NBER WORKING PAPER SERIES

MACROECONOMIC ANNOUNCEMENT PREMIUM

Hengjie Ai
Ravi Bansal
Hongye Guo

Working Paper 31923
http://www.nber.org/papers/w31923

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2023

We thank Leyla Han for the helpful comments and valuable suggestions. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Macroeconomic Announcement Premium
Hengjie Ai, Ravi Bansal, and Hongye Guo
NBER Working Paper No. 31923
November 2023
JEL No. A0,E0,E37,E40

ABSTRACT

The paper reviews the evidence on the macroeconomic announcement premium and its implications on equilibrium asset pricing models. Empirically, a large fraction of the equity market risk premium is realized on a small number of trading days with significant macroeconomic announcements. We review the literature that demonstrates that the existence of the macroeconomic announcement premium implies that investors' preferences must satisfy generalized risk sensitivity. We show how this conclusion generalizes to environments with heterogeneous investors and demonstrate how incorporating generalized risk sensitivity affects economic analysis in dynamic setups with uncertainty.

Hengjie Ai
Department of Finance
Wisconsin School of Business
University of Wisconsin
Madison, WI 53705
hengjie.ai@wisc.edu

Ravi Bansal
Fuqua School of Business
Duke University
1 Towerview Drive Durham,
NC 27708
and NBER
ravi.bansal@duke.edu

Hongye Guo
University of Hong Kong
724 K. K. Leung Building
University of Hong Kong
silver.hongye.guo@gmail.com

1 Introduction

The macroeconomic announcement premium refers to the fact that a large fraction of the equity market risk premium is realized on a small number of trading days with significant macroeconomic announcements. During the period 1961-2023, roughly 44 days per year with macroeconomic announcements account for more than 71% of the aggregate equity market risk compensation.

This survey reviews the evidence on the macroeconomic announcement premium and discusses its implications for general equilibrium asset pricing models. It has four parts. The first part of the survey reviews the stylized facts about the macroeconomic announcement premium. It focuses on three aspects of the macroeconomic announcement premium: the unconditional macroeconomic announcement premium, the pre-FOMC announcement drift, and the predictability of the macroeconomic announcement premium in time series and in the cross section.

The second part of the survey reviews the study of the macroeconomic announcement premium in representative-agent models. The presence of the macroeconomic announcement premium demonstrates that most of the equity market risk compensation is realized when news about macroeconomic risk is revealed, not when the actual risk is materialized. The necessary and sufficient condition for the announcement premium, a condition named generalized risk sensitivity by Ai and Bansal (2018), is demonstrated with a simple example.

The third part of the survey discusses the implications of the macroeconomic announcement premium and generalized risk sensitivity on equilibrium asset pricing models. It covers both representative-agent based asset pricing models as well as heterogeneous-agent models. The basic insights from Ai and Bansal (2018) continue to hold: the macroeconomic announcement premium reflects the fact that risk compensation is realized when information is revealed. It requires a pricing kernel with a forward-looking component.

The last part of the survey discusses the connection between the macroeconomic announcement premium and the study of the impact of monetary policy on asset markets and the real economy. The overall assessment of the current status of research on macroeconomic announcement premiums is provided in the conclusion.

2 Evidence from data

The macroeconomic announcement premium Savor and Wilson (2013) are the first to document the existence of the macroeconomic announcement premium. They show that average returns and Sharpe ratios are significantly higher on macroeconomic announcement days. Table 1 reports the average excess market returns on macroeconomic announcement days and non-announcement days from 1961 to 2023. In this period, on average, 44 trading days per year have significant macroeconomic announcements. At the daily level, the average stock market excess return is 10.68 basis points (bps) on announcement days and 0.93 bps on days without major macroeconomic announcements. As a result, the cumulative excess stock market return on the 44 announcement days averages 4.65% per year, accounting for about 71% of the annual equity premium (6.59%).

