = 1$ SDF prices the shocks to X. Indeed, the SDF depends on the state variable X only because it it determines the announcement type. Further, note that assets with no direct exposure to X still command a risk premium in the first period to the extent they are exposed to the ϵ and η shocks in the second period.

A sufficient condition for the existence of a pre-announcement risk premium is a dependence of the continuation value component of v_1 on the innovation to the state variable X. Because I have modeled the Fed news as a mean zero shock under both realizations of the state variable X, this condition is equivalent to time $t = 1$ uncertainty about the Fed announcement content ϕ.

As I show in Appendix B.2, the model of pre-announcement risk is also consistent with Expected Utility preferences, as well as a host of other preference specifications.

2.1.3 Model Assumptions to Be Checked in the Data

Let me summarize the key model assumptions and their mapping to empirical work in Section 3.

1. **Fed announcements contain at least two different types of information.** In the model, the Fed announcement can mean either an ϵ or an η shock, with potentially divergent impacts on the cross-section of assets. In the empirical part of the paper, I use the realized stock-bond covariance to discriminate between the different information content of the Fed announcement. I further show that asset risk exposures, such as the CAPM beta or beta with respect to interest rate shocks, modulates asset-level exposure to Fed news.

2. **Risk premium earned for exposure to the different shocks differs.** The risk premium at announcement time is given in Equation 11. As I have assumed $\lambda_\epsilon > \lambda_\eta$, for assets with the same loadings $\kappa^i_\epsilon = \kappa^i_\eta$, the risk premium must be higher when $X = 0$, meaning the Fed announcement carries information about real rates. In the empirical work, I confirm that the average return on announcement is higher for announcements classified as primarily about real rates.

3. **Announcement type is predictable.** In the model investors observe the state variable X, and therefore value functions reflect the riskiness of the upcoming announcement. In the empirical work I leverage the cross-sectional heterogeneity to announcements and show that the realized returns of portfolios that take differential exposure to announcement time risk

(stocks with different $\kappa_\epsilon^i, \kappa_\eta^i$ in the model) predict the announcement interpretation. This analysis is motivated by Equation 12 that demonstrates how asset prices at $t = 1$ depend on the type of announcement to be made, as a function of the respective risk loadings.

2.1.4 Magnitude of Pre-Announcement Risk Premium

The goal of the model is to demonstrate the existence of a pre-announcement risk premium in the absence of informational leaks. Specifically, the model demonstrates that differences in announcement time risk premia, as a function of some observable state variable, lead to a positive risk premium in the pre-announcement period. As illustrated by Equation 15, the strength of the pre-announcement risk premium on a given asset depends on two factors: the difference between conditional value functions across realizations of X, and the difference in the asset value across realizations of X.

In order to evaluate the empirical magnitude of such pre-announcement effect, I need to specify an asset pricing model that can capture the announcement time risk-return relationship. The asset pricing model can then provide values of the continuation value at time $t = 2$ and can then be solved backwards to find the risk premium from $t = 0$ to $t = 1$.

I provide one such calibration in Appendix B.1 where I employ the calibrated time-varying rare disasters model from Wachter (2013). I show that the calibrated model can match the magnitude of the pre-announcement market risk premium under standard preference parameters, and standard volatility in the disaster probability and consumption processes. The calibration features a pre-announcement risk premium of 22 bps and additionally matches the empirical differences in risk premia at announcement time as a function of the state variable X.

Recent work in Wachter and Zhu (2019) uses the same calibration to explain the macroeconomic announcement day risk premium, though without addressing the feature that the majority of such returns accrue in anticipation of the news announcements.

To understand the success of the rare disasters model in fitting the data, recall the Law of Total Variance. The $t = 2$ value function variance from the perspective of time $t = 0$ equals

$$\mathrm{Var}_0(V_2) = \mathrm{Var}_0\left(\mathrm{E}_1[V_2|X]\right) + \mathrm{E}_0[\mathrm{Var}_1(V_2|X)]. \tag{16}$$

In the calibration in Appendix B.1, a lot of the value function variation at $t = 2$ stems from a "disaster" state in which economic conditions are revealed to be poor, and yet the Fed announces that it will not cut rates. Therefore a substantial fraction of the total value function uncertainty is resolved in the pre-announcement period, giving rise to the pre-announcement drift.

Of course, other asset pricing models can potentially provide as good or better fit of the data, with different state variables driving the asset returns.

2.1.5 Timing of Pre-Announcement Risk Premium

In this section I provide a slight extension to the model to study the dynamics of the pre-announcement returns. Specifically, I show that the model can match the increasing rate of pre-announcement expected returns. To do so, I split the pre-announcement period into sub-periods and impose structure on the dynamics of the state variable X.

Namely, I let the state variable X_t that governs announcement interpretation follow an AR(1) process. In order to risk-adjust asset payouts, investors need to predict the value of this state variable at a fixed future date. Because of mean reversion in the state variable the uncertainty about time $t = 1$ value is proportional to the persistence parameter raised to the power of time remaining.

Let the pre-announcement period $t = 0$ to $t = 1$ consist of τ subperiods, indexed by j. Relabel the pre-announcement time τ. Like above, the relative share of ϵ and η shocks at announcement depends on the state variable just before the announcement, meaning at $j = \tau$. For ease of exposition let me approximate the $j = \tau$ log value function as

$$v_1(X_\tau) \approx X_\tau. \tag{17}$$

Let the state variable X_t follow an AR(1) process

$$X_{j+1} = \overline{X} + \theta(X_j - \overline{X}) + \sigma_\xi \xi_{j+1} \tag{18}$$

where $\theta < 1$. Consider an investor holding the market from time k until τ—right before the next scheduled Fed announcement. The market return is given by

$$r_{k,\tau} = \mu(\tau - k) + \sigma_d \sum_{j=k+1}^{\tau} (\xi_j + \zeta_j) \tag{19}$$

where ζ_j captures return variation for reasons other than news about the state variable X. Let me assume the risk premium stemming from covariance with optimal consumption is small. Standard calculations (shown in detail in Appendix A.1) reveal that the risk premium commanded by the exposure of the asset to state variable shocks is given by

$$\begin{aligned} RP(k,\tau) &= (\gamma - 1)\,\mathrm{Cov}\left(v_1(X_\tau) - \mathrm{E}_k[v_1(X_\tau)], \sigma_d \sum_{j=k+1}^{\tau} \xi_j \right) \\ &= (\gamma - 1)\,\mathrm{Cov}\left(X_\tau - \mathrm{E}_k[X_\tau], \sigma_d \sum_{j=k+1}^{\tau} \xi_j \right). \end{aligned} \tag{20}$$

What determines the risk premium is the covariance between innovations to the *expectation* of time τ value of X, and the asset return. Because the state variable follows a mean-reverting process, the uncertainty about its terminal value is resolved at an increasing rate as τ approaches. To see

this explicitly, write X_τ as a function of the value at t and subsequent innovations

$$X_\tau = \overline{X} \sum_{j=0}^{\tau-k-1} \theta^j + \theta^{\tau-t} X_k + \sum_{j=0}^{\tau-k-1} \theta^j \sigma_\xi \xi_{\tau-j}. \tag{21}$$

The time k innovation to the expectation of time τ value is

$$\mathrm{E}_k\left[X_\tau\right] - \mathrm{E}_{k-1}\left[X_\tau\right] = \theta^{\tau-k} \sigma_\xi \xi_k. \tag{22}$$

Hence the risk premium commanded by the state variable innovation ξ_k is given by

$$\begin{aligned} RP(k-1,k) &= (\gamma - 1)\,\mathrm{Cov}\left(X_\tau - \mathrm{E}_t[X_\tau], \sigma_d \xi_k\right) \\ &= (\gamma - 1)\,\theta^{\tau-k} \sigma_\xi \sigma_d. \end{aligned} \tag{23}$$

Because $\theta < 1$, expected returns are high just before the announcement. Figure 2 illustrates the expected returns implied by Equation 23. I perform an estimation of Equation 23 in Section 3.5.

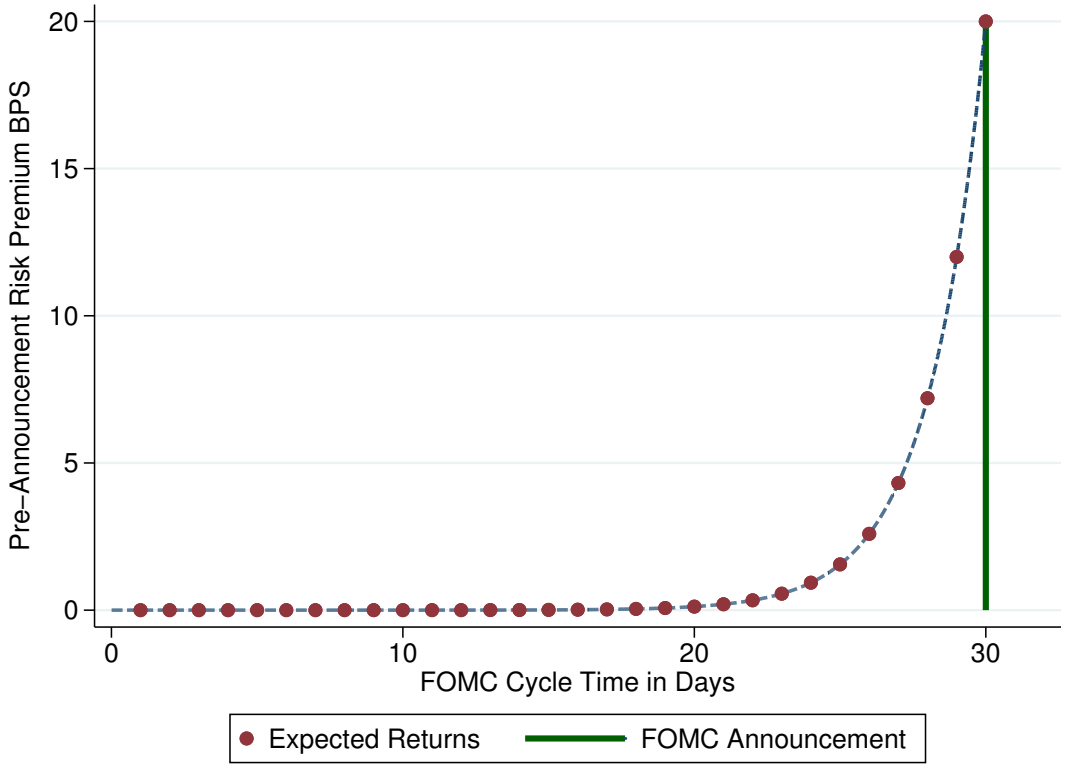

Figure 2: Returns in Anticipation of a Scheduled FOMC Announcement. Announcement at time $t = 30$. Announcement day returns not inclusive of post-announcement returns.

2.2 The Fed's Problem

The model of pre-announcement risk relies on the assumption that Fed's communications are interpreted by the market conditional on the aggregate state of the economy. I will now provide a framework under which such mode of communicating is constrained optimal. The underlying mechanism is the same as in the investors' problem—Fed actions impact markets via a direct effect, as well as via an informational effect. The direct effect stems from monetary non-neutrality and allows the Fed to smooth target outcome variables. The informational effect stems from the Fed having a more precise signal of underlying economic conditions. Recognizing a trade-off between the direct and informational effect, the Fed adopts a conditional announcement strategy.

Suppose the Fed is tasked with setting the funds rate to manage the volatility of two target variables—real rate and inflation. Denote the two state variables by Y^N and let the natural level of the state variables be given by

$$\begin{aligned} Y_1^N &= \chi_1 \\ Y_2^N &= \chi_2 \end{aligned} \tag{24}$$

where $\sigma(\chi_1) = \sigma(\chi_2) = \sigma_\chi$.

The Fed is mandated to minimize the squared deviation from zero of these two state variables. To do so, the Fed only has one tool at its disposal: setting the Fed Funds rate. Define the *stance* F of monetary policy as the difference between the funds rate and the natural rate that would prevail under no Fed intervention. I make this assumption to ensure that market participants cannot invert the decision to infer the Fed's private information. The same results would obtain if the Fed had N tools but at least $N + 1$ policy targets.

Without loss of generality, suppose the stance F moves the two state variables in opposite directions. After Fed intervention, the resulting values of the state variables are

$$\begin{aligned} Y_1 &= Y_1^N + F = \chi_1 + F \\ Y_2 &= Y_2^N - F = \chi_2 - F. \end{aligned} \tag{25}$$

With its mandate in mind, the Fed observes the realization of $\chi = (\chi_1, \chi_2)$ and picks F to minimize the state variables deviation from the respective unconditional means

$$\min_F \ \mathbb{S}(\chi) = \min_F \ (\chi_1 + F)^2 + (\chi_2 - F)^2 \tag{26}$$

resulting in the optimal stance

$$F = \frac{\chi_2 - \chi_1}{2}. \tag{27}$$

Because the Fed only has one tool to target the two state variables, it typically cannot set the

target function to zero. Under the optimal rule, the expected value of the target function is

$$\mathrm{E}[\min_{F} \mathbb{S}(\chi)] \quad = \quad \mathrm{E}\left[\left(\chi_1 + \frac{\chi_2 - \chi_1}{2}\right)^2 + \left(\chi_2 - \frac{\chi_2 - \chi_1}{2}\right)^2\right] = \sigma_\chi^2. \tag{28}$$

This compares favorably with an average deviation of $2\sigma_\chi^2$ under no Fed intervention.

The Fed's smoothing activities have a side effect. While the Fed observes the true state with infinite precision, the market participants only have access to a noisy signal. As a consequence, investors try to back out the true state variable whenever the Fed announces F. Suppose that the value of state variable Y_1, in particular, has some instrumental value to the investors, and so their utility is increasing in the signal precision

$$\mathbb{I}(Y, F, \nu) = -\kappa \left(\chi_1 - \mathbb{B}_1(F, \nu)\right)^2 \tag{29}$$

where $\mathbb{B}_1$ denotes the investor belief after observing their own signal, as well as the Fed stance F. Let the investors' signal be given by

$$\nu_1 \sim N(Y_1^N, \sigma_\nu(X_t)). \tag{30}$$

The $\sigma_\nu(X_t)$ term emphasizes that the precision of the investors' signal depends on the state variable X_t. An equivalent modeling choice would be a time-varying concern about the state variables under a constant signal precision. The underlying motivation is a time-varying relative concern on part of the investors regarding the two state variables in the Fed's mandate. In Appendix C.2 I show evidence from the Survey of Primary Dealers consistent with the view that Fed decisions have time-varying weights on the two components in the policy mandate.

With the stance F being a function of both state variables it is impossible to exactly back out χ. Instead, a given announcement specifies a line in the (χ_1, χ_2) space on which the true value lies. Investors can then pick the point on said line most likely under their prior distribution. As shown in Appendix A.2, the investor belief on state variable Y_1 after observing F is given by

$$\mathbb{B}_1(F, \nu) = \frac{\nu_1 + \nu_2}{2} - F. \tag{31}$$

Recognizing this informational effect, the Fed can tilt its announcement so that investors can better back out χ_1 precisely when the investor signal is of low precision. Specifically, the Fed can weigh the relative importance of the two state variables and make the announcement rule dependent on the state variable X_t which is observed both by the market and the Fed. Define a weighted announcement F_w as

$$F_w(X_t) = (1 - w(X_t))\chi_2 - w(X_t)\chi_1. \tag{32}$$

The key is that the Fed varies the weight systematically, based on X_t. This allows the Fed to convey

more information about χ_1 precisely when the investors' signal is noisy—the innovations to the state variable constitute a coordination mechanism between the Fed and market participants. Investors, knowing that the Fed follows a conditional announcement, have post-announcement beliefs given by

$$\mathbb{B}_1(F_w, w(X_t), \nu) = \left(\nu_1 + \frac{w}{1-w}\nu_2 - \frac{wF_w}{(1-w)^2}\right) \Big/ \left(1 + \frac{w^2}{(1-w)^2}\right) \tag{33}$$

where $F_w = (1-w)\chi_2 - w\chi_1$, and the complete derivation of the formula is in Appendix A.2.

As $w \to 1$, the Fed stance is determined almost entirely by χ_1 and beliefs converge to the true value $\mathbb{B}_1 \to \chi_1$. Conversely, as $w \to 0$, the Fed stance is determined almost entirely by χ_2 and investors beliefs about Y_1 are determined entirely by their own signal ν_1.

Consequently, the expected error in beliefs about Y_1^N is decreasing in w

$$\frac{d}{dw} \mathrm{E}\left[\kappa \left(\chi_1 - \mathbb{B}_1(F_w, w(X_t), \nu)\right)^2\right] < 0. \tag{34}$$

On the other hand, we found earlier that $w = (1-w) = .5$ represents the optimal weight from the perspective of the Fed's direct mandate. Indeed, the expected deviation of the state variables from the corresponding unconditional means increases as w deviates from .5

$$\begin{aligned} \mathrm{E}\left[\mathbb{S}(\chi)\right] &= \mathrm{E}\left[\left(\chi_1 + (1-w)\chi_2 - w\chi_1\right)^2 + \left(\chi_2 - (1-w)\chi_2 + w\chi_1\right)^2\right] &(35)\\ &= 2(1-w)^2\sigma_\chi^2 + 2w^2\sigma_\chi^2 \geq \sigma_\chi^2. &(36)\end{aligned}$$

Therefore, changing w will have the Fed trading off the two effects. To find the optimal conditional announcement rule the Fed solves for the value of $w(X_t)$ such that the expanded target function is minimized in expectation

$$\min_{w(X_t)} 2(1-w)^2\sigma_\chi^2 + 2w^2\sigma_\chi^2 + \mathrm{E}\left[\kappa \left(\chi_1 - \mathbb{B}_1(F_w, w(X_t), \nu)\right)^2 | X_t\right]. \tag{37}$$

This equation can be solved for the optimal value of $w(X_t)$ given a precision of the signal $\sigma_\nu(X_t)$.

To the extent the volatility of the investors' signal $\sigma_\nu(X_t)$ changes with the state variable X_t, the Fed will find it optimal to adjust the weights with X_t. As a result, the announcements will be interpreted by the market conditional on X_t, as required by the model of pre-announcement risk premium.

The crucial friction in the model is that the Fed only has one policy lever, but two targets. This introduces a tension between the two goals, and as a result, market participants cannot fully back out Fed's information from its decision. The same result would obtain if the Fed had N independent tools, but at least $N+1$ different policy targets.

Fundamentally, this restriction on Fed communications could arise as a manifestation of an underlying time consistency problem, as emphasized in the literature starting with Kydland and Prescott (1977). That the Fed cannot credibly reveal all the information it possesses can motivate

the assumed announcement strategy. For instance, in Stein (1989) the policymaker finds it optimal to make imprecise statements as it allows it to credibly communicate some of its private information. In Barro and Gordon (1983) the policymaker commits to an ex ante rule.

3 Empirical Evidence from Pre-FOMC Drift

In this section I demonstrate that market behavior before and at FOMC announcements is consistent with the predictions of the model in Section 2. After briefly summarizing the data I show considerable regularity in the time-series strength of the pre-announcement drift. I then turn to the cross-section to provide direct evidence in support of the model assumptions. I also calibrate a reduced-form expression of the pre-announcement risk premium provided by the model. Finally, I discuss the nature of the information learned in the run-up to the announcements and provide evidence from FOMC transcripts to show that committee members often consider late-breaking news when weighing policy options.

3.1 Data

The main data is from the TAQ database. I construct a panel of intraday returns at one minute frequencies for stocks in the SP500 at the beginning of the month of a given FOMC announcement. Time-series of SP500 constituent stocks is from WRDS. I use SPDR SP500 Exchange Traded Fund (ticker: SPY) prices to construct minute-by-minute returns of the SP500 index; I use data from GovPX to construct minute-by-minute returns of various maturity Treasuries. For the last four years of the sample, I construct 10-year Treasury returns using the iShares 7-10 Year Treasury ETF (ticker: IEF) prices.

Data on intraday Fed Funds Futures contract prices is from the CME Group. I use the Kuttner (2001) methodology (described in Appendix A.3) to construct a daily measure of the expected level of the Fed Funds rate. Each minute during the FOMC announcement day, I calculate the surprise component in the Fed Funds rate change, assuming the then-current prices prevail at end of day. As described in A.3.1, I also calculate daily expected changes in Fed Funds rates.

All other data sources are standard. The data in this study spans 1994-2019. Many papers studying monetary policy start the sample in 1994 because that is when the Fed started announcing its decisions at a press conference. Coincidentally, it is also the time when TAQ data becomes available. The summary statistics are in Table 2.

There are eight scheduled FOMC meetings per year, resulting in a full sample of 208 meetings. In graphs showing intraday returns I restrict the sample to the 197 meetings where the announcement was made at 2pm or later.

3.2 Evidence from the Time Series

There is a considerable amount of time-series predictability in the magnitude of the pre-announcement drift, consistent with the risk-based explanation proposed here. As shown by Equation 15, the risk

premium is increasing in the volatility of the underlying state variable X, and in the dependence of the $t = 1$ value function on the state variable X.