This evidence is broadly consistent with that in Savor and Wilson (2013), Ai and Bansal (2018), and Ernst, Gilbert, and Hrdlicka (2019). Following Ai and Bansal (2018), Table 1 examines the top 5 (by Bloomberg investor attention) pre-scheduled macroeconomic announcements released at a monthly frequency or lower. We combine the PPI and CPI announcements into one "inflation" announcement by using the earlier one each month, as they reveal information of a similar nature. This additional step becomes necessary because in recent years the CPI announcement starts to regularly occur before the PPI announcement, whereas historically the PPI announcements were mostly earlier. During our sample period, the premium on macroeconomic announcement days is large and significant.

Table 1: Macroeconomic Announcement Premium

	# of days p.a.	Daily prem.	Prem. p.a.	t-stat
Market	252	2.62 bps	6.59%	3.29
Non-Ann	208	0.93 bps	1.94%	1.08
Ann	44	10.68 bps	4.65%	5.36
FOMC	10	17.61 bps	1.74%	4.71
Non-FOMC	34	8.65 bps	2.91%	3.71

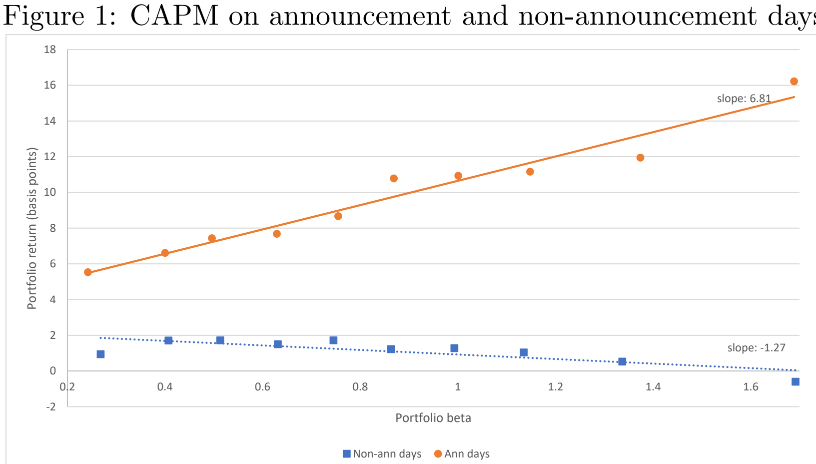
This table documents the average excess return of the U.S. stock market during the 1961-2023 period. The column "# days p.a." is the average number of trading days per annum. The second column is the daily market equity premium on all days, announcement days, and days without announcements. The column labeled "Prem. p.a." is the cumulative excess market returns within a year, computed by multiplying the daily premium by the number of event days and converting it into percentage points. The announcements are the FOMC, Non-farm payroll, GDP (first and last), ISM manufacturing PMI, and the earlier of the CPI and PPI announcements.

The robustness of the macroeconomic announcement premium over the last six decades indicate that it is likely a compensation for risk. Liu and Shaliastovich (2021) argue that state of the union addresses and elections are analogous pre-scheduled events that resolve government policy uncertainty for the economy. Their sample dates back to the 1930s, and they also find high average stock market returns over these events, broadening the scope of evidence related to the announcement premium. Some authors—for example, Kurov, Wolfe, and Gilbert (2021)—find that the premium for the FOMC announcement was low between January 2016 and December 2019 and attribute the decline to reduced uncertainty over this period. Since then, the announcement premium has been above historical average. Specifically, from January 2020 to August 2023, the average announcement premium was 16.33 basis points per announcement, higher than the full sample average of 10.68 basis points.