Results in Table 3 confirm the time-series predictions of the risk-based view. Specifically, I show that the average return is high in times with substantial uncertainty about the announcement, measured by the implied volatility of Fed funds rate post announcement (prior to an announcement, futures prices typically impound nonzero probabilities for two outcomes; the volatility is calculated assuming the surprise change follows a binomial distribution). High levels of risk premia in Fed Funds futures—constructed as a moving average of returns on a zero cost Fed Funds futures portfolio like in Piazzesi and Swanson (2008)—are positively correlated with the pre-announcement drift. (I describe the construction of Fed Funds risk premia in Appendix A.3.) The pre-announcement drift is also strong during times when there is substantial volatility in market returns: high VIX predicts a strong pre-announcement drift. As an alternate measure of market volatility, I use the daily returns of SP500 constituent stocks to calculate the average squared deviation from the corresponding CAPM beta implied return. I call the square root of this quantity *cross-sectional idiosyncratic volatility* (XS-VOL).

In Table 3 I estimate univariate regressions with realized intraday pre-announcement drift on the left hand side. All the right-hand-side variables are lagged so that they are known prior to the day of the announcement. As the table reveals, the previous day SP500 XS-VOL explains a full 30% of the time-series variance in pre-announcement drift strength. In Figure 3 I illustrate these results with histogram plots. Finally, in Figure 4 I plot the moving averages of the pre-announcement drift and XS-VOL to further illustrate the tight time-series relationship between market volatility and drift strength. I interpret the high volatility episodes as times where the uncertainty regarding the underlying state variable is high, corresponding to a great deal of news about in the pre-announcement period.

3.3 Evidence from the Cross-Section

In this section I closely follow the set-up of the model to check that the assumptions listed in Section 2.1.3 hold in the data.

I first describe the methodology to classify announcement time market reaction to Fed announcements, following existing literature. Having constructed the announcement type measure, I show that the cross-sectional sensitivity of assets to the two types of announcements differs as a function of the assets' market and interest rate betas. Recognizing this cross-sectional heterogeneity motivates a predictive regression: I show that the intraday return on market, or the intraday return on interest rate beta sorted long-short portfolio, predicts the realized covariance at announcement time.

3.3.1 Classifying Announcements

I classify Fed announcements following Cieslak and Schrimpf (2019). These authors gauge the informational content of central bank announcements by calculating the correlation between stocks

and various maturity bonds in a short window around the Fed announcement. Noting that a conventional monetary policy shock induces a positive correlation between stock and bond returns, they argue that a negative stock-bond correlation in response to a monetary announcement is evidence of non-monetary information conveyed to the market.

I perform a similar exercise: after each scheduled FOMC announcement, I use fifteen minutes of minute-by-minute returns on the SP500 and the then current on-the-run 10-year Treasury bond to calculate stock-bond covariance.[4] This realized covariance exhibits substantial variation, both meeting-to-meeting and over the business cycle.

For example, consider the FOMC announcement of December 16th, 2008. As of market open, Fed Funds futures market implied an expected cut of 89 bps. The Fed announced a cut of 100 bps, and the market responded with a 340 bps rally. During the post-announcement market gains, the prices of safe assets gained as well, a feature consistent with the textbook account of monetary policy announcements.

In contrast, consider the previous meeting on October 29th, 2008. The market rallied a whopping 977 bps the day before the announcement. At 14:15, the Fed announced a 50 bps cut in the target rate, which represented a 5 bps cut relative to the expectations. Typically, such a cut would be associated with an increase in market valuations. In this case, however, the market ended the day down 264 bps relative to just before the announcement was made. The post-announcement covariance between stock and bond returns was large and negative, indicating that the announcement was interpreted by the market as one about growth expectations. With the Fed cutting more than anticipated the stock market lost value as safe assets gained.

I picture stock and bond returns on these two dates in Appendix Figure C1. Both meetings resulted in a surprise cut of rates relative to expectations but a starkly different market reaction. I interpret the differential response as a reflection of the importance of economic conditions to the interpretation by the market of the Fed's actions. In December, the market was interpreting the lower-than-expected rates as accommodation provided by the Fed. In contrast, in October, the lower-than-expected rate was interpreted as bad news about economic fundamentals.

3.3.2 Asset-level Heterogeneity in Response to Announcements

I will now show that characteristic sorted portfolios display differential exposure to Fed announcements, and particularly so during announcements that are classified as shocks to real rates.

Specifically, I show in Table 4 that two characteristics—market beta and interest rate beta—capture heterogeneity in the stock-level response to Fed announcements. This is in line with the results in Bernanke and Kuttner (2005), who find that high beta industries are more sensitive to Fed announcements. As a new result I show that stocks with high market or interest rate betas are particularly sensitive to changes in the funds rate during announcements that are classified as real rate shocks.

[4]Boguth et al. (2019a) find evidence of price pressure in the post-announcement period. In unreported results I find that the 15-minute covariance predicts longer horizon post-announcement covariance with a beta of roughly one.

I demonstrate this finding by estimating the following triple interaction regression

$$\begin{aligned} R^i_{\mathrm{t}} =& \gamma_1 \Delta\widetilde{\mathrm{FF}}_t + \gamma_2 \Delta\widetilde{\mathrm{FF}}_t \cdot \beta^i_{\mathrm{CAPM}} + \gamma_3 \Delta\widetilde{\mathrm{FF}}_t \cdot \beta^i_{\mathrm{CAPM}} \cdot \mathrm{Pos}_t + \\ & \gamma_4 \Delta\widetilde{\mathrm{FF}}_t \cdot \mathrm{Pos}_t + \gamma_5 \beta^i_{\mathrm{CAPM}} \cdot \mathrm{Pos}_t + \gamma_6 \beta^i_{\mathrm{CAPM}} + \gamma_7 \mathrm{Pos}_t + \epsilon_{i,t} \end{aligned} \tag{38}$$

where $\widetilde{\mathrm{FF}}_t$ is the surprise component of the Fed Funds rate change on announcement, and Pos_t is an indicator variable for announcement with positive realized stock-bond covariance, proxying for the realization of the state variable X in the model. I also estimate a version of this equation where β_{CAPM} is replaced by beta with respect to the level factor of interest rates, and a version with both of the betas and the respective interaction terms[5].

As shown in columns 2 and 3 of Table 4, in both specifications, the triple interaction term emerges as a statistically and economically significant determinant of stock-level response, meaning that high beta and high interest rate beta stocks are particularly sensitive with respect to Fed announcements about short rates. Of course, there could be other characteristics that are equally important in accounting for the cross-sectional response to policy announcements, as documented by Basistha and Kurov (2008), English et al. (2018), and others.

3.3.3 Predicting Announcement Type

The finding in Table 4 motivates the following predictive regression. If the announcement type is indeed predictable, the change in value of a portfolio of stocks that is particularly exposed to a given type of announcement should predict the type.

This is precisely what I find. As shown in Table 5, the market return in the pre-announcement window predicts the announcement type, as proxied by the stock-bond covariance. Likewise, the return on the interest rate beta sorted long-short portfolio predicts the announcement type. If market return is poor before the announcement, a positive covariance announcement is more likely; ditto if interest rate exposure sorted portfolio return is poor. The predictability is particularly strong conditioning on meetings with a substantial amount of uncertainty about Fed action. I proxy for such meetings by conditioning on the expected change being larger than one basis point in magnitude (note that the expected change in rates is observable prior to the announcement). This conclusion continues to hold controlling for the stock-bond covariance before the announcement. Table 5 therefore provides direct evidence in favor of the main claim in the model: the announcement type is predictable using information learned in the immediate run-up to the announcement. Similar predictability obtains with the stock-bond post-announcement correlation as the dependent variable.

3.3.4 Risk Premium Across Announcement Types

Finally, I demonstrate that the announcement time risk premium depends on announcement type, as required by the model. In Figure 5 I sort announcements based on realized 15-minute stock-bond

[5]The calculation of expected and surprise components of Fed funds rate is detailed in section A.3.1.

covariance, and calculate the average market return in quartiles sorted on realized covariance.

As the Figure shows, the quartile corresponding to the highest stock-bond covariance—meaning traditional policy shocks dominated the announcement—see on average a positive return on announcement; those with negative covariance see on average a negative return on announcement. This finding corresponds to the assumption in the model that the two types of announcements command a differential risk premium.

I additionally show that this difference in risk premia tends to be higher when conditioning on the variables that predict a strong pre-announcement drift in the time series. Specifically, the Figure shows that the return differential is high when XS-VOL, VIX, Fed funds risk premia are above their median values, or when the expected change in Fed funds rate is larger than one basis point.

The same result is shown in regression form in Table 12 column 1. Here I regress the post-announcement return on the pre-announcement market return and find a strong negative relationship. In other words, poor market returns in the pre-announcement period predict high average returns on announcement.

Recognizing the importance of two distinct announcement interpretations also provides insight into the announcement time risk premium. As Lucca and Moench (2015) point out, the absence of announcement time risk premium poses a hurdle for any risk-based explanation of the pre-announcement drift.

It might seem surprising that the market commands a negative risk premium in response to the growth announcement. The negative sign can be rationalized in a standard intertemporal setting. Specifically, consider the Bad Beta Good Beta two factor decomposition from Campbell and Vuolteenaho (2004)

$$\begin{aligned} RP(t,t+1) =& \gamma \operatorname{Cov}_t \left(r^i_{t+1}, (\mathrm{E}_{t+1} - \mathrm{E}_t) \sum_{j=1}^{\infty} \rho^j \Delta c_{t+j} \right) \\ & - \operatorname{Cov}_t \left(r^i_{t+1}, (\mathrm{E}_{t+1} - \mathrm{E}_t) \sum_{j=1}^{\infty} \rho^j r^m_{t+1+j} \right). \end{aligned} \tag{39}$$

In words, the risk premium on any asset corresponds to return covariance with innovations to the discounted sum of cash-flows, and to return covariance with innovations to the discounted sum of expected returns.

Suppose the informational shocks correspond primarily to discount rate shocks. As discussed above, the Fed could bring about changes in long horizon expected returns by updating investor beliefs on growth rates or by affecting investors' risk preferences. In order to match a negative market risk premium, it needs to be the case that positive market returns in response to an informational shock correspond to an increase in expected returns going forward. This would be consistent with higher risk-free rates on account of higher expected consumption growth, or a smaller precautionary savings component on account of lower risk compensation.

3.4 Calibration of Pre-Announcement Risk Premium

Given an asset pricing model that can fit the daily evidence regarding expected returns on FOMC days, the theory presented here can account for the fact that a sizable premium is earned prior to the announcement.

I provide an explicit calibration in Appendix B.1. Here I employ the model of time-varying rare disasters developed in Wachter (2013) in combination with the pre-announcement risk model from Section 2. The results in Appendix B.1 match the pre-announcement risk premium under standard assumptions about the volatility of the disaster probability and consumption processes with risk aversion $\gamma = 3.2$ and EIS $= 1$. In the calibrated two-period model the pre-announcement risk premium is 22 bps.

In addition to the magnitude of the pre-announcement drift, the calibrated model can qualitatively match the fact that announcement risk premium is higher for the policy announcements, and that pre-announcement returns have a higher Sharpe ratio than post-announcement returns.

Of course, other asset pricing models could also match the pre-announcement evidence. The main goal of Appendix B.1 is to quantitatively illustrate how differences in announcement risk premia translate into a pre-announcement risk premium.

3.5 Timing of Returns over the FOMC Cycle

The model makes a specific prediction about the shape of aggregate market returns over the FOMC cycle: the pre-announcement risk accrues at an increasing rate before the announcement, as captured by Equation 23, reproduced here

$$RP(k-1,k) = (\gamma - 1)\,\theta^{\tau-k}\sigma_\xi\sigma_d.$$

Naturally, there are other sources of risk in the economy that do not follow this pattern. In this section I use observed market returns over the FOMC cycle to calibrate the parameter θ that governs the timing of pre-announcement returns.

Instead of calibrating the primitives of the model like in the previous section, I seek to estimate θ from a reduced-form specification. Specifically, I assume that the pre-announcement returns are earned according to the functional form in Equation 23 and all parameters save for σ_ξ are constant. I proxy for σ_ξ using the cross-sectional return volatility of the market (XS-VOL), which I showed in Section 3.2 to be a strong determinant of drift strength. I further assume that the risk premia from other sources of risk accrues at a constant rate over the FOMC cycle.

Under these assumptions I can estimate θ along with two nuisance parameters: returns from exposure to other shocks (denoted δ), and the risk price associated with a unit exposure to shocks to the state variable (denoted λ). I use Generalized Method of Moments to estimate the parameters $(\theta, \lambda, \delta)$ in the following equation

$$r_{t,t+1} = \lambda\ \text{XS-VOL}_t\ \theta^{\tau-t-1} + \delta. \tag{40}$$

I perform the estimation on daily returns starting with eight days before a scheduled FOMC announcement. On the announcement day I only use pre-announcement returns. GMM estimation results, reported in Table 1, yield in the estimate of $\theta = .77$ (statistically significant at the 1% level) meaning the state variable governing announcement type has very low persistence. The estimate allows me to illustrate the model-implied daily returns in Figure 6. While there is a statistically significant pre-announcement drift only in the two days prior to the FOMC meeting, the model predicts a pre-announcement drift of 9 bps three days before, 6 bps four days before, and so on. That we don't see this pattern past the first couple days in the data is likely due to lower statistical power, which makes it tougher to pick up these lower expected returns farther away from the FOMC meeting.

Target	Value	S.E.
θ	0.79	0.20
δ	-6.29	9.44
λ	13.80	5.04

Table 1: Calibration of Persistence Parameter θ. Heteroskedasticity robust standard errors. I use GMM to estimate Equation 40. Sample daily returns in the 8 trading days leading up to a pre-scheduled FOMC announcement.

3.6 Information Learned Before the Announcement

The model delivers a pre-announcement drift because there is information learned by both the market and the Fed in the run-up to the policy decision that alters the manner in which the eventual decision is interpreted by market participants. As Figure 6 illustrates, this information is mostly learned in the very last days before the announcement. In this section I discuss the nature of this information, and provide corroborating evidence from FOMC meeting transcripts.

A natural source of information pre-announcement is that both the Fed and the investors condition their respective actions on stock market performance. Because the stock market can exhibit substantial volatility, the announcement time risk loadings can be uncertain right up until the announcement. Prior work has sought to establish a causal impact of stock returns on Fed actions. Gurkaynak et al. (2005) use a VAR setting to estimate this dependence, while Cieslak and Vissing-Jorgensen (forthcoming) use textual analysis of FOMC meeting transcripts to argue that the Fed pays close attention to the market.

Another source of information could stem from various macroeconomic news announcements (MNAs). Taken alone, any given MNA may not materially impact market prices. Indeed, Law et al. (2019) find only four MNAs that can reliably move markets. Still, the constant flow of information from MNAs can potentially allow investors to update beliefs on the state of the economy at a high frequency. For instance, Beber et al. (2015) use MNAs to construct a real-time measure of economic performance without relying on any financial market information.

It is evident from the transcripts of the FOMC that policymakers pay close attention to both

market and non-market data coming in just before the decision on the Fed Funds rate is made. In Appendix Table C1 I provide excerpts from FOMC meeting transcripts pertaining to discussion of MNAs on the morning of the meeting, and discussion of the market reaction to the MNAs. The table also contains numerous examples of discussion about market expectations of Fed behavior. All in all, as shown in Appendix Table C2, the transcripts of 93 of the 168 meetings from 1994 to 2014 contain discussion of MNAs made on the day of the meeting (transcripts are released with a five year lag). In Table 6 I show that FOMC discussions that saw more mention of phrases like "this morning" and the "market" correspond to a stronger pre-announcement drift.

Others have noted the apparent focus on late-breaking news. For instance, in a recent interview on Fed communications, Peter Fisher, a former senior official at the New York Fed, noted that "[T]he Fed has a recency bias...always giving the greatest weight to the most recent data." (quoted in Cecchetti and Schoenholtz (2019)). Contributing to the uncertainty regarding the interpretation of a given announcement could be a feedback effect between market expectations of Fed action, and the Fed taking into consideration market expectations, as described in Stein and Sunderam (2018). As an application of the model, these authors provide an example where the market's belief that Fed action is dependent on incoming macroeconomic data induces, in a self-fulfilling equilibrium, an excess sensitivity of Fed decisions to MNAs made just before the announcement.

On a more fundamental level, to the extent the Fed does not fully control how the market reacts to its pronouncements, it may find it optimal to at least in part react to recent news to provide context to its action. The model of Fed behavior in Section 2.2 formalizes this view.

What could underlie the Fed's informational advantage? For one, the Fed possesses superior information about its own reaction function. Further, it has access to substantial non-public information regarding bank balance sheets on account of its regulatory activities. Finally, it could be that the market perceives the Fed to have superior skills in analyzing publicly available information. Paul (2019) provides statistical evidence that the Fed's forecast outperforms the private sector's, while Li et al. (2018) study information production by the Fed. The exact nature of the private information that the Fed possesses is not critical to my results.

3.6.1 Examples from FOMC Transcripts

Let me highlight a couple of specific FOMC meetings where late-breaking news appeared to have a substantial effect on the determination of Fed action. Table C1 in the Appendix documents many more instances.

Many transcripts reveal attention paid to MNAs during the morning of the meeting. For instance, consider the meeting of October 28th, 2003. Here, the FOMC discussion makes note of positive economic data in the past weeks, including the durable goods order released that morning.

> MR. STOCKTON. In a nutshell, things have been going very well for the U.S. economy in recent weeks. The latest piece of news fitting that pattern was this morning's release of the September report on new orders and shipments of nondefense capital goods.
>
> CHAIRMAN GREENSPAN. I believe it's more likely that evidence of an old-fashioned business

> cycle expansion is beginning to emerge ... when I saw the original Greenbook projection that had inventory liquidation continuing through the rest of the year, I was incredulous. I was even incredulous about it continuing in the third quarter. But clearly that's what we're seeing. Indeed, the data on durable goods inventories for manufacturing confirmed that this morning.

Another suggestive example of the Fed paying attention to very recent information is provided by the FOMC meeting of March 18th, 2008. Held during the early stages of the Great Recession, this meeting came on the heels of Bear Stearns takeover by JPMorgan Chase.

The day saw a slew of activity even before markets opened. At 8:00am, Goldman Sachs announced quarterly earnings (three of Goldman's 2008 quarterly earnings reports occurred the morning of an FOMC meeting). While Goldman's investment banking revenues were down 41% relative to the quarter before, the earnings beat analyst expectations. At 8:17am Lehman Brothers released quarterly earnings. They saw a 57% decrease in net income, which was still good enough to beat expectations. At 8:30am the Census Bureau reported that housing permits in the previous month were given out at the lowest rate since 1991. As shown in Appendix C1 the FOMC meeting transcript reveals close attention being paid to these developments, including queries during the meeting about the Fed Funds curve, and references to the stock market performance in response to the announcements that morning.

Of course, there is no counterfactual available to prove that any given Fed decision, or the corresponding market reaction would have been different absent late-breaking news. Let me give one more example, from the meeting on January 31st, 2001. This two-day meeting occurred after a string of poor macroeconomic news, the latest of which was the Conference Board consumer confidence index released on the first day of the meeting.

> CHAIRMAN GREENSPAN. All in all, I think what is involved here is a judgment about how this economy is evolving. ... since we are dealing with mood swings that are rooted in an unchanging human nature, then I think it follows that monetary policy must also compress itself into a narrower timeframe. ... I have been concerned about the possibility that our moving so fast in a month would suggest either a knowledge of facts that nobody else knows or that we are getting scared. Fortunately, I guess, the markets as a result of yesterday's consumer confidence index have now put something like a 20 percent probability that we'll move 75 basis points.
>
> MS. MINEHAN. ... after listening to the television a bit this morning and seeing the degree to which there were now expectations in the market of an even bigger move–and not being able to reconcile in my own mind the real risks with a balanced risk statement–I came around to your position.

The meetings I have mentioned here are by no means extraordinary in terms of attention paid to recent events. In order to provide systematic evidence of attention paid to recent events, I count the use of terms such as "this morning," "this week," and "market" in the transcripts of FOMC meetings. The results in Table 6 demonstrate that the frequency of these terms are associated with stronger pre-announcement drift. The right-hand-side variables are calculated as shares of

total words in the transcript, and normalized to have standard deviation of one. A one standard deviation increase in the frequency of the term "this morning" is associated with a 13 basis point increase in the pre-announcement drift.

3.7 Discussion

The model in this paper demonstrates how a peculiar feature of FOMC announcements can give rise to a pre-announcement drift. Specifically, in the model a positive drift obtains because announcement time risk premia differ across announcement type and the announcement type is predictable.

In order to demonstrate the quantitative relevance of the model, I need a calibrated asset pricing model that can match the risk return trade-off at announcement time. In Appendix B.1 I show that the calibrated rare disasters model of Wachter (2013) can be used to match the announcement time moments, and consequently the pre-announcement risk premium.

While the calibration can deliver on the quantitative side, it sidesteps the question of mechanisms underlying the Fed's ability to affect macroeconomic outcomes. Under the rare disasters framework, it could be that monetary policy via its effect on financial stability affects the probability of macroeconomic disasters. Naturally, other asset pricing models could equally well (or better) capture the announcement time dynamics—and hence the pre-announcement drift—with different underlying economic mechanisms.

Indeed, rationalizing the asset market exposure to monetary policy shocks on announcement times remains an area of active research: for a recent contribution in this literature see Pflueger and Rinaldi (2020). The goal of this paper, however, is to demonstrate a channel via which a model that can match the announcement time dynamics can also produce the pre-announcement evidence, regardless of the underlying channels of policy transmission.

I have motivated the two contrasting interpretations of Fed announcements via the recently documented Fed information effect. However, the model does not require that the Fed information effect in and of itself commands a large risk premium—the key requirement is that the announcement risk premium differs across announcement type. For that reason the model would be well consistent with a small or even zero risk premium for informational announcements, as long as the other announcement type earns a non-zero risk premium.