Macroeconomic announcements—in particular, the FOMC announcement—affect other asset markets and other countries as well. Savor and Wilson (2013) and Lucca and Moench (2015) show that short-term Treasury bills do not earn significantly higher average returns on announcement days, and that the premium for longer-term Treasury notes and bonds appears to increase with maturities but is lower in magnitude than that of equities. Mueller, Tahbaz-Salehi, and Vedolin (2017) show that major foreign currencies have a clear announcement premium on FOMC announcement days. They argue that the premium reflects compensation for monetary policy uncertainty through constrained financial intermediaries. Savor and Wilson (2014) show that currency carry trade portfolios have higher expected returns on macroeconomic announcement days. Brusa, Savor, and Wilson (2020) show that during FOMC announcement days, stock markets in other countries also exhibit high returns. In contrast, monetary policy announcements in other countries do not exhibit the same influence on global stock market returns as the FOMC announcements. Guo, Jia, and Sun (2022) document a significant stock market risk premium during the period of Chinese central announcement. Overall, the macroeconomic announcement premium is an empirical regularity with a broad scope and a high consistency.

Evidence from the cross section of equity returns Savor and Wilson (2014) study the expected return-beta relation across various portfolios on announcement days and non-announcement days. They demonstrate that the Capital Asset Pricing Model (CAPM) holds very well on macroeconomic announcement days. That is, there is a robust linear relation between assets' average returns on macroeconomic announcement days and their betas. Figure 1 reproduces the Savor and Wilson (2014) result. We sort the cross sections of stocks into deciles using their ex-ante market betas, which are estimated on a rolling one-year window with daily returns. The horizontal axis is the realized beta for each portfolio, and the vertical axis is the average return on announcement days (circles) and non-announcement days (squares), respectively. The solid line is the security market line estimated using announcement day observations, and the dashed line is the fitted security market line using non-announcement day returns. As demonstrated in Savor and Wilson (2014), the security market line on announcement days has a significantly positive slope with an estimated slope coefficient of 6.81 basis points. Because the slope of the security market line is the market risk premium under CAPM, the expected return-beta relationship provides additional evidence for the macroeconomic announcement premium.

Figure 1: CAPM on announcement and non-announcement days



This figure shows the security market lines on 10 beta-sorted stock portfolios on announcement and non-announcement days. The x-axis is the ex-post beta, and the y-axis is the excess return of the portfolio. Data are from 1961 to 2023.

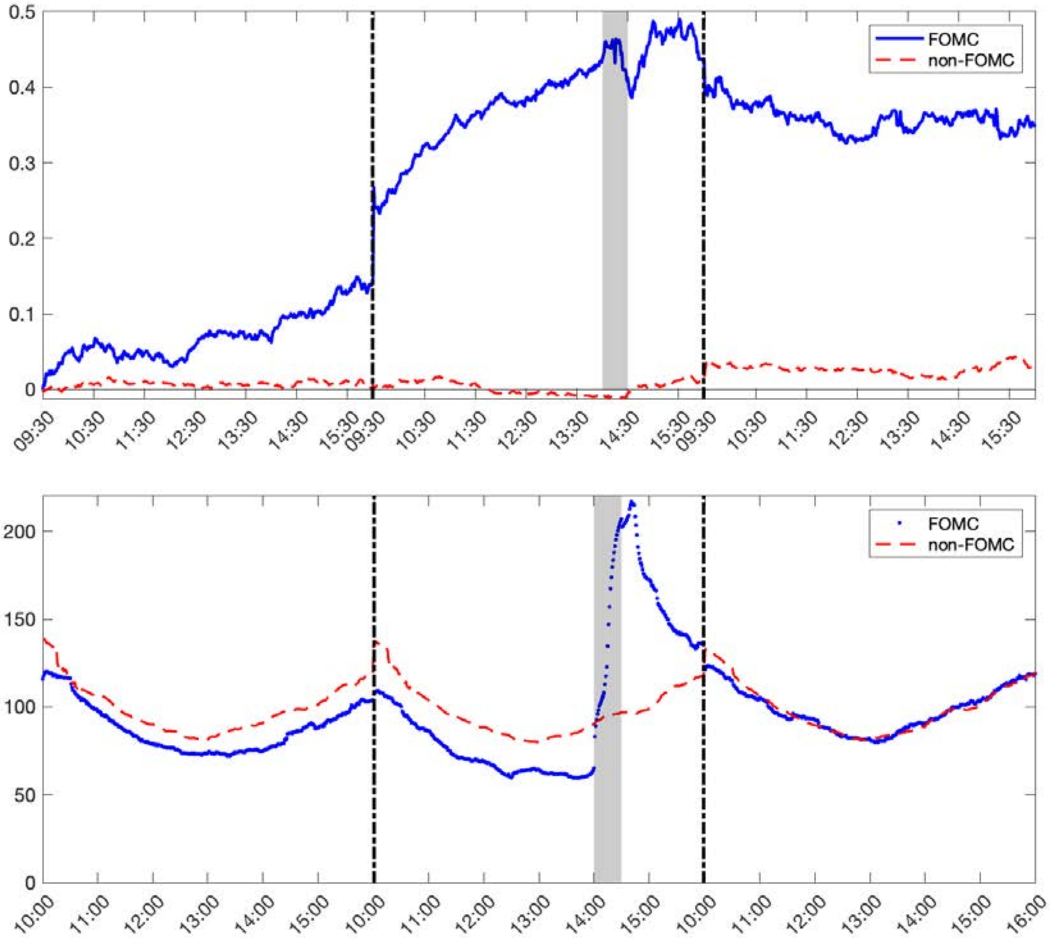
The literature has since built on Savor and Wilson (2014) and expanded it both theoretically and empirically. Wachter and Zhu (2022) put forth a model that accounts for both the announcement premium and the steep security market line on the announcement day. Andrei, Cujean, and Wilson (2023) develop a noisy rational expectations model and demonstrate that the security market line is steep on days when public information reduces disagreement among investors, but flat on non-announcement days, thereby providing an explanation for the robustness of the CAPM relationship on announcement days. Ozdagli and Velikov (2020) demonstrate that monetary policy shock is a price risk factor in the cross section of equity returns. Ai, Han, Pan, and Xu (2022) expand the scope of evidence by showing that stocks that are more sensitive to monetary policy announcement surprises earn a higher premium on FOMC announcement days.

The pre-macroeconomic announcement drift Many of the macroeconomic announcement premiums exhibit a drift, meaning that a significant portion of the premium is realized hours before the announcement. The most famous example of this is the pre-FOMC announcement drift documented by Lucca and Moench (2015). Figure 2 extends the sample period and reproduces Lucca and Moench (2015)'s findings.

The top panel shows the average three-day cumulative return of the S&P 500 E-mini futures around FOMC announcement days. The bottom panel is the realized volatility during the same time period. The shaded area, 14:00-14:30 p.m., depicts the timing of most pre-scheduled FOMC meetings. The solid lines represent the average cumulative returns (top panel) and realized volatility (bottom panel) on FOMC announcement days, and the dashed lines represent those on the non-FOMC announcement days. Consistent with Lucca and Moench (2015), we find that the 24-hour return before the pre-scheduled FOMC announcement during the period of September 1997 to August 2022 is 37.5 basis points on average. The realized volatility during the pre-FOMC announcement period is significantly lower (18.69 daily bps) than the realized volatility during the same hours on non-announcement days.

Several other macroeconomic announcements, including the GDP, Unemployment/Non-farm Payroll, and ISM manufacturing PMI index announcements, also exhibit drifts during hours leading up to the announcements. Using S&P 500 E-mini futures, Hu, Pan, Wang, and Zhu (2022) show that other macroeconomic announcements also exhibit a large risk premium in the hours before the announcement. In addition, we show that the realized volatility for other macroeconomic announcements during the same hours is also slightly lower compared to that on non-announcement days. In Table 2, the second column reproduces the average returns of Hu, Pan, Wang, and Zhu (2022), and the third column displays the realized volatility during the same hours for GDP, Non-farm Payroll, ISM announcements, and non-announcement days. The pre-announcement return and volatility are defined as the average cumulative returns and volatility from 4:30 p.m. of the previous trading day to five minutes ahead of the announcement. Overall, the average return during the pre-announcement trading hours is often significantly higher compared to that on a non-announcement day. Ai, Bansal, and Han (2022) provide an equilibrium model for the high average return and