In recent work Bauer and Swanson (2020) show that the empirical evidence for a Fed information effect documented by Nakamura and Steinsson (2018) can alternatively be rationalized as Fed private information about its reaction function, rather than private information about the state of the economy. They do not, however, challenge the evidence on stock-bond covariance on announcement time that I employ as a proxy for announcement type in this paper, following Cieslak and Schrimpf (2019) and Jarociński and Karadi (2020). As such, their results do not present a hurdle for the empirical results regarding the predictability of announcement type as proxied by the stock-bond covariance. Naturally, other structural interpretations of the stock-bond covariance on announcement time could exist, but the model mechanism proposed here could still account for the pre-announcement risk premium.

Regardless of the underlying channels, the model does require that the Fed can exert substantial power over asset prices. Such large impact on asset valuations might seem tough to square with the long-term neutrality of monetary policy and is a topic of active research interest. For instance, Pflueger and Rinaldi (2020) combine a New Keynesian model of the Fed with habit preferences to generate asset market reaction to policy news consistent with the data. Their work shows that even if monetary policy is neutral in the long run (as it is in the New Keynesian model) it can still command a significant risk premium[6]. Transmission channels outside the New Keynesian framework could be equally important. For instance, Fed policy can have significant impact on financial stability, and hence affect real outcomes. Along the same lines, the Fed's private information about bank balance sheets could be another channel underlying the information effect.

The main goal of this paper, however, is to show how a pre-announcement premium can be rationalized, conditional on being able to match the announcement time dynamics, without taking a stance on the relative importance of the underlying transmission channels.

4 Testing Further Implications

I now turn to exploring the implications of the model to auxiliary puzzles: the bi-weekly pattern in aggregate market returns over the FOMC calendar, the pre-announcement drift in FX markets, and the apparent lack of drift in Treasury markets. I will also discuss the pre-announcement drift found in the context of other macroeconomic announcements and corporate dividend or earnings announcements.

4.1 Return Seasonality over the FOMC Cycle

Cieslak et al. (2019) document that aggregate market returns follow a striking seasonal pattern over the FOMC announcement cycle—even weeks with respect to the last FOMC meeting see higher aggregate market returns than odd weeks. These authors attribute this finding to communications from the Fed: turns out that non-FOMC information emanating from the Fed tends to be concentrated in even weeks. They additionally argue that market participants have systematically underestimated the amount of accommodation the Fed can provide, leading to higher-than-expected realized returns during times when the Fed communicates.

The model proposed in this paper provides a risk-based account of this return seasonality consistent with investor expectations that are on average correct. According to the model of the Fed's decision, the announcements that are made conditional on the state variable X_t benefit investors by providing them more information, leading to lower expected returns unconditionally. According to the model of pre-announcement risk, the conditional announcements induce more uncertainty in the run-up to the announcement, leading to high pre-announcement returns.

In effect, the Fed's operating procedure is re-allocating risk over time: the same action lowers ex-

[6]The literature on the term structure of equity risk premium has found that short-term risks command substantial risk compensation, see Van Binsbergen et al. (2012) and subsequent work.

pected returns over the entire FOMC calendar, but increases them right before Fed announcements. The model therefore implies that should the Fed adopt a more passive policy the pre-announcement drift would be weaker—but expected returns in other times would increase.

As a result, the moving average of market returns displays strong seasonality over the FOMC calendar. I illustrate this in Figure 7. Here I plot a replication of the main finding in Cieslak et al. (2019) along with expected returns based on the GMM estimation in Section 3.5. The estimated model fits well the magnitude and the "shark fin" shape of returns over the FOMC calendar.

I test the model prediction with respect to aggregate return cyclicality in Table 7. As I reported in the empirical work in Section 3, cross-sectional volatility (XS-VOL) is a good predictor of pre-announcement drift intensity. According to the model, then, times with high XS-VOL should also see strong cyclicality of returns. This is precisely what I find. As column 4 in Table 7 demonstrates, even weeks in the high volatility subsample have daily expected returns of 13 bps, compared to 3 bps unconditionally. The remainder of the high volatility subsample, however, sees expected returns that are 9 bps lower.

4.2 Drift in Fixed Income Prices

Part of the pre-FOMC drift puzzle is the apparent lack of a corresponding drift in fixed income markets, as documented in Lucca and Moench (2015). Because the Fed's policy action directly affects the near end of the yield curve, one might expect any pre-announcement movements to show up in fixed income markets.

I find the nearly zero unconditional drift in longer maturity bonds in 1994-2018 consistent with the account proposed in this paper. In the model the pre-announcement drift represents an aggregate reduction in the market risk premium. We would therefore expect that a given asset's pre-announcement drift intensity is proportional to its exposure to the market risk premium.

Campbell et al. (2017) find that the CAPM betas of nominal bonds have changed considerably over time. In the sample period of this paper, 1994-2018, nominal bond betas started at slightly positive values, drifted into negative territory, and exhibited substantially large negative values during the financial crisis.

In order to account for time-varying betas of long maturity bonds, I calculate a "beta-implied" drift in bond prices in the pre-announcement window. Specifically, I first estimate CAPM betas of 10-year Treasury bonds using daily bond returns in a 30-day rolling window. I then multiply the estimated conditional beta with the observed drift in the SP500 index

$$\widehat{R}^{10\text{y}}_{t,pre} = \widehat{\beta}^{10\text{y}}_{t-1} \times R^{\text{SP500}}_{t,pre}.$$

The behavior of this beta-implied drift in 10-year bond returns closely tracks the observed pre-announcement drift in the 10-year bond price. I illustrate this finding in Figure 8. Here I'm plotting the 8-meeting (meaning one calendar year) moving average of drift in the 10-year bond price, and the beta-implied drift.

The calculation implies an upward drift in bond returns during the positive beta periods, and a downward drift in the negative beta periods. On average the beta-implied drift is close to zero. In the sample period, the observed drift in the 10-year Treasury bond is on average 1.1 bps.

Regressions reported in Table 8 confirm that the conditional beta model does a good job of accounting for drift in Treasury prices. The time-series correlation between the moving averages of beta-implied drift and observed Treasury drift is .62.

Like Lucca and Moench (2015), I find no material pre-announcement drift in the Fed Funds futures market. This finding is consistent with the model: I claim that the pre-announcement drift arises because the different types of announcements command a different risk premium and not because the market expectations of Fed action are systematically different as a function of the state variable.

4.3 Drift in FX Markets

The view that pre-announcement drift corresponds to a reduction in aggregate risk premium also helps rationalize the pre-announcement returns in foreign exchange markets. As documented by Mueller et al. (2017), FX rates tend to show excess returns on FOMC days, in part before the announcement is made. Karnaukh (2020) and Borisenko and Pozdeev (2017) also find predictability in FX returns around Fed announcements.

Following the approach I take with Treasury returns, I again seek to account for the pre-announcement returns by measuring the conditional exposure of currency exchange rates to market returns.

Specifically, I estimate CAPM betas in a rolling 30-day window for the seven major currency exchange rate pairs with the US dollar: AUD, CAD, CHF, EUR, GBP, JPY, and NZD. On each Fed announcement day I multiply the most recent beta estimate with the realized pre-announcement return on the SP500 to find a beta-implied currency pair return. I then regress the realized currency pair returns on the beta-implied return.

As shown in Table 9, the estimated coefficients are all around 1, as predicted by theory. Note that the currency pair returns are calculated from end-of-day prices and are therefore contaminated by post-announcement returns. Still, because the right-hand-side uses the pre-announcement return this provides evidence that reduction in aggregate risk premium is responsible for the drift in currency prices.

4.4 Other Central Bank Announcements; FOMC Announcements before 1994, and Going Forward

Should we expect to find similar pre-announcement drifts before other central bank announcements? According to the model, there are two requirements for a drift to occur. The candidate announcement needs to have a material impact on asset prices, and the announcement impact needs to exhibit systematic time variation.

In recent work, Brusa et al. (2020) document that FOMC announcements are unique among

global central bank communications in their ability to move asset prices. Other central bank announcements have little impact on international equity markets. What is more, even local stock markets show little excess returns on local central bank announcement days. Because the model presented here relies on the central bank exerting control over asset prices on announcement, the inability of other central banks to move markets would suggest an absence of a pre-announcement drift.

Indeed, Lucca and Moench (2015) report no pre-announcement drift in European, British, or Japanese markets in anticipation of the corresponding central bank announcements. That said, Schmeling and Wagner (2019) do find a two-day pre-announcement drift of over 20 bps in anticipation of ECB announcements from 1999 to 2014. They also find a borderline statistically significant impact of policy rate changes on local market returns.

With respect to the pre-FOMC drift, Lucca and Moench (2015) find a stronger drift since 1994 when the Fed started to announce a specific target rate. They find no drift before 1980 when the Fed held more frequent meetings. According to the model, high-frequency meetings would bring along a weaker pre-announcement drift as volatility of surprise changes at each announcement would have to be smaller, keeping constant the target policy path.

The pre-announcement drift has been weak since the first draft of Lucca and Moench (2015) was circulated: Gilbert et al. (2020) document that the drift has averaged roughly zero since 2011. I find the recent data consistent with the time-series evidence documented in Section 3. Specifically, I attribute the weak pre-announcement drift to low aggregate volatility, and to low uncertainty about Fed action during the zero lower bound era. From 2010 to 2018 the standard deviation of surprise Fed Funds rate changes was 1.1 bps, compared to 5.0 bps from 1994 to 2009. Even after the Fed achieved liftoff, the announcement time surprises have been small. This might reflect the success of Fed in better communicating their plans, though the early stages of rate increase cycles are often the times where Fed action is most predictable. Consistent with this view, both market and Fed Funds rate volatility increased in 2018 relative to the recent past and the pre-announcement drift returned to 15 bps as the Fed contemplated ending the hiking cycle. As shown in Figure 4, market volatility has a strong positive correlation with the time-series strength of the pre-announcement drift.

Note too that the two-day pre-announcement return since 2011 has been 21 bps, statistically significant at the 1% level. There were eight meetings from 2011 to 2012 where the announcement was made at 12:30pm and perhaps market participants figured that the decision was correspondingly made earlier. Lucca and Moench (2018) report that the pre-announcement drift since 2011 has been present only prior to meetings that are associated with a Chair press conference. The lack of a pre-announcement drift during meetings without a press conference is consistent with the model presented here, recognizing that market participants only expect significant policy action during meetings followed by a press conference, as argued in Boguth et al. (2019b).

4.5 Earnings and Dividend Announcements

Existing work such as Frazzini and Lamont (2007), Hartzmark and Solomon (2013), and Hartzmark and Solomon (2018) has documented a pre-announcement drift in anticipation of earnings and dividend announcement dates.

In Table 10 I demonstrate the existence of pre-announcement drift before scheduled earnings and dividend announcements. I'm again using the sample of SP500 stocks. For each stock in the SP500 at the beginning of a month, I use the IBES database to record the date and time of the scheduled quarterly earnings and dividend announcements. The pre-announcement return $t-1$ to t is defined as the last full trading day (meaning 9:30am-4:00pm) without the announcement having taken place. Due to IBES data availability the sample spans 1994-2018 for earnings and 2002-2018 for dividends.

As Table 10 demonstrates, the average return on pre-announcement days is 8 and 6 bps for earnings and dividends news, respectively. To comport with the theory presented here it is necessary that corporate announcements command a time-varying risk premium. For instance, it could be that stock returns are more sensitive to corporate news in times when market-maker wealth is low. To the extent investors learn about announcement time sensitivity in the run-up, the theory in this paper can explain the existence of pre corporate announcement drift.

It might seem that the risk posed by a single announcing firm could be diversified away. However, on any given day the announcing firm news might represent a substantial fraction of the market-level news. In the language of Savor and Wilson (2016), the announcing firm "superloads" on the market return. Consistent with the model, Table 10 shows that pre-announcement returns are particularly pronounced for stocks with high market betas.

4.6 Other Macroeconomic Announcements

The evidence on pre-announcement drift before other macroeconomic news announcements (MNAs) is mixed. Lucca and Moench (2015) and Ai and Bansal (2018) find no pre-announcement drift before other MNAs, while Hu et al. (2018) find a positive premium for three MNAs.

In Table 11 I report pre-announcement returns for the four MNAs that Law et al. (2019) identify as having a statistically significant impact on market prices on announcement. I restrict the sample to such announcements because theory predicts the candidate MNA should have a material impact on asset prices on announcement. Consistent with the results in Hu et al. (2018) I find a statistically significant return in anticipation of these announcements.

Note though that in contrast to the pre-FOMC announcement drift these returns tend to be concentrated just before to the announcement itself. The MNAs in question happen at 8:30am or 10:00am, and the statistically significant pre-announcement returns accrue with respect to the closing prices the day before. Extending the lookback window to noon on the prior trading day (meaning a lookback window of 4 hours in trading time) renders the announcement premium insignificant. Note too that the pre-announcement returns tend to be much stronger during MNAs that happen to occur in the morning before FOMC meetings.

According to the model the announcement time market sensitivity to the MNAs needs to vary over time. Existing literature has found evidence consistent with this feature. Goldberg and Grisse (2013) find significant heterogeneity in Treasury and FX rate exposure to macroeconomic announcements, and associate it with a perceived re-weighting of Taylor rule inputs. Similarly, Law et al. (2019) ascribe the time-varying impact of MNAs to monetary policy following different regimes over time. Boyd et al. (2005) find that news of higher than expected unemployment is good news for stocks in expansions, bad news during contractions. It could also be that in bad times there's more information in MNAs, while in good times the surprise component of any given MNA is mostly noise. Because the pre-MNA drift is much stronger for announcements that happen right before FOMC announcements it could be that they are informative primarily because they are important inputs to the Fed's decision.

5 Discussion, Related Literature

What other theories could account for the pre-FOMC announcement drift, or drifts before other announcements?

5.1 Informational Leaks

It could be that the pre-announcement drift is caused by informational leaks from the Fed. The resolution of uncertainty via a news leak would result in an upward drift in market prices even if the leaked news are on average neutral. As argued in Lucca and Moench (2015), from an institutional viewpoint it seems unlikely that policy decisions have been systematically leaked over the span of twenty plus years. That said, Cieslak et al. (2019) provide a substantial list of leaks from the Fed. Ai and Bansal (2018) likewise attribute the pre-announcement returns to informational leaks. In a recent working paper, Finer (2018) finds intriguing evidence on abnormally high taxi cab traffic between the Federal Reserve Bank of New York and commercial bank headquarters around the time of FOMC announcements. Still, the statistically significant abnormal cab rides tend to happen after the FOMC blackout window, not during the pre-announcement drift period. Likewise, most of the leaks documented by Cieslak et al. (2019) happened outside the pre-announcement window. Other work, such as Bernile et al. (2016) and Kurov et al. (2019) find evidence of informed trading in a very tight window (of the order of thirty minutes) before scheduled macroeconomic announcements. Abdi and Wu (2018) find that bond market returns over eight days prior to the announcement have predictive power over the realized funds rate surprise.

There are key features of the empirical evidence that are hard to square with the leaks hypothesis. As noted by Lucca and Moench (2015), if the pre-FOMC drift is caused by informational leaks, the realized market return pre-announcement should predict the eventual response to the Fed statement. Equivalently, the direction of the market pre-FOMC should be able to predict the realized surprise change in Fed Funds target rate. I test these two predictions in Table 12. Contrary to the leaks hypothesis, I find that the realized return from market open to Fed announcement is negatively

correlated with the market return post-announcement.

In principle, an informational leak could reduce the volatility of the announcement with no change in the expectation of the outcome, resulting in a positive pre-announcement drift without corresponding predictability. However, because the outcome in this setting—the post-announcement Fed funds rate—is almost always a binomial random variable, a change in volatility is accompanied by a change in the mean. As shown in Table 12 the pre-announcement change in the expected Fed Funds rate change does not explain the market drift: there is slight positive correlation between the realized pre-announcement market return and change in the market expectation of Funds rate change.

The principal ingredient of the model proposed here—high-frequency variation in announcement time market dependence on Fed announcements—suggests a trading strategy to illustrate the difficulty facing a leak-based explanation. Suppose an investor is on the receiving end of a leak and knows with certainty the end-of-day Fed Funds rate at the beginning of a FOMC announcement day. With the ability to take any position in the market portfolio, what are the returns this illegally informed investor could reap?

The simplest strategy would be to buy the market right before the announcement if the Fed announces a surprise cut in rates, and short the market right before the Fed announces a surprise increase in rates. However, because of the announcement time interpretation of Fed action changes a lot in the time series, this strategy would not reliably earn positive returns. As reported in Table 13, a naive leak-trading strategy that buys the market just before an announced cut, and shorts the market just before an announced raise would only make 12 bps per meeting, with 87 bps of volatility. In contrast, the long only pre-announcement strategy earns 21 bps with 52 bps of volatility. In the pre-announcement period the illegally informed investor would have to be long the market before a surprise increase announced later in the day, and short the market before a surprise cut.

Now, perhaps uncertainty regarding the Fed announcement is entirely resolved via leaks. The resolution of uncertainty in the pre-announcement period would then give rise to positive returns with no corresponding predictability over announcement returns. In that case we should see no response from the equity market on announcement—which is contradicted by the data.

It could be that the Fed attempts to manage expectations and "talk down" the market beliefs regarding the policy decision. However, such biased expectations should be reflected in Fed Funds futures prices. Like Lucca and Moench (2015), I find no material drift in Fed funds futures prices in the pre-announcement window. In sum, I find that the dynamics on FOMC days are not consistent with a purely leak-based explanation.

5.2 Theories Other than Informational Leaks, Other Related Work

A number of recent papers study the pre-FOMC drift. Karnaukh (2020) studies the pre-announcement drift in foreign exchange markets. She finds that the dollar appreciates before rate cuts, and depreciates before rate increases, arguing this provides evidence for limited attention and market

segmentation. Mueller et al. (2017) also study the FX market. They find that a portfolio in global currencies financed by a short position in the dollar earns high returns on FOMC days, in large part before the announcement. Borisenko and Pozdeev (2017) document that local currencies tend to depreciate in anticipation of rate cuts and appreciate in anticipation of rate increases in various global markets.

Lucca and Moench (2015) document that number of articles in business print increases in anticipation of the announcement. Fisher et al. (2020) show that media coverage of a number of macroeconomic announcements, including FOMC statements, increases in anticipation of the scheduled release date. They further demonstrate that market returns are higher on FOMC announcement days that see a large increase in media attention prior to the announcement. These findings are consistent with the view that investors interpret Fed announcements using information learned in the pre-announcement period.

Birru and Figlewski (2010) study the intraday evolution of the SP500 risk-neutral return distribution on FOMC announcement days. They find that the variance of the risk-neutral distribution of market returns shrinks substantially during the intraday trading before the announcement is made. Hu et al. (2018) find that half of the announcement day drop in VIX occurs in the pre-announcement period. Like here, they interpret the pre-announcement returns through a model in which there is resolution of uncertainty about announcement time market exposure to the news, though without taking a stance on the nature of this information. Both of these empirical findings are consistent with the model of pre-announcement risk presented here.

On the theoretical side, Johnson and So (2018) study expected returns around firm scheduled events. They argue that sell orders are more expensive than buy orders in the run-up to announcements, leading to systematic overpricing of stocks that are about to make an announcement. To the extent such mispricing is predictable, it should not lead to excess returns earned in the pre-announcement window. Similarly, Bilyi (2019) proposes a model where the pre-FOMC drift arises because of the combination of heterogeneous valuations and short-sale constraints. His model shares some of the time-series and cross-sectional predictions with the model presented here, such as drift being stronger at times with high uncertainty about the announcement, and high beta stocks showing a stronger drift. Like here, Bilyi (2019) finds that the empirical evidence is inconsistent with a purely leak-based explanation. Bàtyi (2019) constructs a learning-based model in which investors rationally concentrate attention on stocks about to make an announcement. In such a model, the presence of other value-relevant announcements can make investors rationally direct attention to FOMC announcements only in the last days prior to the scheduled time and so prices become more informative in the pre-announcement window. Ertan et al. (2020) study individual investor trading around scheduled announcements. Albuquerque (2012) provides a model in which seasonalities in firm announcements affect the aggregate market return distribution.

There are a number of papers on announcement effects outside the issue of pre-announcement drift. Law et al. (2019) study the market impact of a slew of MNAs with the goal of estimating the conditional effect of MNAs over the business cycle. They find evidence of systematically different

behavior over the business cycle. Goldberg and Grisse (2013) study conditional sensitivities of Treasury and FX rates to MNAs. Balduzzi et al. (2001) study the impact of MNAs on the Treasury yield curve, as do Hördahl et al. (2015) who decompose the impact of announcements into a shock to the path of expected short rates and changes in risk premia, which work in opposite directions. Kadan and Manela (2019) estimate the value of private information regarding MNAs under various preference parameters. Gilbert (2011) studies the conditional reaction of the market to MNAs as well as subsequent data revisions.