Figure 2: The Pre-FOMC Announcement Drift



This figure plots the average cumulative return and 30-minute realized volatility around FOMC announcements. The top panel depicts the average three-day cumulative return (in percentages) around FOMC and non-FOMC announcement days. The solid line displays the average cumulative return during regular trading hours from 9:30 a.m. on one trading day before the FOMC announcements to 16:00 p.m. on days afterward. The dashed line is the average cumulative return on all three consecutive trading days that do not include any FOMC announcement. The shaded area, 14:00-14:30 p.m. is the half-hour window containing most of the FOMC releases. The bottom panel plots the intraday average market realized volatility during three trading days around FOMC and non-FOMC announcement days. The dotted line is the realized volatility for FOMC announcement days, and the dashed line is that for non-FOMC announcement days. Realized volatility (bps) is the average rolling sum of squared 1-minute log returns on the S&P 500 E-mini futures over the past 30 minutes. The dashed line is the same calculation on all three consecutive trading days that do not include any FOMC announcement. The realized volatility is calculated for each minute from 10:00 to 16:00 p.m.. The shaded area, 14:00-14:30 p.m., is the half-hour window containing most of the FOMC releases. The sample period is from 1997 to 2022.

low volatility during the pre-announcement period based on information acquisition activities of heterogeneously informed investors.

The realization of a high average return before scheduled announcements has motivated researchers to investigate the possibility of information leakage. The theoretical model of Ai and Bansal (2018) provides conditions under which the resolution of uncertainty is associated with realizations of a risk premium. Under these conditions, leakage of information will result in the

Table 2: Pre-announcement drift

	Average Return	Realized Volatility
GDP	8.42	63.63
	(2.07)	
Non-farm Payroll	8.48	60.20
	(2.95)	
ISM	14.43	78.24
	(3.26)	
Non-announcement	0.97	68.46
	(1.02)	

This table documents the average return and realized volatility during pre-announcement hours for the GDP, Unemployment/Non-farm Payroll, and ISM manufacturing reports. Both the GDP and unemployment reports are published at 8:30 a.m., whereas the ISM report is announced at 10:00 a.m. Average return is calculated as the cumulative return from 4:00 p.m. of the previous trading day to five minutes ahead of the respective announcements. Realized volatility (bps) is the average sum of squared one-minute log returns on the S&P 500 E-mini futures from the same time period. The "Non-announcement" row contains all other days except FOMC and the above macro announcements, and reflects the window of 4 p.m. of the previous day to 9:30 a.m. of the same day. The sample period is from 1997 to 2022.

realization of risk compensation during the same period. Ai and Bansal (2018) also present a continuous-time model where information arrival happens hours before the pre-scheduled announcement probabilistically and demonstrate that their model can generate an pre-announcement drift. Cieslak, Morse, and Vissing-Jorgensen (2019) document a biweekly cycle in average stock market returns around FOMC announcements. Starting in week 0 from the day before the announcement day, they show that the stock market returns in week 0, 2, 4, and 6 are especially large on average. They interpret this evidence as the result of systematic informal communication from the Fed officials. Morse and Vissing-Jorgensen (2020) further investigate these instances of informal communication using the calendars of the Fed governors. Bernile, Hu, and Tang (2016) examine the 30-minute periods immediately preceding the FOMC announcements over which the announcements' content is pre-released to selected media under strict embargo. They argue that the content is leaked despite the embargo, demonstrating the difficulty in locking up information once it reaches the media in some form. Abdi and Wu (2018) argue that informed trading occurs in the corporate bond market before the FOMC announcements.