A voluminous literature studies the time-varying impact of Fed announcements. Nakamura and Steinsson (2018) show that conventional contractionary monetary shocks typically bring along an increase in expected growth rates on account of an informational channel. Quantitatively, they attribute two thirds of the response in real rates to monetary shocks to this effect on investor expectations. Similarly, Jarociński and Karadi (2020) suggest that monetary policy announcements contain two types of information: news about the short term interest rate, and news about the monetary authority's view of economic fundamentals. These authors seek to untangle the two channels in order to better estimate the impact of monetary policy decisions on the economy. Cieslak and Schrimpf (2019) decompose the informational content of the four major central bank announcements. In addition to news about real rates and growth, they also measure innovations to the risk premium. Paul (2019) finds substantial time-series heterogeneity in the stock and house price impact of monetary surprises. Gurkaynak et al. (2005) find that a single factor is not sufficient to capture Fed announcement impact on asset prices. They attribute over three quarters of the response in yields to news orthogonal to the change in the Fed funds rate.

Basistha and Kurov (2008) and Kurov (2010) study conditional exposures to Fed announcements. Fleming and Piazzesi (2005) find that the response of Treasury rates to FOMC announcements depends on the shape of the term structure at announcement time, while Kontonikas et al. (2013) find a "wrong-signed" response during the crisis. Velikov (2017) finds evidence of cross-sectional return predictability after FOMC announcements while Ozdagli and Velikov (2020) study the performance of FOMC announcement exposure sorted portfolios outside Fed announcement events. Hanson and Stein (2015) study the behavior of long rates in response to monetary announcements. Boguth et al. (2019a) study price discovery in the aftermath of Fed announcements. Sangrey (2018) estimates compensation for jump risk in prices, including on FOMC announcement days. Kroencke et al. (2019) and Brooks et al. (2019) find evidence of a post-announcement drift in returns and fund flows. Neuhierl and Weber (2018) find that the market tends to have drifted up before expansionary announcements, and continues to gain in price after such expansionary announcements.

Stein (1989) and Stein and Sunderam (2018), discussed above, study strategic aspects of Fed communications.

A recent literature has sought to explain why CAPM risk premium tends to be earned on macroeconomic announcement days and why expected returns on such days are high without a corresponding increase in aggregate market volatility, as documented in Savor and Wilson (2014). Andrei et al. (2019) provide a theoretical account: they argue that the econometrician fails to observe the

CAPM on most days because betas are mismeasured, but on announcement days public information releases ensure more precise beta measurement and the CAPM becomes evident. Implicit in their model is the view that betas vary a lot over time. Wachter and Zhu (2019) tackle the quantitative issue and propose a time-varying rare disaster model in which MNAs allow investors to learn about a latent disaster probability. Their model is able to match the evidence regarding the market Sharpe ratio on announcement days. FOMC announcements are an example of MNAs that see a high market risk premium and the CAPM in the cross-section, though the effect stems primarily from the pre-announcement returns. Also part of this literature is work in Ai and Bansal (2018) that argues the MNA risk premium cannot obtain under expected utility preferences. Their model can explain the pre-announcement drift only if the news is leaked by the Fed which is inconsistent with lack of positive correlation between pre-and post-announcement returns. In Laarits (2019) I argue that the announcement risk premium is also consistent with expected utility preferences.

Finally, rationalizing the asset market exposure to monetary policy news on announcement time is an area of active research. Pflueger and Rinaldi (2020) present a New-Keynesian framework with habit preferences to capture the impact of policy shocks on the equity market, as well as inflation breakevens.

6 Conclusion

High average returns before FOMC announcements present an asset pricing puzzle. In this paper I show that a pre-announcement drift arises in a model where the market's response to Fed announcements exhibits substantial time variation. The key element of the model is a tight connection between announcement time market sensitivity to Fed news and the pre-announcement information.

I motivate this time variation in market exposure by documenting how market participants interpret Fed actions in light of recent news. If recent news has been good, the market tends to interpret a surprise increase in the Fed Funds rate as a reflection of optimistic growth expectations on behalf of the Fed. If recent news has been poor, the market tends to interpret a surprise increase in the Fed Funds rate as a reflection of higher real rates going forward. I also provide a framework under which the Fed finds it constrained optimal to communicate in this manner. The model therefore underlines the importance of the informational channel of monetary policy to understanding how policy action and communication affect real outcomes.

Furthermore, the model spells out how the Fed impacts the resolution of uncertainty over the FOMC calendar, providing an alternative explanation of the market cyclicality documented in Cieslak et al. (2019). According to the model, should the Fed decide to do less to counter aggregate fluctuations, the pre-announcement drift would be weaker, but expected returns at other times would increase. The model does not allow me to directly compare the magnitude of these two effects. To do this, it would need to directly model the informational frictions underlying the Fed's announcement procedure.

7 Tables

	mean	p1	p50	p99	sd	count
SP500 R_{pre}	0.220	-0.642	0.116	1.591	0.498	208
SP500 R_{post}	-0.026	-2.984	-0.003	2.248	0.995	208
SP500 R_{all}	0.193	-2.596	0.071	2.898	1.022	208
$\Delta\widetilde{FF}_{pre}$	-0.026	-7.500	0.000	7.222	1.544	194
$\Delta\widetilde{FF}_{post}$	-0.317	-17.944	0.000	12.000	4.067	208
$\Delta\widetilde{FF}_{all}$	-0.348	-14.778	0.000	12.000	3.869	208
10y Treasury R_{pre}	0.015	-0.560	0.026	0.631	0.218	208
10y Treasury R_{post}	0.058	-1.112	0.015	1.486	0.516	208
10y Treasury R_{all}	0.073	-1.374	0.080	1.375	0.569	208
Cov(Stocks, Tr. 10y) post FOMC	1.004	-148.393	-0.543	175.150	53.260	208
L-S β_{Yield} R_{pre}	0.103	-1.773	0.015	3.009	0.957	208
SP500 XS-VOL (t-1)	1.849	0.862	1.662	5.094	0.759	208
VIX(t-1)	0.198	0.102	0.179	0.480	0.082	208
MA Fed Funds risk premia	0.236	-0.217	0.098	1.605	0.377	208
Fed Funds Implied Volatility	0.056	0.000	0.020	0.250	0.075	208
Market Ret (t-10) to (t-1)	0.303	-7.741	0.549	6.529	3.133	208
Market Ret (t-10) to (t-1), if negative	-0.987	-7.741	0.000	0.000	2.046	208

Table 2: Summary Statistics on FOMC Meeting Level. All scheduled FOMC meetings 1994-2019. Returns in percentages; change in implied Fed Funds target in basis points. "Pre" refers to the pre-announcement period from market open to one minute before the announcement. "Post" refers to the the post-announcement from one minute before the announcement to market close. "All" refers to the entire trading day. $\Delta\widetilde{FF}$ is the surprise change in Fed Funds rate. Cov(Stocks, Tr. 10y) post FOMC is the realized stock-bond covariance in minute-by-minute returns for 15 minutes after the announcement. L-S β_{Yield} R_{pre} refers to the pre-announcement return of a portfolio long high interest rate exposure stocks, short low interest exposure stocks. SP500 XS-VOL is the cross-sectional volatility of stocks in the SP500. Fed Funds risk premia is the 12-month moving average from holding the next month Fed Funds Futures portfolio, after Piazzesi and Swanson (2008). Fed Funds Implied volatility is calculated as the volatility of a binomial random variable using probabilities backed out from Fed futures prices. $(t-10)$ and $(t-1)$ refer to 10 and 1 trading day before the announcement, respectively.

	SP500 Return 9:30-announcement					
SP500 XS-VOL (t-1)		0.360***				0.258***
		(9.63)				(3.98)
VIX(t-1)			3.001***			1.239*
			(6.62)			(2.06)
Fed Funds Implied Volatility				1.138*		-0.281
				(2.36)		(-0.70)
MA Fed Funds risk premia					0.426***	0.110
					(4.54)	(1.04)
Constant	0.220***	-0.445***	-0.373***	0.157***	0.120***	-0.512***
	(6.38)	(-6.65)	(-4.86)	(4.14)	(3.44)	(-6.23)
Observations	208	208	208	208	208	208
R^2	0.000	0.301	0.246	0.030	0.104	0.337

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Pre-FOMC Announcement Drift. Left-hand-side variable is the intraday SP500 returns from market open to FOMC announcement. The first column shows the unconditional average in the sample. $(t-1)$ refers to the prior trading day: all right-hand-side variables are known at the beginning of the day. XS-VOL is the cross-sectional volatility of stocks in the SP500. Implied volatility of announcement is calculated as the volatility of a binomial random variable using probabilities backed out from Fed futures prices. Fed Funds risk premia is the 12-month moving average from holding the next month Fed Funds Futures portfolio, after Piazzesi and Swanson (2008). Heteroskedasticity robust standard errors.

	Stock Return Announcement-16:00			
$\Delta\widetilde{\text{FF}}_{\text{post}}$	-7.564**	-3.629	-4.690	-3.181
	(-3.26)	(-1.94)	(-1.95)	(-1.75)
$\Delta\widetilde{\text{FF}}_{\text{post}}$ x β_{CAPM}		-4.181*		-2.457*
		(-2.07)		(-2.10)
$\Delta\widetilde{\text{FF}}_{\text{post}}$ x β_{CAPM}		-1.307		-1.008
		(-1.61)		(-1.45)
β_{CAPM} x Pos.		0.0316		-0.0107
		(0.65)		(-0.24)
β_{CAPM}		0.00565		0.0302
		(0.17)		(0.90)
$\Delta\widetilde{\text{FF}}_{\text{post}}$ x β_{Yield}			-3.541	-3.113
			(-1.44)	(-1.29)
$\Delta\widetilde{\text{FF}}_{\text{post}}$ x β_{Yield}			-2.931	-2.773
			(-1.85)	(-1.73)
β_{Yield} x Pos.			0.113	0.110
			(1.25)	(1.19)
β_{Yield}			-0.126	-0.130
			(-1.77)	(-1.81)
$\Delta\widetilde{\text{FF}}_{\text{post}}$ x Pos.		2.152	-1.447	2.176
		(0.98)	(-0.44)	(0.97)
Pos.		0.172*	0.140	0.161
		(2.00)	(1.27)	(1.89)
Constant	-0.00382	-0.111	-0.0480	-0.0931
	(-0.06)	(-1.62)	(-0.58)	(-1.39)
Observations	89633	89633	89624	89624
R^2	0.059	0.080	0.101	0.105

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Stock-level Response to Surprise Fed Funds Change on Announcement Days. Left-hand-side variable is the stock return from announcement to close of trading. Stocks in the SP500 at the beginning of the month of the announcement. Pre-scheduled announcements 1994-2019. $\Delta\widetilde{\text{FF}}$ refers to the surprise change in Fed Funds rate. β^{CAPM} is the CAPM beta of the stock, calculated monthly using daily returns from the previous calendar month. Pos. is an indicator variable for announcements with positive realized stock-bond covariance. β^{Yield} is the beta of the stock with respect to the level factor of Treasury yields. Standard errors clustered by day. Firm-level fixed effects.

	Cov(Stocks, Tr 10y)			If $\lvert \mathrm{E}_t[\Delta \mathrm{FF}_{t+1}] \rvert > .01$		
SP500 $\mathrm{R}_{\mathrm{pre}}$	-27.67*		-16.22	-38.02**		-25.08**
	(-2.58)		(-1.83)	(-3.20)		(-3.09)
L-S β_{Yield} $\mathrm{R}_{\mathrm{pre}}$		-14.27*	-7.005		-19.46**	-12.56
		(-2.46)	(-1.41)		(-2.94)	(-1.96)
Cov(Stocks, Tr 10y) Pre FOMC			4.122			0.665
			(1.81)			(0.21)
Constant	7.172	2.541	7.643*	13.03*	3.746	11.11*
	(1.92)	(0.70)	(2.07)	(2.54)	(0.88)	(2.38)
Observations	208	208	208	107	107	107
R^2	0.059	0.058	0.101	0.154	0.157	0.214

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Predicting Announcement Time Stock-Bond Covariance. Left-hand-side variable is the realized stock-bond covariance in minute-by-minute returns for 15 minutes after the announcement. Pre-scheduled meetings 1994-2019. Fourth to sixth column restrict sample to meetings with expected change in Fed Funds rate larger than one basis point in magnitude (expected change is known before the announcement time), as a proxy for meetings where there is more uncertainty about Fed action. L-S β_{Yield} $\mathrm{R}_{\mathrm{pre}}$ refers to the pre-announcement return of a portfolio long high interest rate exposure stocks, short low interest exposure stocks. Heteroskedasticity robust standard errors.

	SP500 Return 9:30 to Announcement					
Count "This Morning"	0.127*					0.0686
	(2.54)					(1.61)
Count "This Week"		0.151**				0.0959
		(2.72)				(1.83)
Count "Recent"			0.0827*			0.0486
			(1.98)			(1.16)
Count "Market"				0.152***		0.126**
				(3.67)		(2.92)
Count "Volatility"					0.0332	-0.0464
					(0.89)	(-1.36)
Constant	0.0103	-0.0164	0.0227	-0.292*	0.243***	-0.628***
	(0.10)	(-0.16)	(0.17)	(-2.01)	(4.62)	(-3.60)
Observations	168	168	168	168	168	168
R^2	0.061	0.086	0.026	0.087	0.004	0.169

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Textual Analysis of FOMC Meeting Transcripts. Left-hand-side variable is the realized pre-announcement return. Count of phrases spoken at FOMC meetings, normalized by total count of words. Phrases in quotation marks matched allowing for upper- and lowercase letters, and any word endings. Scheduled FOMC announcements 1994-2014. Right-hand-side variables normalized to unit standard deviation. Heteroskedasticity robust standard errors.

	Daily Market Excess Return			
Even Week FOMC Cycle		0.0651*	0.0650*	0.00470
		(2.29)	(2.29)	(0.16)
XS-VOL > p50			-0.0231	-0.0858*
			(-0.83)	(-2.09)
Even Week x XS-VOL > p50				0.117*
				(2.10)
Constant	0.0343*	-0.000511	0.0114	0.0437*
	(2.43)	(-0.02)	(0.55)	(2.13)
Observations	6522	6522	6522	6522
R^2	0.000	0.001	0.001	0.002

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Market Excess Returns over the FOMC Cycle. Left-hand-side variable is the daily market excess return. Daily returns 1994-2019. XS-VOL is the cross-sectional volatility of stocks in the SP500. XS-VOL > p50 is an indicator variable for days where XS-VOL was above its median value at the last FOMC meeting. Heteroskedasticity robust standard errors.

	$\Delta\widetilde{\text{FF}}_{\text{pre}}$	$\Delta\widetilde{\text{FF}}_{\text{pre}}$	10y Tr.	10y Tr.	10y Tr.	10y Tr. MA
SP500 R_{pre}		0.0393		-0.0993***		
		(0.18)		(-3.34)		
Beta-imp. 10y Tr.					0.617***	
					(6.31)	
Beta-imp. 10y Tr. MA						0.742***
						(6.40)
Constant	-0.0256	-0.0349	0.0153	0.0372*	0.0212	0.0202
	(-0.23)	(-0.28)	(1.01)	(2.31)	(1.52)	(1.70)
Observations	194	194	208	208	208	208
R^2	0.000	0.000	0.000	0.052	0.162	0.392

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Pre-announcement Drift in Fed Funds Futures and Treasury Prices. First two columns show the change in Fed Funds Futures implied change in target rate. FF surprise quoted in basis points. Third and fourth column show the average drift in Treasury prices. Beta-implied drift is calculated by multiplying 10-year Treasury bond CAPM beta with the drift in SP500. Treasury beta is calculated using a 30-day rolling window. MA refers to 8-meeting moving averages.

	$\Delta \frac{\text{AUD}}{\text{USD}}$	$\Delta \frac{\text{CAD}}{\text{USD}}$	$\Delta \frac{\text{CHF}}{\text{USD}}$	$\Delta \frac{\text{EUR}}{\text{USD}}$	$\Delta \frac{\text{GBP}}{\text{USD}}$	$\Delta \frac{\text{JPY}}{\text{USD}}$	$\Delta \frac{\text{NZD}}{\text{USD}}$
Beta-imp. Δ AUD/USD	1.182**						
	(3.24)						
Beta-imp. Δ CAD/USD		1.550***					
		(4.16)					
Beta-imp. Δ CHF/USD			0.576				
			(1.24)				
Beta-imp. Δ EUR/USD				1.125*			
				(2.60)			
Beta-imp. Δ GBP/USD					0.777		
					(1.69)		
Beta-imp. Δ JPY/USD						0.697*	
						(2.23)	
Beta-imp. Δ NZD/USD							1.070*
							(2.59)
Constant	-0.108	-0.102*	-0.126*	-0.112*	-0.121**	0.00615	-0.105
	(-1.79)	(-2.33)	(-2.11)	(-2.38)	(-2.97)	(0.13)	(-1.67)
Observations	208	208	208	208	208	208	208
R^2	0.048	0.078	0.007	0.032	0.014	0.024	0.032

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Pre-announcement Drift in Foreign Exchange Markets. Pre-scheduled FOMC announcements 1994-2019. The left-hand-side variable is the FOMC announcement day change in the foreign exchange rate over USD. The beta implied change is the change in the foreign exchange rate implied by its market beta and the realized pre-announcement return on the SP500. Foreign exchange rate betas are calculated using a 30-day rolling window. In the regression using EUR/USD exchange rate EUR is replaced with ECU (European Currency Unit) exchange rate prior to the introduction of the Euro.

	Earnings		Dividends	
(t-3) to (t-2)	0.0153	-0.00443	0.00385	0.000167
	(1.40)	(-0.19)	(0.32)	(0.01)
(t-2) to (t-1)	0.0330**	0.0224	0.0317*	-0.00680
	(2.96)	(0.97)	(2.52)	(-0.23)
(t-1) to t	0.0769***	0.0282	0.0595***	0.0295
	(6.56)	(1.24)	(4.48)	(1.01)
t to (t+1)	0.110***	0.153**	0.0964**	0.166*
	(4.32)	(3.27)	(3.10)	(2.53)
(t+1) to (t+2)	0.00101	-0.0113	-0.0347*	0.00569
	(0.07)	(-0.40)	(-2.27)	(0.16)
$\beta_{\text{i, CAPM}}$		0.00838*		0.0220***
		(2.55)		(5.06)
$\beta_{\text{i, CAPM}}$ x (t-3) to (t-2)		0.0198		0.00364
		(0.79)		(0.12)
$\beta_{\text{i, CAPM}}$ x (t-2) to (t-1)		0.0106		0.0373
		(0.45)		(1.23)
$\beta_{\text{i, CAPM}}$ x (t-1) to t		0.0487*		0.0290
		(2.09)		(0.97)
$\beta_{\text{i, CAPM}}$ x t to (t+1)		-0.0428		-0.0665
		(-0.90)		(-1.03)
$\beta_{\text{i, CAPM}}$ x (t+1) to (t+2)		0.0121		-0.0389
		(0.43)		(-1.11)
Constant	0.0425***	0.0342***	0.0411***	0.0183***
	(30.31)	(10.44)	(26.23)	(4.22)
Observations	2669102	2669102	1935853	1935853
R^2	0.000	0.000	0.000	0.000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Pre-Announcement Drift Before Earnings and Dividend Announcements. Left hand side variable is stock-level daily return. Earnings and dividend announcement date and time from IBES. Daily returns of SP500 stocks from 1994-2019 (earnings) and 2002-2019 (dividends). Indicator variables indicate trading days relative to the announcement. Day t indicates the last full trading day before the announcement. Heteroskedasticity robust standard errors.

	Open (t-1) to Ann.		Noon (t-1) to Ann.		Close (t-1) to Ann.	
FOMC day		0.271*		0.214*		0.0263
		(2.35)		(2.19)		(0.37)
Constant	0.0522	0.0491	0.0351	0.0327	0.0635***	0.0632***
	(1.86)	(1.73)	(1.55)	(1.42)	(4.33)	(4.27)
Observations	1495	1495	1495	1495	1495	1495
R^2	0.000	0.001	0.000	0.001	0.000	0.000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Pre-Announcement Drift Before Other Macroeconomic Announcements. Left hand side variable are market returns in the indicated time period around the announcement. Macroeconomic announcements on FOMC days included, following Law et al. (2019), are the Consumer Board Confidence Index (CONCCONF), Initial Jobless Claims (INJCJC), ISM Manufacturing Index (NAPMPMI), and Change in Nonfarm Payrolls (NFPTCH). The Bloomberg identifier of the macroeconomic announcement is in parentheses. Sample from 2003 to 2019.

	SP500 R_{post}		$\Delta\widetilde{FF}_{pre}$		$\Delta\widetilde{FF}_{post}$	
SP500 R_{pre}	-0.407*	-0.309		0.0393	1.590**	1.371*
	(-2.20)	(-1.65)		(0.17)	(2.86)	(2.37)
$\Delta\widetilde{FF}_{post}$		-0.0622**				
		(-2.64)				
Market Ret (t-10) to (t-1)						0.0698
						(0.38)
Market Ret (t-10) to (t-1), if negative						-0.235
						(-0.92)
Constant	0.0639	0.0224	-0.0256	-0.0349	-0.668*	-0.873
	(0.95)	(0.34)	(-0.23)	(-0.34)	(-2.01)	(-1.80)
Observations	208	208	194	194	208	208
R^2	0.042	0.104	0.000	0.000	0.038	0.043

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Leaks Hypothesis. Pre-scheduled FOMC Announcements 1994-2019. Left-hand-side variables are returns on the SP500 after the announcement, and the changes in the implied Fed Funds rate pre-and post-announcement. $\Delta\widetilde{FF}$ is the surprise change in Fed Funds rate. $(t-10)$ and $(t-1)$ refer to 10 and 1 trading day before the FOMC announcement, respectively. Heteroskedasticity robust standard errors.

Strategy	$E[R]$	$\sigma(R)$	Sharpe
Long-Short Pre Announcement	-0.044	0.414	-0.302
Long-Short Post Announcement	0.107	0.765	0.396
Long-Short Entire Day	0.063	0.758	0.234
Long Only Pre Announcement	0.220	0.498	1.252
Long Only Post Announcement	-0.026	0.995	-0.074
Long Only Entire Day	0.193	1.022	0.536

Table 13: Trading on a Hypothetical Fed Leak. Pre-scheduled FOMC Announcements 1994-2019. Percentage returns of a strategy that is long the market if the *ex post* surprise in Fed Funds rate is negative; short the market if *ex post* surprise in Fed Funds rate is positive. Annualized Sharpe ratios calculated on a strategy that invests in the risk-free rate on days with no pre-scheduled FOMC announcements.

8 Figures

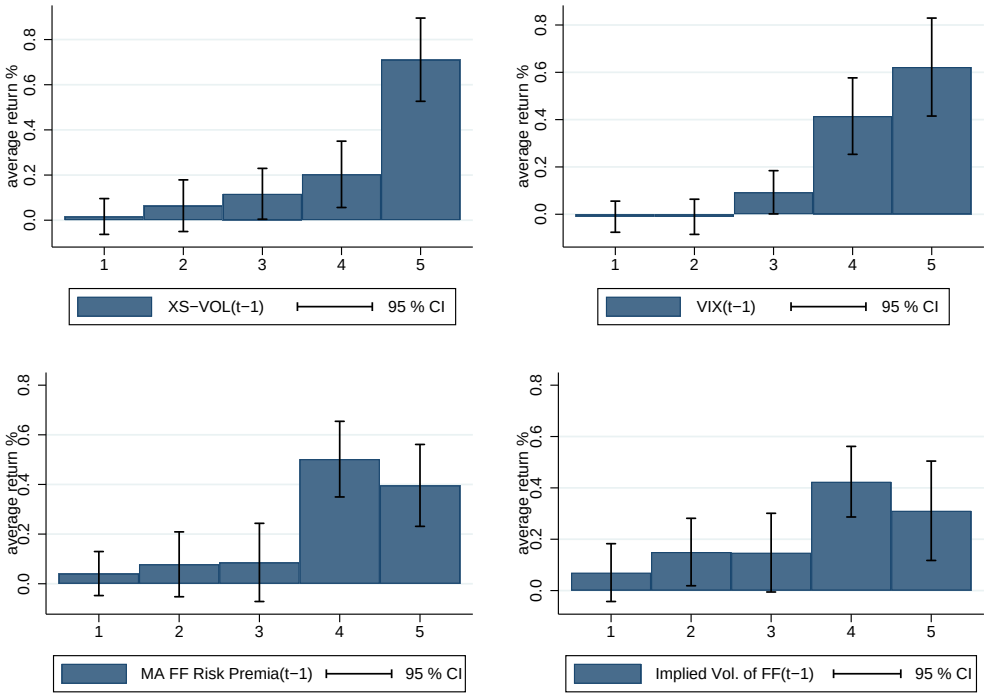

Figure 3: Average Pre-announcement Drift Conditional on Time (t-1) Variables. XS-VOL is the cross-sectional volatility of SP500 returns. Fed Funds risk premia is the 12-month moving average from holding the next month Fed Funds Futures portfolio, after Piazzesi and Swanson (2008). Implied volatility of announcement is calculated as the volatility of a binomial random variable using risk-neutral probabilities backed out from Fed Futures prices.

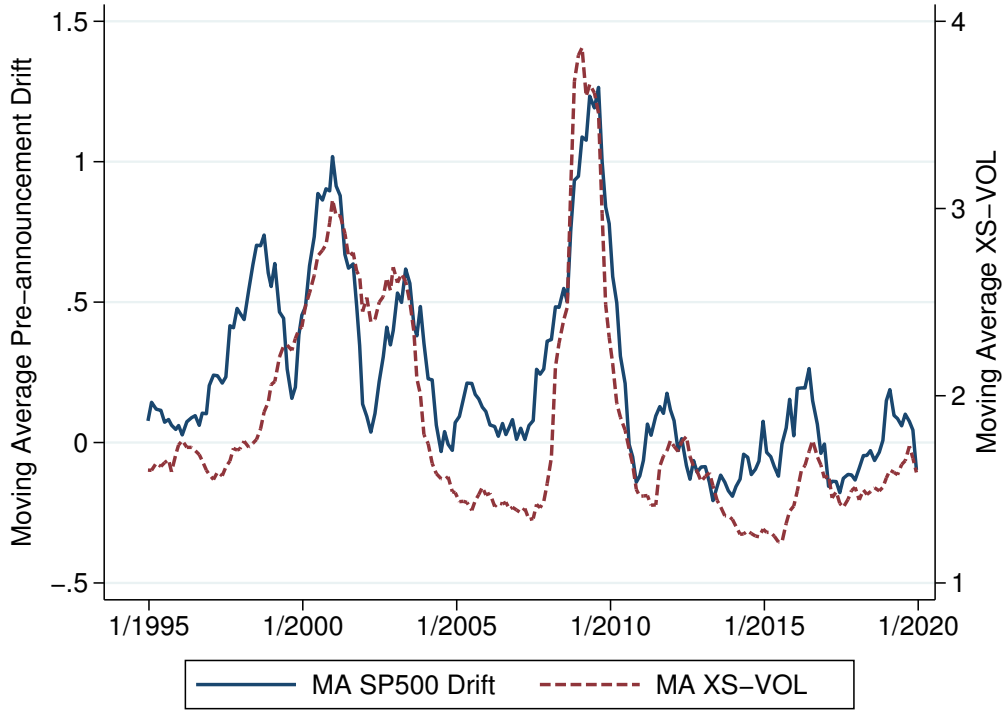

Figure 4: Moving Average of Pre-announcement Drift, Moving Average of XS-VOL. 8-meeting moving averages. Eight scheduled meetings represent one calendar year. XS-VOL is the cross-sectional volatility of SP500 returns.

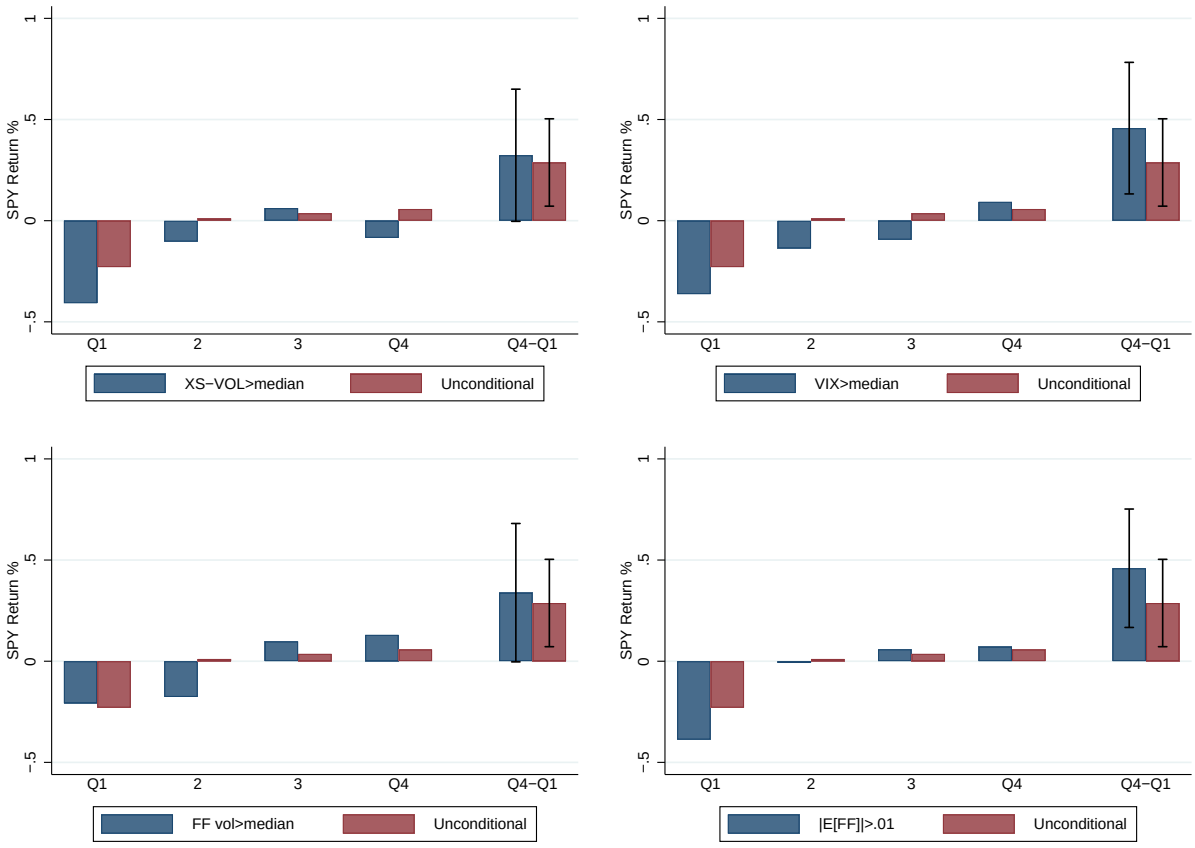

Figure 5: Announcement Risk Premia and Post-Announcement Stock-Bond Return Covariance. FOMC announcements 1994-2019. 15-minute returns of SPY are sorted into quartiles based on the observed stock-bond covariance in the window. Covariance calculated for each meeting using fifteen minutes of minute-by-minute SP500 and 10-year Treasury bond returns. Fifth columns show the difference in average returns between the extreme quartiles with 95% confidence intervals.

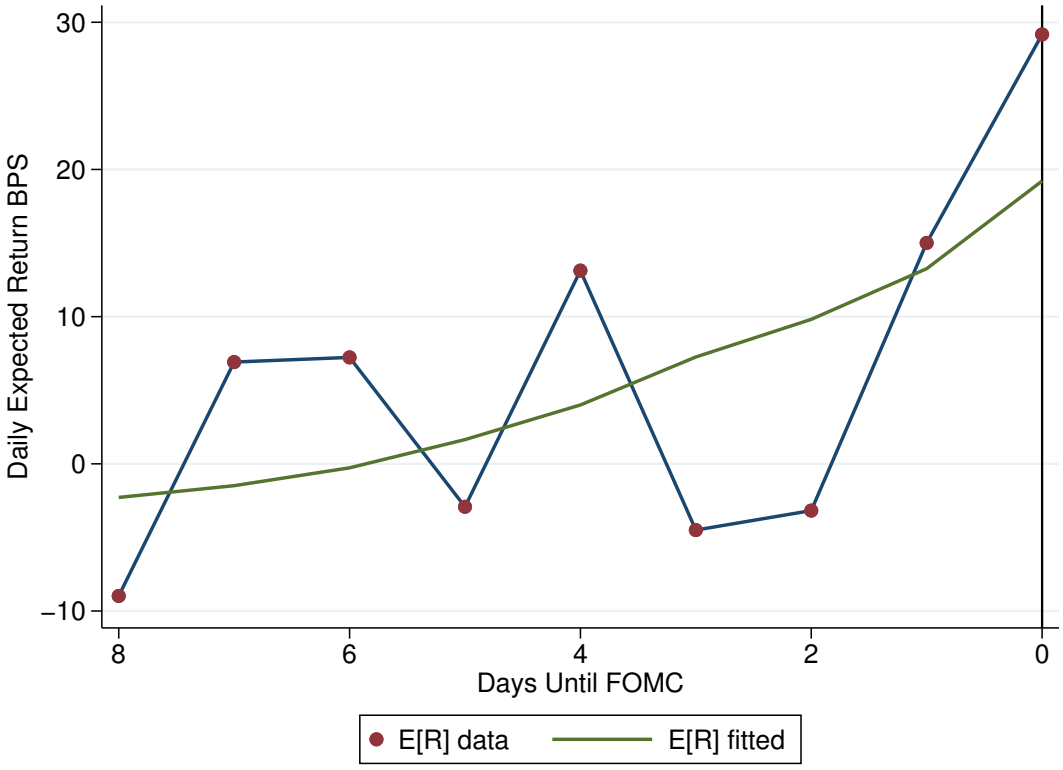

Figure 6: Average Returns Leading up to FOMC Announcement Fitted to Model Implied Functional Form. Daily returns in the 8 trading days leading up to a pre-scheduled FOMC announcement fitted to $r_{t,t+1} = \lambda$ XS-VOL$_t$ $\theta^{\tau-t-1} + \delta$, where XS-VOL is cross-sectional volatility of SP500. Sample from 1994 to 2019. Announcement day returns not inclusive of post-announcement returns. Estimation described in Section 3.5.

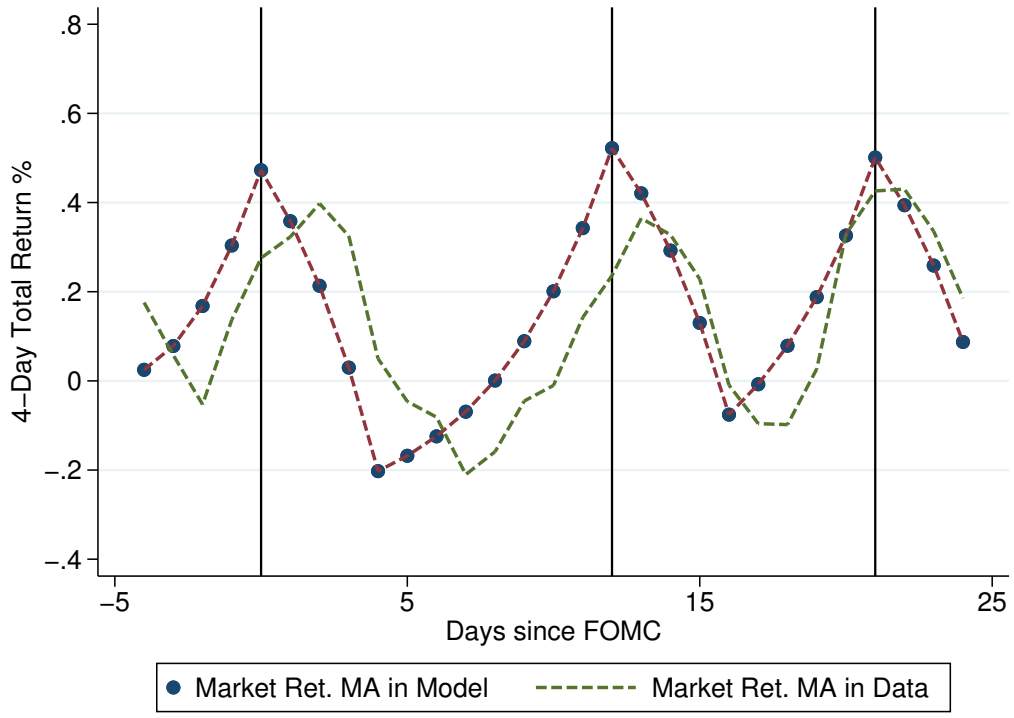

Figure 7: Four Day Cumulative Market Returns over the FOMC Cycle in the Data and in the Model. Daily returns 1994-2019. Model implied returns are calculated using the GMM estimation in Section 3.5, assuming a Fed communication occurs on days indicated with vertical lines.

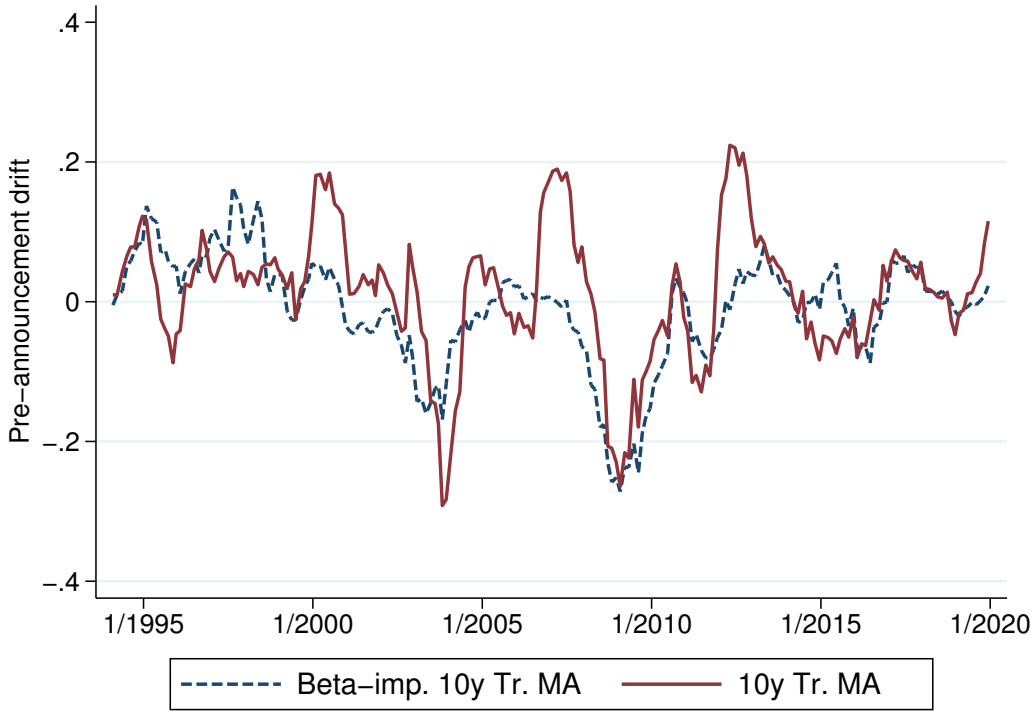

Figure 8: Moving Average of Pre-announcement Drift in 10-year Treasury Prices. Moving average of pre-announcement drift in 10-year Treasury prices implied by conditional bond beta and drift in SP500. Moving average calculated over 8 scheduled FOMC meetings (representing one calendar year). 10-year Treasury bond beta is estimated using a rolling 30 calendar day window.

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A Online Appendix A

A.1 Solving for Risk Premia

In this section I provide more detail on the calculation of risk premia in Section 2. In this appendix I am reusing notation—the Greek characters here do not have the same interpretation than before.

Let the log SDF be given by $m_{t+1} = a - \Lambda\eta_{t+1}$ and let the log asset return be $r_{t+1} = \mu + \beta\eta_{t+1} + \beta^{\xi}\xi_{t+1}$. The shocks η_{t+1} and ξ_{t+1} are normally distributed with zero means, and volatilities σ^{η} and σ^{ξ}. The asset return then has to satisfy the pricing equation

$$\begin{aligned} 1 &= \mathrm{E}_t\left[\exp\left\{m_{t+1}\right\}\exp\left\{r_{t+1}\right\}\right] \\ 1 &= \mathrm{E}_t\left[\exp\left\{a-\Lambda\eta_{t+1}\right\}\exp\left\{\mu+\beta\eta_{t+1}+\beta_{\xi}\xi_{t+1}\right\}\right]. \end{aligned}$$

To find the risk premia, let me first take the expectation and solve for μ

$$\mu = -a + \Lambda\beta\sigma_{\eta}^2 - \frac{1}{2}\Lambda^2\sigma_{\eta}^2 - \frac{1}{2}\beta^2\sigma_{\eta}^2 - \frac{1}{2}\beta_{\xi}^2\sigma_{\xi}^2. \tag{41}$$

Similarly, solve for the risk-free rate by finding r^f in

$$\begin{aligned} 1 &= \mathrm{E}_t\left[\exp\left\{m_{t+1}\right\}e^{r^f}\right] \\ \implies r^f &= -a - \frac{1}{2}\Lambda^2\sigma_{\eta}^2. \end{aligned}$$

The continuously compounded risk premium on the asset is then given by

$$\begin{aligned} \ln\left(\frac{\mathrm{E}_t[R_{t+1}]}{R^f}\right) &= \ln\left(\mathrm{E}_t[R_{t+1}]\right) - \ln(e^{r^f}) \\ &= \mathrm{E}_t[\ln(R_{t+1})] + \frac{1}{2}\sigma^2\left(\ln(R_{t+1})\right) - r^f \\ &= \mu + \frac{1}{2}\beta^2\sigma_{\eta}^2 + \frac{1}{2}\beta_{\xi}^2\sigma_{\xi}^2 - r^f \\ &= -a + \Lambda\beta\sigma_{\eta}^2 - \frac{1}{2}\Lambda^2\sigma_{\eta}^2 - \frac{1}{2}\beta^2\sigma_{\eta}^2 - \frac{1}{2}\beta_{\xi}^2\sigma_{\xi}^2 + \frac{1}{2}\beta^2\sigma_{\eta}^2 + \frac{1}{2}\beta_{\xi}^2\sigma_{\xi}^2 + a + \frac{1}{2}\Lambda^2\sigma_{\eta}^2 \\ &= \Lambda\beta\sigma_{\eta}^2. \end{aligned} \tag{42}$$

A.2 Fed's Problem Calculations

The conditional announcement rule is given by

$$F_w(X_t, \chi) = (1 - w(X_t))\chi_2 - w(X_t)\chi_1. \tag{43}$$

The announcement F_w defines the following line in (χ_1, χ_2) space

$$\chi_2 = \frac{F_w + w\chi_1}{1 - w}. \tag{44}$$

Investor beliefs will be given by the point on the line defined by Equation (44) closest to their signal. Denote with lowercase x_1 and x_2 the investor posterior. The distance squared from the point ν is given by

$$(x_1 - \nu_1)^2 + (x_2 - \nu_2)^2 = (x_1 - \nu_1)^2 + \left(\frac{F}{1-w} + \frac{wx_1}{1-w} - \nu_2\right)^2 \tag{45}$$

The derivative with respect to x_1 is given by

$$\frac{d}{dx_1} : 2(x_1 - \nu_1) + \frac{2w}{1-w}\left(\frac{F}{1-w} - \nu_2 + \frac{wx_1}{1-w}\right). \tag{46}$$

Setting the derivative to zero and solving for x_1 results in

$$\begin{aligned} 0 &= (x_1 - \nu_1) + \frac{w}{1-w}\left(\frac{F}{1-w} - \nu_2 + \frac{wx_1}{1-w}\right) && (47)\\ x_1\left(1 + \frac{w^2}{(1-w)^2}\right) &= \nu_1 + \frac{w}{1-w}\nu_2 - \frac{wF}{(1-w)^2} && (48)\\ \implies x_1 &= \left(\nu_1 + \frac{w}{1-w}\nu_2 - \frac{wF}{(1-w)^2}\right) / \left(1 + \frac{w^2}{(1-w)^2}\right). && (49) \end{aligned}$$

Under the unconditional announcement rule $w = (1-w) = .5$ the expression for post-announcement x_1 collapses to

$$x_1 = \frac{\nu_1 + \nu_2}{2} - F. \tag{50}$$

A.3 Mechanics of Fed Funds Futures Contracts

The Chicago Board of Trade (now CME Group) started trading Fed Funds futures contracts in 1988. Following the literature, I use $f^{(n)}_{m,d}$ to denote end of day price (quoted as a rate) of the n-month ahead Fed Funds futures contract in month m, day d. For example, $f^{(0)}_{m,1}$ refers to the price of the current month Fed Futures contract on month m one day into the month.