Some authors have presented suggestive evidence against the leakage of information. Lucca and Moench (2015) show that returns on the S&P 500 index during the pre-FOMC announcement period have little predictive power for its returns during the hours after the announcement. Cocoma (2018) uses post-announcement returns, defined as the S&P 500 return from after the FOMC announcement (typically 2:30 p.m.) to the close of the trading day to separate the sample into "good news periods" and "bad news periods." "Good news" is defined as positive post-announcement day returns, and "bad news" is defined as negative post-announcement day returns. She shows that pre-FOMC announcement returns on good news days are not systematically higher than those on bad news days and are in fact slightly lower. In addition, substantial leakage of the content of the announcement, however, should trigger heightened realized volatility. Contrary to this implication, as shown in Figure 2 and Table 2, the realized volatility during the pre-announcement period is slightly lower than that on non-announcement days.

3 Theoretical foundation

The fact that most of the equity market risk premium is realized on a few macroeconomic announcement days presents a challenge to standard asset pricing models. Take the classic Breeden (1979) model, for example. Risk evolves slowly as Brownian motions, and as a result, the risk premium investors receive on the market portfolio will be proportional to the holding period of the asset. The data on the macroeconomic announcement premium paints a very different picture: the risk premium on most trading days is very small and even negligible. Most of the risk premium is realized on a small number of trading days where uncertainty about the macroeconomy is resolved.

Ai and Bansal (2018) provide a theoretical study on conditions under which the macroeconomic announcement premium arises in general equilibrium. Dynamic preferences in general equilibrium models can in general be written recursively as

$$V_t = u\left(C_t\right) + \beta \mathcal{I}\left[V_{t+1}\right], \tag{1}$$

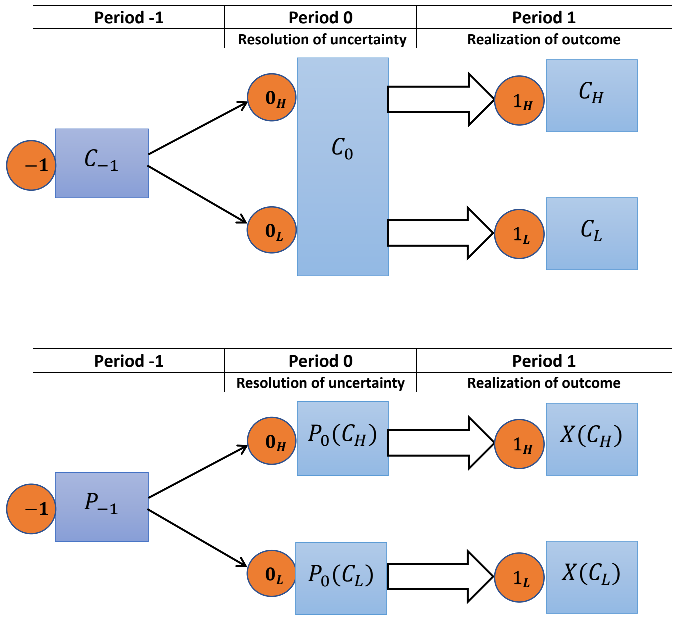
where V_t represents life-time utility at time t, C_t is consumption at time t, $u\left(\cdot\right)$ is a utility function that converts current-period consumption into utility, and the certainty equivalent functional $\mathcal{I}\left[\cdot\right]$ converts continuation utility in the next period, V_{t+1}, which is a random variable, into its certainty equivalent. Ai and Bansal (2018) demonstrate that under regularity conditions, the macroeconomic announcement premium is positive if and only if the representative consumer's preference (1) satisfies a condition called generalized risk sensitivity (GRS).