The futures are cash settled. At maturity, the month m Fed Funds futures contract pays out 100 minus the average end of day effective Fed Funds rate during the trading days of the month. That is, at maturity the current month contract price has to equal

$$f^{(0)}_{m,D} = \frac{1}{D}\sum_{j=1}^{D} FF_{m,j} \tag{51}$$

where D denotes the number of trading days in the month.

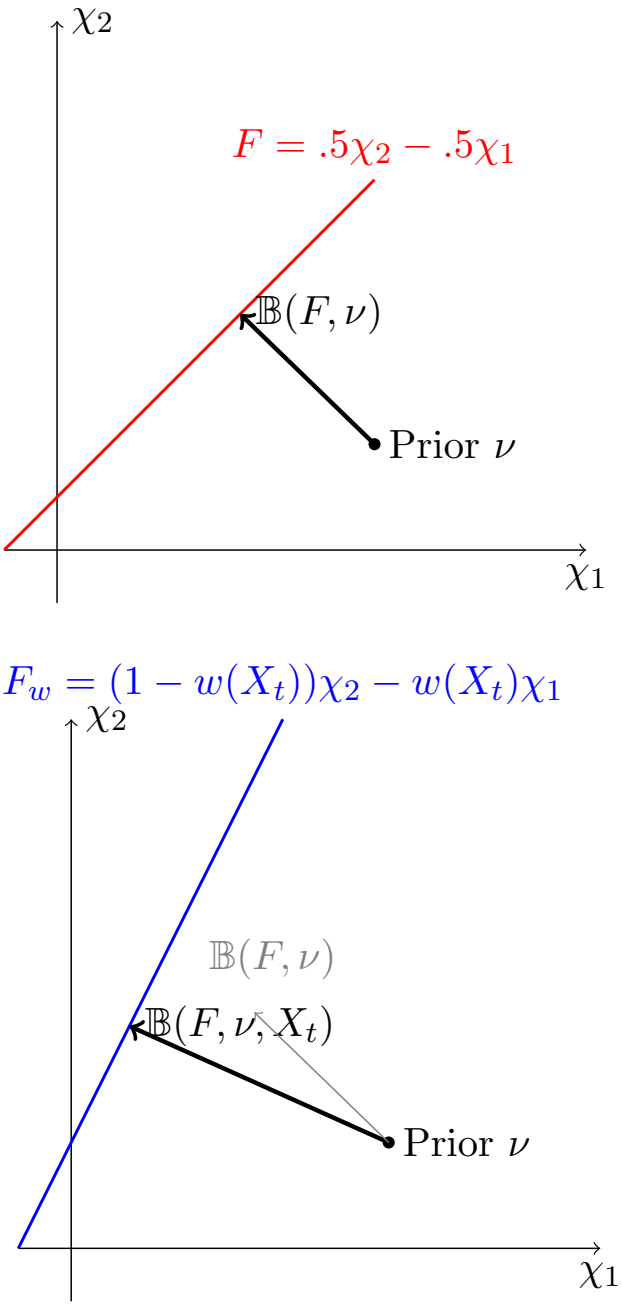

Figure A1: Illustration Investor Beliefs Under Fixed and Conditional Announcements. Top panel shows investor posterior belief under a fixed decision rule, bottom panel shows investor posterior belief under a conditional decision rule.

A.3.1 Calculation of Intraday Fed Funds Surprises

I employ the Kuttner (2001) methodology to calculate daily Fed Funds futures implied surprise changes in the Funds rate. The one day surprise change in the effective Fed Funds rate on month m, day d is given by:

$$\Delta\widetilde{FF}_{m,d} = \frac{D}{D-d}\left(f^{(0)}_{m,d} - f^{(0)}_{m,d-1}\right)$$

Let me relabel month m, day d as time $t+1$. By definition of surprise, the realized and surprise change in the Fed Funds rate from day t to $t+1$ is given by

$$\Delta FF_{t+1} = \mathrm{E}_t\left[\Delta FF_{t+1}\right] + \Delta\widetilde{FF}_{t+1}. \tag{52}$$

The only complication to this calculation arises near ends of month. With liquidity moving to next months' contracts, small amounts of noise in the underlying price can cause severe measurement noise as the denominator $D-d$ becomes small. I again follow Kuttner (2001) and use the change in the next month futures price to calculate the change during the last three trading days of a month.

A.3.2 Fed Funds Risk Premia

Piazzesi and Swanson (2008) find considerable risk premia in the Fed Funds futures market. They calculate returns on the zero cost portfolio that enters into a Fed Funds Futures contract at the beginning of month and sells to close the position at the end of the last trading day. Specifically, they calculate:

$$rx^{(n)}_t = f^{(n)}_{t,1} - \frac{1}{D}\sum_{j=1}^{D} FF_{t+n,j} \tag{53}$$

In principle, this calculation should take into account the costs from mandatory margins posted by traders. However, Piazzesi and Swanson (2008) find that the impact of taking into account margin requirements does not have a material effect on the measures of risk premia.

B Online Appendix B

B.1 Calibration of the Pre-Announcement Risk Premium

In this section I provide the details of a calibration that demonstrates how the model can quantitatively match the pre- and post-announcement risk premia. Specifically, I combine the calibrated model in Wachter (2013) with the model of pre-announcement risk to account for the key empirical facts both pre-, and post-announcement.

Consider again the two-period set-up from Section 2. In the first period market participants observe a signal X which determines the interpretation of the Fed announcement. In the second period the Fed announcement is revealed. Like in the main text, the Fed acts by changing the funds rate, but the market reaction the the announcement depends on the realization of X.

They key state variable in the Wachter (2013) model is a time-varying probability of rare disasters

p_t. I capture the two announcement types by how they differentially affect the disaster probability going forward. I specify that the Fed's announcement is particularly informative about disaster probability if it is interpreted as a policy shock—meaning if it comes on the heels of bad news. The forward-looking disaster probability jumps if recent news has been poor and yet the Fed increases rates relative to expectations, thereby revealing it is unwilling to provide accommodation. During an informational announcement, in contrast, a surprise cut in rates is associated with a slight increase in disaster probability as investors update down their beliefs about growth rates going forward. The full disaster probabilities as a function of the Fed announcement and recent news are reported in Figure B1. Note that the probability of good news in the first period is 80%.

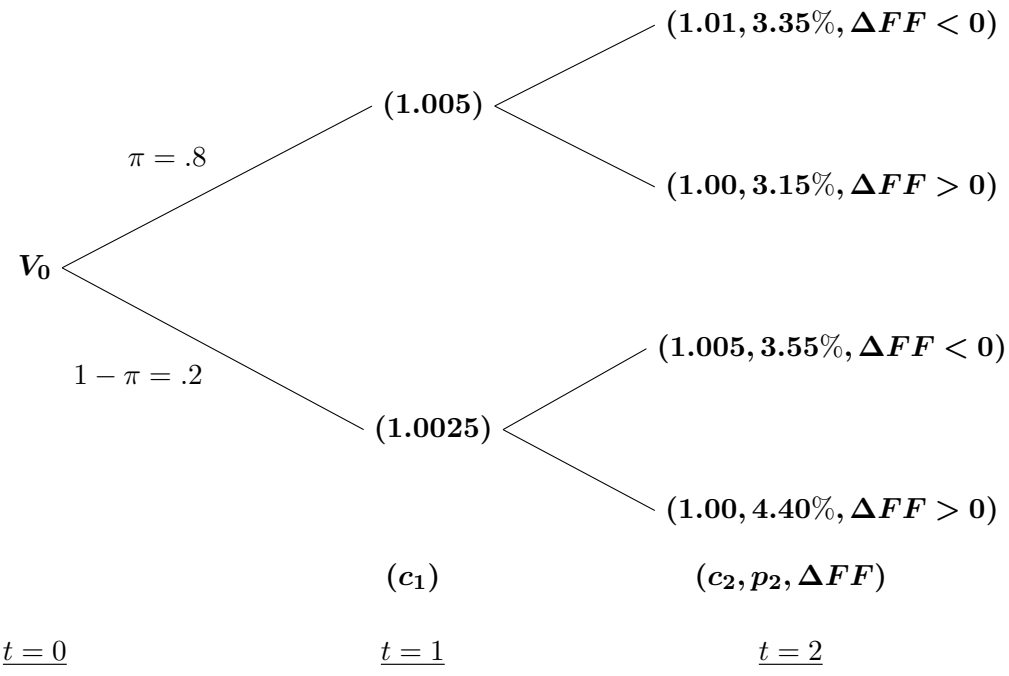

Figure B1: Calibration Timeline. In the first period, investors learn the type of the announcement to be made. In the second period, the investors learn the announcement. In the second period both states have equal probability.

The value function at time $t = 2$ is calculated according to the parameter values in the main calibration of Wachter (2013) (I use risk aversion $\gamma = 3.2$ instead of $\gamma = 3$) with the disaster probabilities indicated in Figure B1. The value functions at previous periods are calculated according to the Epstein-Zin recursion under the indicated consumption process and the value functions at $t = 2$ take into account that in expectation the time-varying disaster probability reverts to mean.

Table B1 summarizes the calibration results. The calibration is able to match the magnitude of the pre-announcement risk premium with reasonable amounts of volatility in consumption process, and in the disaster probability. Under the quantities listed in Figure B1 the pre-announcement risk premium is 22 bps, compared to 23 bps in the data.

In the Wachter (2013) calibration, the average annualized volatility of disaster probability is

1.14%. Under my calibration, each Fed announcement sees an average volatility of disaster probability of .334% which aggregates up to .94% per year (there are 8 FOMC meetings per year). In other words, under this calibration a large fraction of disaster probability news is learned on FOMC announcement days. Similarly, under my calibration the total volatility in the consumption process is 1.28% on FOMC days, compared to 2% over the entire year. In Table B1 I compare these quantities to the values implied by the Wachter (2013) calibration under the assumption that 85% of the c_t and p_t volatility is realized on FOMC days. Note too that the average disaster probability at $t = 2$ is slightly below the unconditional average used in Wachter (2013).

Quantity	Model	Data
Pre-announcement		
Risk Premium (bps)	22.1	23.3
Return Volatility $\sigma(R)$	1.81%	.50%
Announcement		
Risk Premium (bps)	10.0	-7.7
Return Volatility $\sigma(R)$	1.21%	1.50%
Announcement, $X = 0$		
Risk Premium (bps)	54.3	34.5
Return Volatility $\sigma(R)$	2.68%	1.59%
Announcement, $X = 1$		
Risk Premium (bps)	-1.1	-18.2
Return Volatility $\sigma(R)$	.84%	1.47%
Whole Day		Wachter (2013)×85%
Disaster probability vol. $\sigma(p_t)$	.35%	.34%
Consumption volatility $\sigma(c_t)$	.45%	.60%

Table B1: Risk Premium Pre-, and Post-Announcement. $X = 0$ refers to poor news in the run-up to the announcement.

The model is also able to match the qualitative fact that the market portfolio Sharpe ratio is higher in the pre-announcement, than the post-announcement period. However, under the calibration the market return volatility pre-announcement is over one percentage point higher than in the data. This reflects the Sharpe ratio of disaster probability shocks in the Wachter (2013) model. Indeed, Wachter and Zhu (2019) calibrate a macroeconomic announcement premium of 8.8 bps with associated market return volatility of 1%. This announcement day Sharpe ratio is in line with the calculations presented here, reflecting that both rely on the same underlying calibration. The very low observed market volatility in the pre-announcement period might in part reflect a lack of return innovations due to other sources of risk: Lucca and Moench (2015) show that pre-announcement period trading volume is on average 18% lower than the trailing 21-day volume.

Finally, a different asset pricing model—say a long run risk model—can also potentially account

for the pre-announcement risk premium, insofar as it can match the daily evidence of returns and volatility on macroeconomic announcement days.

B.2 Alternative Preference Specifications

In the main text I specified that investors have Epstein-Zin preferences. In this section I briefly discuss other preference specifications that can account for a pre-announcement risk premium.

B.2.1 CRRA

The pre-announcement risk premium under CRRA is

$$RP = \gamma \operatorname{Cov}\left(c_1(X) - \mathrm{E}_0[c_1(X)], \sigma_d\left(X - \mathrm{E}_0[X]\right)\right). \tag{54}$$

In contrast to Epstein-Zin preferences, under CRRA it is necessary that optimal consumption $C_1(X)$ is a function of the realization of X. With that assumption CRRA utility is consistent with a pre-announcement risk premium earned in the run-up to a scheduled announcement. Of course, CRRA preferences have other features that make them hard to reconcile with asset pricing data.

It might seem odd to appeal to consumption changes at such short horizons. However, the interpretation of C_1 in this setting is the optimal consumption amount the investor would choose to consume with $t = 1$ information, pinned down by the Envelope Condition via the restriction

$$u'(C_1(X)) = \frac{dV_1(X)}{dW_1}. \tag{55}$$

Equation 54 is derived under the assumption that the consumption decision at $t = 1$ is made with all available information, meaning it is made conditional on the realization of X. If the consumption process cannot adjust in the pre-announcement period then the marginal utility of current consumption can no longer serve as the pricing factor—we instead need to price assets directly with the value function derivative. Recognizing the importance of the Envelope theorem in this setting rationalizes an announcement (and pre-announcement) risk premium under CRRA preferences as described in Laarits (2019), in contrast to the claim in Ai and Bansal (2018). Quantitatively speaking, it may well be necessary to go beyond CRRA preferences, as exemplified by the calibration presented in Appendix B.1.

B.2.2 Non-Standard Preferences

Preferences other than Epstein-Zin and CRRA are also consistent with a pre-announcement risk premium. Strzalecki (2013) shows that the recursive definition

$$V_t = u(c_t) + \beta \mathcal{I}_t[V_{t+1}] \tag{56}$$

can capture an array of non-standard preference specifications with the appropriate specifications of certainty equivalent functional $\mathcal{I}$ and flow utility function u.

Let's derive the SDF under this preference specification. Define the value function formally as

$$\begin{aligned} V_t(W_t, X_t) = &\max_{\theta} \{u(c_t(X_t)) + \beta \mathcal{I}_t[V_{t+1}(W_{t+1}, X_{t+1})]\} \\ &\text{s.t.} \quad \theta \cdot p_t \leq \phi \cdot p_t = W_t \end{aligned} \tag{57}$$

where θ contains the portfolio weights of the representative investor over a full slate of Arrow-Debreu assets, ϕ is the endowment of the representative investor, and p_t is a vector of time t prices. Asset payouts are in the consumption good. The time t wealth, W_t, is defined as the market price of the investor's endowment. Prices are such that investors decide to consume exactly the endowment amount in each period.

At the optimum, any asset with current price p_t^i and stochastic payout χ_{t+1} next period has to satisfy investor first order conditions. Namely, a small investment of today's wealth W_t in the payout x_{t+1} must leave the value function unchanged

$$p_t^i \frac{dV_t(W_t, X_t)}{dW_t} = \mathrm{E}_t \left[\frac{dV_t(W_t, X_t)}{dW_{t+1}} \chi_{t+1} \right] \tag{58}$$

$$\implies p_t^i = \mathrm{E}_t \left[\frac{dV_t(W_t, X_t)}{dW_{t+1}} \Big/ \frac{dV_t(W_t, X_t)}{dW_t} \chi_{t+1} \right]. \tag{59}$$

Current value function depends on future wealth only via the effect on the continuation value

$$\begin{aligned} \frac{dV_t(W_t, X_t)}{dW_{t+1}} &= \frac{dV_t(W_t, X_t)}{dV_{t+1}(W_{t+1}, X_{t+1})} \frac{dV_{t+1}(W_{t+1}, X_{t+1})}{dW_{t+1}} \\ &= \beta \frac{d\mathcal{I}_t[V_{t+1}(W_{t+1}, X_{t+1})]}{dV_{t+1}(W_{t+1}, X_{t+1})} \frac{dV_{t+1}(W_{t+1}, X_{t+1})}{dW_{t+1}}. \end{aligned} \tag{60}$$

The Envelope condition ensures that the benefit of an incremental increase in current wealth equals the benefit of an incremental purchase the consumption good

$$\frac{dV_t(W_t, X_t)}{dW_t} = u'(c_t) \tag{61}$$

Therefore the SDF under preference relation 56 is given by

$$\begin{aligned} M_{t,t+1} =& \frac{dV_t(W_t, X_t)}{dW_{t+1}} \Big/ \frac{dV_t(W_t, X_t)}{dW_t} \\ M_{t,t+1} =& \beta \frac{d\mathcal{I}_t[V_{t+1}(W_{t+1}, X_{t+1})]}{dV_{t+1}(W_{t+1}, X_{t+1})} \frac{dV_{t+1}(W_{t+1}, X_{t+1})}{dW_{t+1}} \Big/ \frac{dV_t(W_t, X_t)}{dW_t} \\ =& \beta \frac{d\mathcal{I}_t[V_{t+1}(W_{t+1}, X_{t+1})]}{dV_{t+1}(W_{t+1}, X_{t+1})} \frac{u'(c_{t+1})}{u'(c_t)}. \end{aligned} \tag{62}$$

The condition for a pre-announcement risk premium is as follows. The discount factor in Equation

62 needs to have non-zero covariance with innovations to the state variable X_t. This covariance could stem from the consumption component, like in the case of CRRA preferences, or from the continuation value component, like in the Epstein-Zin specification in the main text.

C Online Appendix C

C.1 Excerpts from FOMC Transcripts

In the below table I show discussion of macroeconomic news releases made in the morning of the FOMC meeting, as well as discussion pertaining to the market reaction to the MNAs and market expectations of Fed action.

FOMC	MNAs	Discussion Excerpts
02/04/1994	Employment Report	MR. PRELL. Earlier this morning I had a brief discussion with a senior official at the Bureau of Labor Statistics. The civilian unemployment rate for January was reported at 6.7 percent under the new survey. ... The Labor Department believes that weather had a serious effect on the payroll increases, particularly in construction. MR. BOEHNE. How are financial markets interpreting that? MS. LOVETT. **Initially, the market moved up by almost a point at the long end–at the 30-year mark–as the headline news on the nonfarm number came across the wire. There has been some backing away from that.** The market is still up; it was up about 3/8 to 1/2 when we came in here. **It may be that market participants are trying to read through some of the underlying data in terms of hours and so forth.** So, it's lost some of its initial gain, but it is still up. CHAIRMAN GREENSPAN. Let me just go get the latest report. [Secretary's note: Chairman Greenspan left the meeting very briefly at this point.] MR. KOHN. The other interesting aspect was that bill rates went down 3 or 4 basis points and the funds rate, which had opened at 3-1/8 to 3-3/16, went down to 3 to 3-1/16 and remained there. **So in some sense at least the certainty of firming today was taken out by the employment numbers.** Now, maybe as the bond market and everyone else reassesses them, the adjustment will be reversed. CHAIRMAN GREENSPAN. The long end is now down 3/32. MR. LINDSEY. **They got to the last page of the release!** ... MR. LINDSEY. I notice that the hours were way up, from 125.2 to 126.3. Is that the basis of your higher GDP forecast? MR. PRELL. Well, that's the key element in my judgment that would probably raise the forecast. But these numbers are all being affected by weather; evidently, we're going to have to sort through the data to get a more refined assessment.

08/16/1994 Housing Starts and Permits

CHAIRMAN GREENSPAN. After talking to my colleagues on the Board of Governors, I think there is a sentiment on the part of the Board to raise the discount rate 50 basis points in line with what a number of the Reserve Banks are requesting. I think implicit in that, in the view of the Board, is to request this Committee to allow all of the increase to pass through. Also, I might add, implicit in that general policy view is our adoption of symmetric instructions to the Desk. The more I think about that as a potential sort of policy package, the less I like all of the other alternatives. I started off at either no change and asymmetry or 50 basis points with symmetry on the grounds that 25 basis points struck me as risking the other shoe dropping syndrome. **But I must say, the more I listened to this group and your comments on the elements involved and such things as the housing starts figures this morning**–incidentally, Mike, the adjusted permits if we add back the nonpermit issuing areas are down only .8, not 1.7.

MR. PRELL. **I just got these numbers at the break and I think the picture in the adjusted permits and the single-family starts is really one of rough stability in the past three months.**

CHAIRMAN GREENSPAN. **In other words, if we had a very weak residential construction area or a weak motor vehicles area, I would say we might want to pause and do nothing. But I think the evidence is increasingly convincing that we probably need to do 50 basis points.** I must admit that I was going to start out more even-handed–on the one hand, on the other hand, if you will–but I convinced myself to steer away from that. [Laughter] So with those apologies, I open up the discussion.

09/27/1994 Consumer Confidence

MR. PRELL. Mr. Chairman, I might bring to the Committee's attention **a late-breaking piece of news here this morning.** The Conference Board released its survey for September. The headline is that consumer confidence registered its third consecutive monthly loss in September, declining 2 points. In June the index had registered 92.5 but it is now at 88.4. The punch line in this release is that **"the current level of consumer confidence has been associated in the almost 30-year history of the survey with a reasonably lively economy."** So it's consistent with the notion that consumer sales have slipped a bit but are not far below the higher levels that we reached earlier this year.

...

MR. MCTEER. Mike, this is a follow-up to Bob Parry's earlier question to Joan. In Part II of the Greenbook, Section III-1, there is a sentence that says: "The press release announcing the August policy moves was widely interpreted as indicating that subsequent action was on hold, at least for a few months, and longer-term rates initially fell somewhat." Is that saying that you think the rates fell because of the "on hold" phrase as opposed to the action itself?

MR. PRELL. Well, this is open to varying interpretations! [Laughter] Certainly, as we perceived it, **that announcement has been an element in the sense that it gave traders a period of safety in which they didn't have to worry that every bit of incoming economic data would necessarily carry with it the risk of a tightening action.** So, they probably were a little more relaxed about the near-term outlook.

...

CHAIRMAN GREENSPAN. **I think bond dealers would prefer that (1) the Fed never did anything, (2) that no one released any statistics, and (3) that everything was trading incrementally. Under those conditions they would feel comfortable.** Any further questions?

07/06/1995 Initial Jobless Claims, Leading Indicators

MR. PRELL. Thank you, Mr. Chairman. I will be very brief. **Initial claims for the week of July 1 were published this morning and were unchanged at 369,000.** You will recall that two weeks ago they showed a spike up to 396,000; they came off last week and were unchanged in the latest week. Insured unemployment was up to 2.7 million. That has been trending up recently, so the rise wasn't particularly surprising in light of the initial claims. **The leading economic indicators were down 0.2 percent in May, as we and most other people had anticipated.** The change in the prior month stood at minus 0.6 percent; there was a revision from minus 0.5 percent to minus 0.4 percent, I believe, in the preceding month. For what it's worth, we were speculating that **the measure of the probability of recession that we presented in the Greenbook would be about 54 percent and, with the revision to the earlier month–this is a very sensitive measure–it is now at 48 percent.** [Laughter] The Johnson Redbook came out yesterday afternoon–up 1.4 percent for June–and you have the auto sales figures before you. As I indicated yesterday, they were up slightly in June to 14.9 million units for light vehicles, which is in line with the Greenbook forecast.

MR. MOSKOW. Peter, I was on the "morning call" this morning and one of the subject was the fed funds futures rate. **My recollection from this morning was that the fed funds futures rate is now indicating a 60 or 65 percent probability of a 25 basis point cut in the fed funds rate this month. I was just wondering how that ties in with what you were saying here this morning.**

MR. FISHER. I think we heard the same thing from the same sources at different times this morning. Looking through the pricing of the contract and the different time horizons one has to adjust for, there is a 60ish percent probability, if you read it literally, of a move early in the month–meaning now. **And there is an implied probability closer to 100 percent of a 25 basis point easing by the end of the month. Without going too far into the gymnastics of it, that's how one interprets 14 basis points on a contract that settles near the end of the month, given the different probabilities and different time horizons.**

12/19/1995

MR. FISHER. The shutdown of the Commerce Department has resulted in the postponement of today's scheduled statistical releases, and the fiscal battle remains unresolved. So, having no hot news to report, I want simply to underscore a few key points about the Greenbook forecast as it stands. Being naturally argumentative, I'm going to focus particularly on some differences we have with notions that have been expressed frequently around this table recently and that may have a direct bearing on your policy decision today.

...

MR. MELZER. Peter, **you mentioned that the bond market was selling off further this morning. What is it doing now?**

MR. FISHER. **The long bond is at 6.22 percent, I think, so it is backing up a bit. The middle of the maturity range is also backing up.**

MR. KOHN. **There was more news on the budget and, as I understand it, more pessimism about the prospects for an agreement.**

CHAIRMAN GREENSPAN. How many 32nds was that down?

MR. KOHN. It was down about 1/2 point.

MR. FISHER. Yes, 1/2 point. In yield, the long bond traded up to 6.22 percent early overnight in Tokyo, came down to 6.18 percent, and was back up to the 6.22 - 6.24 percent range in the last hour.

CHAIRMAN GREENSPAN. **(Consulting a pocket electronic market monitor) The truth is the markets are down 10/32. The cash market for the long bond is at 6.22 percent.**

VICE CHAIRMAN MCDONOUGH. You are our official source on the matter of long-term bond rates! [Laughter]

CHAIRMAN GREENSPAN. With all the technology we have in this room, I can't have a little old gadget?

MR. BLINDER. It's in the transcript that you made that remark! [Laughter]

11/16/1999 Industrial Production

MR. PRELL. Mr. Chairman, Karen Johnson is going to lead off our remarks, but let me just mention to **the Committee that we released industrial production data this morning–I trust a few minutes ago.** We failed to put a copy of the release in front of you, so let me just tell you about it. There were some small net revisions to the data for August and September that left September IP down 0.1 percent instead of the 0.3 percent decline that was published previously. And the October increase in industrial production was 0.7 percent. In manufacturing we had a 0.1 percent increase in September, also an upward revision, and 0.6 percent in October. **I think these numbers are significantly above market expectations, so perhaps those of you with electronic gadgets can see whether there has been any market reaction.**

CHAIRMAN GREENSPAN. **I just looked and the tape is delayed.**

MR. PRELL. I'm not sure whether that's good news or not.

VICE CHAIRMAN MCDONOUGH. The reaction is delayed?

CHAIRMAN GREENSPAN. This gadget is very slow. [Laughter] Let's turn now to Karen Johnson.

02/02/2000 Auto Sales, New Home Sales, Purchasing Managers' Survey

MR. PRELL. Chart 1 summarizes our forecast. But, before I get into the numbers here, **I should take note of some late-breaking news. First was the upside surprise in the BEA's advance estimate of fourth-quarter GDP, published on Friday.** The 5.8 percent real output increase exceeded our guess by about a half point. However, we decided not to redo the forecast and to go with the Greenbook numbers for this presentation. This wasn't simply for the sake of convenience. To be sure, BEA knew more about the fine detail of the fourth-quarter data than we did, but the key differences between their estimate and ours related mainly to assumptions about missing numbers. And we were reasonably content to stick with ours for the time being.

MR. PRELL. I might just say, **in terms of signs of strong demand, that we have received a preliminary reading on January auto sales.** And they seem to have come in at almost 18 million units–17.9 million–for light vehicles, which is well above the rate we are anticipating for the first quarter. **So that in combination with the construction data this morning means that we've had two pieces of much stronger spending data than we had built into the Greenbook forecast.**

MR. STOCKTON. **This morning's reading from the purchasing managers' survey for January on prices paid–the red line–suggests that upward pressures have continued early this year.**

MR. FISHER. The drama came last Friday with the release of the GDP and ECI data. **Prior to that date, there really had been two contending camps in the market.** One saw the inversion of the yield curve as a temporary phenomenon, expecting the curve to steepen again once this Committee began to tighten over the course of the first quarter. They were thus taking short positions in the long end. A different camp expected the inversion of the yield curve to continue. They expected it to flatten when this Committee began its widely expected tightening. They anticipated a reduction in Treasury supply at the long end but an increasing agency and corporate supply in the short end. And it was also their sense that a late cycle firming by the central bank should slow activity and foster a rally in the bond market. Thus, they took long positions in the long end of the bond market. **Last Friday, the initial reaction seemed to favor the first camp as the yield curve backed up, and some in that camp seem to have been tempted to double up their positions.** But then the yield curve began to go down rather quickly again, and they were caught scrambling to cover their shorts, which caused a fair bit of see-sawing in the yield curve all day on Friday.

01/31/2001 Consumer Confidence

MR. SLIFMAN. The lower left panel shows the Michigan survey's index of consumer sentiment. **And, as you can see on the table we distributed at the lunch break, the Conference Board's expectations index, which was released this morning, also fell sharply in January.**

CHAIRMAN GREENSPAN. ... All in all, I think what is involved here is a judgment about how this economy is evolving. To me the evidence strongly suggests that we are in an advanced high-tech and just-in-time inventory type of economic system, including the capital goods markets where adjustments happen far faster because information is so much more readily available. **If that is the case, since we are dealing with mood swings that are rooted in an unchanging human nature, then I think it follows that monetary policy must also compress itself into a narrower timeframe.** ...

In that context, moving by 50 basis points today, as a number of you have suggested, strikes me as the right move along with retaining the balance of risks statement to the down side. **I have been concerned about the possibility that our moving so fast in a month would suggest either a knowledge of facts that nobody else knows or that we are getting scared. Fortunately, I guess, the markets as a result of yesterday's consumer confidence index have now put something like a 20 percent probability that we'll move 75 basis points.**

MS. MINEHAN. ...

In thinking about the press statement, I had reflected on whether a balanced risk statement would work to solve the problem that President McDonough mentioned regarding the possibility that the size of the cumulative easing moves over a month's time might feed into the pessimistic psychology about the economic outlook. I wondered whether a balanced risks statement might help calm things. **But after listening to the television a bit this morning and seeing the degree to which there were now expectations in the market of an even bigger move–and not being able to reconcile in my own mind the real risks with a balanced risk statement–I came around to your position.** So, I'm wholeheartedly in agreement with your recommendation.

10/28/2003 Durable Goods Orders

MR. STOCKTON. **In a nutshell, things have been going very well for the U.S. economy in recent weeks.** The data have been coming in almost uniformly stronger than we had expected six weeks ago. **The latest piece of news fitting that pattern was this morning's release of the September report on new orders and shipments of nondefense capital goods.** New orders outside of aircraft were up nearly 4 percent last month, after having been about flat in August. Shipments of nondefense capital goods excluding aircraft were up 2.5 percent in September, more than reversing the decline in August. The figures are a bit stronger than we had expected and would probably lead us to add about 1 percentage point to the projected growth of equipment spending in both the third and the fourth quarters, bringing the increases to 13 percent and 12 percent, respectively.

MR. KOHN. ... But with the rise in profits and equity prices and persistent increases in sales, business responses could return to normal more quickly and fully than is assumed in the forecast, allowing much more of the natural resiliency of the economy to show through to even stronger spending. **The upward revision to August orders data we saw this morning and the further gain in September I think underline this upside risk.**

MR. GRAMLICH. I had been a little worried about the timing because of the pattern of retail sales; growth was very strong in July and August and weakened quite a bit in September. First, the numbers could be revised. **Second, the new orders statistics that we got this morning and the strength in housing seem to belie any September weakness, so there may be no particular problem in that pattern.**

CHAIRMAN GREENSPAN. If it turns out that the economy, after going through this recent surge, simmers down very dramatically and indeed exhibits weakness, then from a policy point of view we're obviously well positioned at this stage. I think a weakening in economic activity is unlikely. **I believe it's more likely that evidence of an old-fashioned business cycle expansion is beginning to emerge. The pieces are falling into place.**

...

There is no question that in July and August firms were liquidating inventories, and the data we have for September confirm that the liquidation continued through the end of the quarter. **My recollection is that, when I saw the original Greenbook projection that had inventory liquidation continuing through the rest of the year, I was incredulous. I was even incredulous about it continuing in the third quarter. But clearly that's what we're seeing. Indeed, the data on durable goods inventories for manufacturing confirmed that this morning.**

05/04/2004		MR. STOCKTON. Thank you, Mr. Chairman. **After countless meetings and much effort to assemble the Greenbook over the past few weeks, I must admit that it was disappointing to come to work last Thursday to find that our forecast had a half-life shorter than a jar of mayonnaise in the Mojave Desert.** [Laughter] As you know, the BEA reported that their advance estimate of the growth in real GDP in the first quarter was 4.2 percent at an annual rate–a full percentage point less than the forecast that we had published only the day before. We spent the last few days poring over the details of that release in order to assess its implications for understanding where the economy has been and where it might be going. That task was made somewhat simpler by the fact that so much of our error was concentrated in inventory investment. Indeed, our projected increase in final sales for the first quarter of 4.25 percent at an annual rate was only slightly above the BEA's estimate of a 4 percent increase, with small differences spread out over several categories of spending. And after incorporating yesterday's data on construction outlays, the BEA would likely raise its estimate of the growth of final sales close to our April forecast.
12/14/2004	Trade Balance	MR. STOCKTON. **This morning, trade data for October were released. The trade deficit came in at $55.5 billion, up $4.5 billion from September and noticeably larger than both we and the markets had anticipated.** The increase in the deficit primarily reflected a surge in merchandise imports; exports increased only modestly. These data will no doubt lead us to revise down our projection for real net exports in the current quarter, although we obviously have not had time to digest fully the implications for the outlook. CHAIRMAN GREENSPAN. Dave, you put down finger-crossing as a serious econometric technique. I want to communicate that in my experience the t-value is quite high. [Laughter]
03/22/2005	PPI	MR. STOCKTON. **A slightly tighter economy has added to a growing list of worries that would make any compulsive hand-wringer proud.** That list would also contain higher oil prices, larger increases in non-oil import prices, a steep rise in commodity prices, a reemergence of price pressures from intermediate materials, some deterioration in near-term inflation expectations, and a disappointingly large increase in core PCE [personal consumption expenditures] prices in January. **To our relief, this morning's PPI for February did not add to this list. The increase in core finished goods–at 0.1 percent–and the increase in core intermediate materials–at 0.5 percent–were right in line with the Greenbook projection.**

08/08/2006 BEA Productivity and Costs

MR. POOLE. By the way, were the unit labor costs released this morning?
DAVID WILCOX. They should have been released by 8:30, I think. MR. POOLE. Maybe we'll see what happened there during the break. My argument is that we have very generalized inflation pressure across regions of the world and across commodity and service sectors. The pressure is not isolated. Could you comment on that observation?
CHAIRMAN BERNANKE. Thank you. I see it's 11:00, and I'm told that coffee is ready outside. Why don't we take a fifteen-minute break. Thank you. [Coffee break]
CHAIRMAN BERNANKE. **David Wilcox has a couple of comments on the productivity data from this morning.**
MR. WILCOX. Thank you, Mr. Chairman. Just very briefly, **these data came in, in most respects, pretty close to our expectation.** I would note that the productivity figures for the second quarter are built on the output data that were incorporated in last week's advance GDP number. We expect nonfarm business productivity in the second quarter to be revised up. Based on information available today, it would be revised up 0.8 percentage point, to 1.9 percent. Probably because of some fluctuations in hours, the productivity number in Q1 is 0.3 percentage point stronger than we had expected. In Q2, it's 0.3 percentage point weaker. On balance, the profile there looks much as we had expected. Compensation per hour is 0.5 percentage point stronger in Q1 than we had projected and right on our Greenbook projection in Q2.
CHAIRMAN BERNANKE. Thank you. Let's turn now to Governor Warsh.
MR. WARSH. Thank you, Mr. Chairman. **The Treasury markets have convinced themselves in recent days and weeks of the prospects of lower growth, lower rates, and some degree of comfort with inflation, and they seem to have lurched to that on a somewhat accelerated basis in the past several weeks.** But with some degree of humility, I'll say I'm not quite as convinced as they are. **I suspect that they may lose some of their conviction if some of the data that we've all talked about this morning around this table come to pass.** So we need to be keen in looking at inflation expectations, at the shape of the curve, and at the prices of some of these Treasury securities to evaluate the market reaction to what we do.

09/20/2006

MR. KOS. Thank you, Mr. Chairman. Among market participants, September has a reputation for being difficult on portfolios, for sudden bursts of volatility that lead to risk aversion and wider spreads, and for sometimes spectacular blowups in the speculative community. The ERM crisis in 1992, Long-Term Capital Management in 1998, and the aftermath of the terrorist attacks in 2001 are three of the more notable examples. **Until Monday, this year looked different.** Spreads were and they continue to be narrow. Volatility has generally been low, with the notable exception of energy. Yields are benign, and equity prices, if anything, have been rising in recent weeks.
The massive loss disclosed on Monday by a large hedge fund has had remarkably, almost suspiciously, little spillover effects thus far.

01/31/2007 GDP

CHAIRMAN BERNANKE. Good morning, everyone. Let's start with asking Dave Stockton to report on this morning's data.

MR. STOCKTON. So, Mr. Chairman, this was sort of done on the fly. **Unlike the BEA, I won't be able to go back and revise these remarks. [Laughter] Total GDP this morning came in at 3.5 percent. That was 0.9 percentage point stronger than we had forecast in the Greenbook.** There were really two sources of our miss in the fourth quarter. Of that miss, 0.5 was the net export component, which Karen will speak about in a second, and 0.4 was nonfarm inventory investment. So perhaps Karen will give the quick story on the net export side, and then I'll complete the report

MR. REINHART. ... The last exhibit gives the latest version of table 1, which circulated Monday. **It trims the wording of alternative B to be a little more upbeat about firmer economic growth in section 2, which feels right this morning.**

09/18/2007 PPI

MR. DUDLEY. **The tone in financial markets has improved a bit in recent days.** Nevertheless, we still appear to be in an environment in which **the dominant theme is risk aversion.** This can be seen in a matrix that measures the correlation among the price movements in the major asset classes (see exhibit 16). In times when markets are calm and untroubled, the correlation coefficients are generally low. As you can see in the exhibit, which examines these correlations since the August 7 FOMC meeting, the correlation coefficients have been very high recently.

MR. LOCKHART. So I believe our decision today boils down to whether we cut .25 percentage point or .5 percentage point, obviously in combination with careful wording of the statement that conveys a rationale focused on economic fundamentals while signaling some recognition that the problems in the capital markets have the potential to deliver a credit shock to the broad economy. **I consider it appropriate to adjust the federal funds rate to the now-weaker economic outlook, and I support a 50 basis point move with the rationale that at least 25 basis points of that represents recognition of a lower equilibrium rate and the remainder is a preemptive, preventive measure designed to renew confidence, facilitate conditions that resolve uncertainty, and shorten the necessary adjustment timeline in a deleveraging financial sector.** It is a fair question whether the process of information revelation–that is, removing uncertainty–will be accelerated by an aggressive rate cut. **My view is that this action, along with other liquidity actions, removes the psychological barrier–that being the concern that the Fed might fail to ensure enough upfront liquidity and might be pursuing an inadvertently tight policy**, compounding problems by putting undue stress on the real economy. I think a distinction can be drawn between trying to influence the psychology around dangerous financial sector circumstances and bailing out the markets, and care should be taken to reflect this in the minutes.

CHAIRMAN BERNANKE. On inflation, I think the slowing that we are likely to see will probably remove some of the upside risk that we have been concerned about. I don't know how these housing developments will affect owners' equivalent rent. We saw some perverse effects last time. They are still possible. **A very small piece of information is that the PPI numbers yesterday actually had some favorable news in them in terms of both intermediate goods and medical costs.** So the near term still looks to be fairly good. But I don't dismiss inflation risks by any means, and we know that policy changes can work through expectations as well as through resource pressure, and so I consider that to be a serious concern.

10/31/2007 ADP Private Payroll, Employment Cost Index

MR. STOCKTON. ... **We had two other important pieces of information this morning. One was the ADP survey of private payroll employment growth. Their estimate for the gain in private payrolls in October is 106,000.** That is above the 50,000 that we implicitly had built into our forecast. Again, this has significant information content in terms of its predictive content for payrolls; they have improved their methodology over the past couple of years as they have gotten into this. While I don't think we would move our estimate all the way to their 106,000, we would certainly raise it from the 50,000 that we have–probably to 75,000 or 80,000, at least, for an estimate of payroll employment growth in October. **The other piece of data that came out this morning was the employment cost index.** It is showing hourly compensation for private-sector workers up at an annual rate of 3.1 percent in the third quarter. **That is considerably below our estimate** of 3.8 percent through the third quarter and leaves the twelve-month change in that measure of hourly compensation flat at 3.1 percent. So that basically is showing no signs of any acceleration whatsoever.

MR. EVANS. Thank you, Mr. Chairman. I find myself in agreement with so many things that have been said already, no matter how the conflict may appear. **This is a close call. I think it's a tough decision.** I have, frankly, gone back and forth in thinking about the nuances here. **It is the case that the data have been better than I expected at the time of our September meeting. The ADP report this morning sort of continues that. It didn't have to work out that way, but 106,000 is a pretty strong number.** I'm still trying to figure out exactly how to project that to payroll employment. The bad news that we have seen in terms of surveys has hardly been surprising, given our views and what we would have expected in September.

...

One view is that 50 basis points in September was seen as enough, and we would be judging our future actions on the basis of deterioration in our forecast–data that come in worse than that or some information about risks that are hard to quantify but we thought would be important. I haven't seen the impetus for that. So that's one view. Then the other view is the risk-management perspective. **Maybe many people, President Yellen included, thought that more than 50 was required but only 50 in September was really achievable without startling markets.**

03/18/2008 Housing Starts and Permits

MR. STOCKTON. **This morning's data on housing starts also suggest little end in sight to the ongoing recession in housing.** Single-family starts fell more than 6.5 percent, to 707,000 units, in February, and permits dropped a similar amount. Both figures were very close to our expectations. Multifamily starts moved up to 360,000 units, but that figure follows some low figures late last year, and we wouldn't attach much signal to that reading.

VICE CHAIRMAN GEITHNER. Mr. Chairman, it is kind of awkward to ask this in the midst of a meeting, but I think it is important. **I think there was a pretty big change this morning at least in risk perceptions today across a bunch of markets. Can you tell what the fed funds curve has done this morning?**

MR. DUDLEY. I think that the April fed funds futures contract earlier this morning was priced at 1.99, and it was up by 4 basis points. I don't know if it moved subsequently.

MR. MADIGAN. Vice Chairman, it has moved up somewhat further at least as of maybe an hour ago. It looked as though, at least for this meeting, the odds were roughly evenly balanced between 75 and 100, in terms of what was priced in.

MR. DUDLEY. **Stocks are up about 2 percent. Both Lehman's and Goldman's earnings showed declines, but they were less significant than expected. So share prices for both of them have rallied a lot.** Lehman's stock was up 19 percent when I last looked–I don't know where it is today. So a lot of reversals occurred yesterday in terms of the investment banks.

VICE CHAIRMAN GEITHNER. **Financial credit default swaps this morning are much, much narrower.**

MR. EVANS. Thank you, Mr. Chairman. I support your recommendation. **I came in here thinking that I preferred 50 basis points, but I also recognize that I expected that we would have to go beyond that after this meeting.** So I fully support 75 and the language that you discussed.

MR. FISHER. **I think 75 basis points, Mr. Chairman, is way too much.** My thought is that it encourages the financial markets. They're not going to be satisfied. I said this last time. **It's Jabba the Hutt. They will keep asking for more and more. We have to quit feeding them.** I'm in a pizza mode, by the way, in this conversation. I do have a suggestion, however.

MR. MISHKIN. You mean Pizza the Hutt, not Jabba the Hutt. [Laughter]

09/16/2008 CPI

MR. DUDLEY. Just to give you a snapshot of what has happened since Sunday evening, **stocks are down worldwide–4 percent plus everywhere.** Yesterday, the U.S. stock market was down about 4.5 percent, and SP futures indicate a lower opening today. There was significant upward pressure in that market–overnight LIBOR rates today were 6.44 percent–and that pressure in Europe is leaking over into our market. Yesterday the federal funds rate opened at 3 to 3.5 percent. Despite our doing a $20 billion repo at our normal 9:30 a.m. time, the upward pressure on the funds rate yesterday continued. It rose to as high as 6 percent in the late morning, and that is why we came in with a second operation of $50 billion around noon yesterday.

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MR. STOCKTON. In response to your request for some economy in our remarks this morning, I'm going to set aside my prepared remarks and just hit some of the highlights here. **We did receive a great deal of macroeconomic data since we closed the Greenbook last Wednesday. We didn't seem to get any of it right, but it all netted out to just about nothing.** [Laughter] ...

Now, on the inflation side, this morning's CPI report for August actually came in a little better than we were expecting.

MR. MADIGAN. Relative to the Bluebook version, the language of alternative B has been revised in three material ways. First, B2 now notes that "strains in financial markets have intensified." Second, the clause "some indicators of inflation expectations have been elevated" has been dropped from B3 in view of the recent declines in inflation compensation and survey measures of inflation expectations. Finally, the first sentence of B4 has been revised to suggest that the Committee now sees the significant risks to growth and inflation as roughly balanced. **Given market participants' expectation that the funds rate could trade soft to the target for a time in light of recent developments, gauging exactly what is built into markets for the outcome of today's meeting is difficult. But earlier this morning, market prices appeared to incorporate high odds of at least a 25 basis point easing today or possibly more. Thus markets might well see a decision to keep the funds rate constant and to make no appreciable change to the language of the statement as signaling less concern about financial developments than they anticipated.**

01/27/2010 Home Sales

MR. STOCKTON. You should have at your place a table and charts of the single-family home sales for December that were released this morning. **As you can see, total sales were 342,000. That was weaker than we had expected.** We had been thinking around 360,000. But with the upward revisions to October and November, actually the quarterly average was just about exactly what we had been anticipating. That said, stepping back from this one release and thinking about the configuration of the home sales and production data that we have seen, **I think that both in trajectory and in overall tenor we are looking at a weaker housing market than we had thought and that the most recent data probably give some reflection of Governor Duke's fears and President Lacker's hopes that there may be more downside risk than upside risk to our housing forecast.** [Laughter]

08/09/2011

MR. LOCKHART. Thank you, Mr. Chairman. **Yesterday's equity market selloff certainly gives pause, but I don't think it obsoletes the views that I prepared as long ago as Sunday afternoon**, the diagnosis that pertains to the context of policy. I wanted to start by saying that President Bullard in an earlier meeting posed a good question when he asked if there was ever a time in the past 25 years when uncertainty did not seem higher than at other times, and he got quite a laugh when he asked about that. I do think the context of this meeting really does present a lot more uncertainty than whatever the Committee could consider normal. ... I think the Tealbook nicely captures the central forecasting challenge of the moment, which is determining the forces responsible for what it calls the "greater-than-expected restraint on the expansion." ... **We're one month into the third quarter, a quarter that the Tealbook projects GDP growth at 3 percent, with little indication in the data of that level of growth.** We really don't know how the European debt situation is going to play out in coming weeks. **We don't know beyond yesterday's developments and this morning's, if we're tracking them without BlackBerrys, how the market will sort out the implications of the downgrade.** We don't know whether the projection of inflation settling out will come true, and we don't really know whether there are underlying forces at work, forces captured in the Tealbook's phrases "persistent spending weakness" and "supply-side corrosion and damage," that portend a longer and deeper problem of sluggish growth. The outlook, of course, always involves a lot of uncertainty, but it certainly feels to me that the combination of uncertainties at this juncture is unusual. And, at least going into this past weekend, it inclined me, obviously excluding extreme financial instability, to emphasize an agnostic view regarding the outlook. So I am holding to the base-case outlook that I submitted in my last forecast in June of stronger economic growth and subsiding inflation in the second half, but with less conviction. **The BEA's NIPA revisions somewhat changed the narrative in my thinking. The revisions, along with the negative tone of the incoming data, make it harder to sustain my previous forecast.** When I submitted my projections in June, I was thinking of restraints on economic growth primarily in terms of commodity shocks and the economic fallout from the earthquake and tsunami disaster in Japan. I think now the list has to be expanded to the uncertainties associated with the ongoing government debt messes here and in Europe. **Friday's employment report somewhat took the edge off of accumulating doubts, but at this point, I'm reluctant to entirely dismiss the possibility of an outright contraction, which is also a change in my thinking since June.**

11/02/2011

MR. WILCOX. Thank you, Mr. Chairman. I'll be referring to the first exhibit in the package called "Forecast Summary." **A long time ago, when I was sitting at the breakfast table this morning [laughter], I was reminded once again of the value of a supportive home environment.** One of my daughters attempted to bolster my confidence by helpfully observing, "Just keep in mind, Dad, that they're much more likely to remember you today for whether you're wearing a good tie and whether you've got any good jokes to tell. At least Mom has picked out a good tie for you." [Laughter]

Let me proceed in reverse order, beginning with the GDP release. Part of the upside surprise in final sales was in federal purchases–a source of strength that we think, for obvious reasons, has no staying power. **More fundamentally, however, Thursday's report showed a much lower level of disposable personal income in the third quarter than we had expected in the Tealbook.** While we think some of that downside surprise might be transitory, we're estimating that perhaps half of it might persist, a factor that caused us to temper the extent to which we extrapolated forward the recent strength in consumption spending.

06/20/2012 JOLTS report

MR. TARULO The only other thing I'd note is that the **JOLTS report released this morning shows job openings down significantly from the March level and below consensus estimates.** Even putting aside Charlie Evans's concerns about whether the job openings number may overstate the real number of openings, **we've actually seen a decline now.**

CHAIRMAN BERNANKE ... With respect to the language–Steve, today has been pretty calm, I think, in Europe. Is that correct?

MR. KAMIN. Yes. The sovereign spreads for Italy and Spain, having fallen yesterday, have fallen again today, at least as of this morning. The Greek government looks as though it's on the cusp of putting together its coalition government. **So it does seem as though the markets are calm for now.**

CHAIRMAN BERNANKE. I think I would therefore, along with a number of you, **strike the bracketed paragraph at the end of the statement.** This is something that we might consider doing, for example, in conjunction with other central banks should the situation arise that stresses intensify.

01/30/2013 GDP

MR. WILCOX. Thank you, Mr. Chairman. **Top-line GDP growth was estimated this morning by the BEA at minus one-tenth of 1 percent, which was very close to our forecast of plus one-tenth of 1 percent.** That's as close as we get to a bull's-eye.

MR. FISHER. Just a sign error. [Laughter]

MR. ENGLISH. [...] Given this morning's GDP release, which showed a small decline in real GDP in the final quarter of 2012, **you might prefer to change the first sentence to indicate that the incoming data "suggests that growth in economic activity paused in recent months"** (as shown in blue), rather than say it "indicates that growth in economic activity slowed," as we had it in the Tealbook.

MR. EVANS. [...] As I noted yesterday, given the fits and starts of growth–including this morning's number–we've seen over the last several years that we need to guard against complacency. So while I see reason to be more hopeful that we will make substantial progress, it's a ways away.

07/31/2013	GDP	MR. WILCOX. I think that it would be safe to say that this is one presentation that will not have been over-rehearsed. We obviously have not had the chance to dig through the details of this rather lengthy report. You should have a table, I believe, in front of you that summarizes a couple of the very top-line, headline numbers. It looks to me like a mixed picture. GDP growth over the first half of this year is unrevised from what we had expected. Economic growth in the first quarter is down 0.6 percentage point relative to BEA's earlier publication, and it came in 0.6 stronger than we had expected in the second quarter. [...] **the sense I have is that maybe the underlying thrust of economic activity is a little weaker despite the fact that first-half growth is exactly what we had expected.** MR. EVANS. I remain far from convinced that the economy is safely on its way to a substantial economic growth trajectory that achieves escape velocity within the next two to four quarters. **I remain less optimistic that downside risks will be avoided. I think in this morning's GDP release–although I certainly don't understand the nuances there–it seems as though the first half is weak.** That causes some of these risk concerns, and we still have a puzzlingly low trajectory for inflation.
09/18/2013	CPI	MR. WILCOX. I am happy to report as well that this morning's CPI report was so close to our forecast that I authorized our inflation analyst to spike the CPI release in the end zone and do a victory dance.

Table C1: Excerpts from FOMC Transcripts. Discussion pertaining to recent Macroeconomic News Announcements (MNAs) and the market reaction thereto.

Year	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5	Meeting #6	Meeting #7	Meeting #8
1994	Employment Report	Trade Balance	Housing Starts and Permits		Housing Starts and Permits	Consumer Confidence	Retail Sales	Trade Balance
1995				Initial Jobless Claims, Leading Indicators			CPI, Industrial Production	
1996	Consumer Confidence, Retail Sales			Home Sales	Trade Balance			Housing Starts and Permits
1997					Housing Starts and Permits			CPI, Housing Starts and Permits
1998			Housing Starts and Permits	Auto Sales	CPI, Trade Balance	Consumer Confidence	Business Inventories	
1999			Housing Starts and Permits	Leading Indicators			Industrial Production	
2000	Auto Sales, New Home Sales, Purchasing Managers' Survey	Trade Balance	CPI, Housing Starts and Permits				Business Inventories, Industrial Production	International Trade Balance
2001	Consumer Confidence	Trade Balance		Durable Goods Orders				
2002	GDP	Trade Balance		Durable Goods Orders	Retail Sales			
2003		Housing Starts and Permits		Durable Goods Orders		Retail Sales	Durable Goods Orders	
2004	Durable Goods Orders	Housing Starts and Permits				Housing Starts and Permits	Trade Balance	Trade Balance
2005		PPI		Consumer Expenditures	BEA Productivity and Costs	Housing Starts and Permits		Retail Sales
2006				Initial Jobless Claims	BEA Productivity and Costs			Trade Balance
2007	GDP	Housing Starts and Permits		GDP		PPI	ADP Private Payroll, Employment Cost Index	

2008	GDP	Housing Starts and Permits				CPI	Durable Goods Orders	CPI
2009		CPI		Durable Goods Orders	Labor Productivity		ADP Private Payroll	PPI
2010	Home Sales	Housing Starts and Permits		Home Sales	Blue Chip Economic Indicators, NFIB Survey	Housing Starts and Permits		Retail Sales
2011	Home Sales		Durable Goods Orders					Retail Sales
2012		Retail Sales		JOLTS report			Zillow House Price Index	JOLTS report, Trade Balance
2013	GDP	Housing Starts and Permits		CPI, Residential Construction	GDP	CPI	ADP Payrolls, CPI, Retail Sales	CPI
2014		CPI, Housing Starts and Permits	ADP Payrolls, BLS Employment Cost, GDP Growth	CPI	GDP Growth	CPI, PPI		CPI

Table C2: Macroeconomic News Releases Made in the Morning of FOMC Meeting. List restricted to announcements that are mentioned in the transcripts of the FOMC meeting.

C.2 Evidence from Survey of Primary Dealers

The following excerpts are from the New York Fed's Survey of Primary Dealers, available online at `https://www.newyorkfed.org/markets/primarydealer_survey_questions.html`.

The Surveys demonstrate that market participants view the Fed policy targeting either unemployment or inflation in a time-varying manner, depending on aggregate economic conditions.

August 2018

Some dealers indicated that they assumed the target federal funds rate or range would be more sensitive to deviations in inflation than to deviations in the unemployment rate. Additionally, several dealers cited various reasons they expect a low sensitivity to changes in the unemployment rate.

July 2017

In explaining their responses, several dealers noted that they assumed a larger response in the level of the target federal funds rate or range to a 50 basis point shock to core PCE inflation than to a 50 basis point shock to the unemployment rate.

September 2016

Some dealers expected that the Committee would continue to characterize economic activity as expanding at a "moderate rate." With regard to labor market conditions, some dealers suggested that the Committee would reference continued improvement in the labor market while several others expected that the Committee would note that the pace of job gains had moderated.

July 2015

Some dealers expected the July FOMC statement to note a moderate expansion in economic growth. Some also indicated that the statement would reflect an upgrade to the current assessment of the labor market. Several dealers anticipated that the statement would note that the weaker-than-expected economic growth in the first quarter of 2015 was largely transitory, while several other dealers expected the statement to reflect a modest upgrade to the Committee's characterization of domestic housing market activity. Several dealers expected there to be no material changes to the July FOMC statement.

July 2014

Many dealers expected the July FOMC statement to acknowledge an improvement in economic conditions. Some dealers noted improvements in the labor market and several dealers emphasized the pickup in second quarter economic growth as well as inflation moving closer to mandate consistent levels. Several dealers expected no substantial changes.

July 2013

Some dealers expected no material changes to the July FOMC statement. Of those that did expect changes, several dealers each noted their expectation that the Committee would more explicitly focus on recent low inflation as well as highlight weaker growth data over the intermeeting period. Several dealers discussed the possibility that the FOMC would provide either additional details regarding the expected pace of asset purchases, similar to those provided in Chairman Bernanke's June 19th press conference, or language that would highlight the data dependency of

asset purchases. Several dealers also thought that it was possible that the Committee may decide to strengthen or reinforce the current forward rate guidance.

Some dealers stated that an earlier expected start to reducing the pace of asset purchases has led to increased expectations for a higher path of policy rates, as market participants perceived a link between the Federal Reserve's asset purchase and federal funds rate policies. Several dealers also noted changes in the perception of the FOMC's view of the appropriate policy rate path and the Committee's more optimistic economic projections as shifting short rates higher. In explaining their response to 'Other/technical factors', some dealers cited the unwind of leveraged positions and carry-related trades as contributing to the increase in short rates.

September 2012

A few dealers expected that the forecasts in the summary of economic conditions could be upgraded in some fashion, with a couple of dealers indicating that it could note improvement in the labor market. In contrast, a few dealers expected that the summary would be downgraded, and some dealers expected it would be little changed.

Most dealers expected some sort of easing to be announced in the September FOMC statement. Most dealers expected that the forward guidance on the path of the federal funds rate would be extended into 2015. Several dealers specified that the guidance to be extended to "mid-2015" and a couple of dealers expected that the forward guidance could be extended past mid-2015. Some dealers noted that the announcement of an asset purchase program was possible, with a few dealers noting the possibility of open-ended purchases.

August 2011

Many dealers expected that the August statement would contain a downgrade to the characterization of economic conditions, and a few expected the statement to contain reference to the benchmark revisions to GDP and its impact on the outlook for economic growth. A couple of dealers expected that the statement would reference the moderation in headline inflation. The announcement of additional policy action to lengthen the duration of the SOMA portfolio was expected by a couple of dealers, as was some indication of the Committee's willingness to ease policy. Some dealers did not expect any substantial changes to the statement.

C.3 Stock and Bond Returns on FOMC Announcement Days

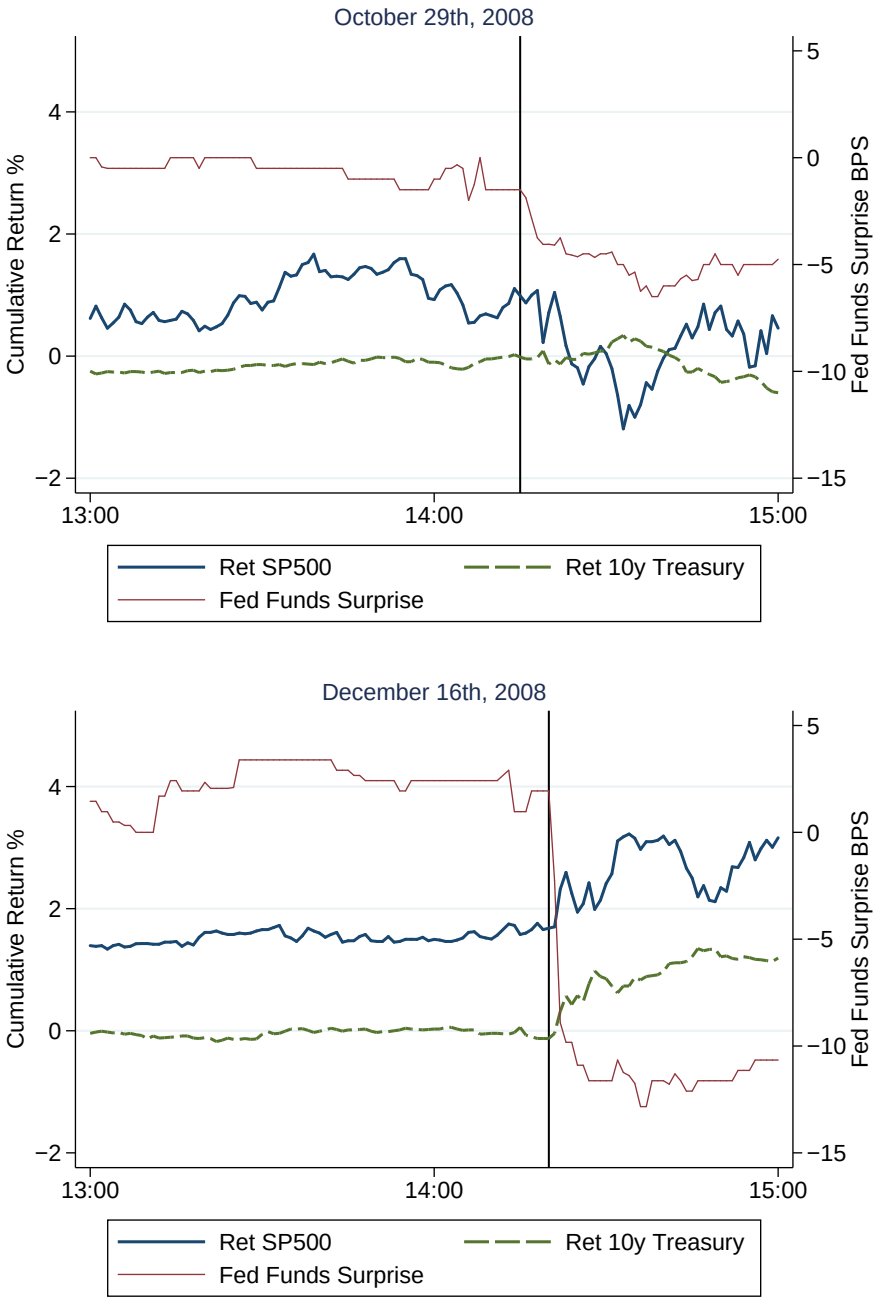

Figure C1: Intraday Stock and Bond Returns on Two Consecutive FOMC Announcements. On October 29th, 2008: expected cut 45 bps, realized cut 50 bps, post-announcement stock-bond covariance negative. On December 12th, 2008: expected cut 90 bps, realized cut 100 bps, post-announcement stock-bond covariance positive.