To understand generalized risk sensitivity, consider the following representative-agent economy with three periods, as shown in Figure 3. In the top panel, the only uncertainty is in period 1, where the consumption of the representative agent, C_1, is a random variable. Assume that C_1 can take on N possible values, $\{C_1\left(s\right)\}_{s=1}^{N}$ with $C_1\left(1\right) = C_L$ being the lowest realization and $C_1\left(N\right) = C_H$ being the highest realization, and $C_1\left(1\right) \leq C_1\left(2\right) \leq \cdots C_1\left(N\right)$. Denote the probability of each state to be $\pi\left(s\right) = \frac{1}{N}$ for all s.[1] The figure depicts two values of the realizations of C_1: C_H and C_L. In period 0, consumption is a constant, C_0, but the representative agent receives an announcement that carries information about future consumption.[2] For simplicity, we assume that

[1]For simplicity, in this example, we assume equal probability for all states. Ai and Bansal (2018) assume a non-atomic probability space and do not need this assumption.

[2]Here, C_0 is aggregate consumption. As in Lucas (1978), although aggregate consumption is fixed, individual investors are free to adjust their consumption and investment. The optimality conditions with respect to consumption and investment choices pin down the asset prices in the economy.

Figure 3: A three-period economy with an announcement



the announcement fully resolves uncertainty and reveals the true value of C_1. Period -1 is the pre-announcement period, where the agent does not know the upcoming announcement.

In the bottom panel of the figure, we plot the prices of an asset that has a one-time payoff in period 1, denoted $X(C_1)$. Here, we assume that the asset's payoff is a function of aggregate consumption. As a result, the announcement that resolves uncertainty about C_1 also reveals the payoff, $X(C_1)$. P_{-1} is the pre-announcement price of the asset, and P_0 is the post-announcement price. The asset is said to earn a macroeconomic announcement premium if the investment strategy of buying the asset before the announcement and selling right afterwards provides a higher expected return than the risk-free asset. That is,

$$\frac{E[P_0]}{P_{-1}} > R_{f,0},$$

where $R_{f,0}$ denotes the risk-free rate between period -1 and period 0.

The lifetime utility of the representative agent is written as

$$u(C_{-1}) + \mathcal{I}[u(C_0) + \beta u(C_1)]. \tag{2}$$

Here, the utility is constructed using recursion (1) in two steps. First, after the announcement in period 0, all uncertainty about the future is resolved, and there is no need for the certainty equivalent aggregator. Period-0 utility is hence represented as $V_0(s) = u(C_0) + \beta u(C_1(s))$. Second, in period -1, we apply the recursion to compute the period--1 utility as $u(C_{-1}) + \mathcal{I}[V_0(s)]$, which is the same as (2). We do not impose a discount factor β in this step because the announcement window (i.e., period 0) is very short and not meaningfully far away from period -1.[3]

In this economy, the stochastic discount factor can be computed as the intertemporal rate of substitution of the representative agent. We call the stochastic discount factor that computes the period-0 payoff in terms of the period--1 consumption numeraire the announcement stochastic discount factor, or $ASDF$. Using the chain rule,

$$ASDF\,(s) = \frac{1}{\pi\,(s)} \frac{u'\,(C_0)}{u'\,(C_{-1})} \times \frac{\partial \mathcal{I}}{\partial V_s}. \tag{3}$$

Because an equal probability is assumed for all states, the only term in (3) that depends on s is $\frac{\partial \mathcal{I}}{\partial V_s}$. The term $u'\,(C_0)$ does not depend on s because we assume that consumption in period 0 does not depend on the announcement, as shown in Figure 3. Intuitively, during a short announcement window (period 0), it is virtually impossible for aggregate consumption to respond to macroeconomic news. Suppose we focus on payoffs that are pro-cyclical; that is, they are increasing in period-1 consumption, $C_1\,(s)$, or equivalently, increasing in s. The risk premium on such a payoff is positive if the vector of partial derivatives, $\left\{\frac{\partial \mathcal{I}}{\partial V_s}\right\}_{s=1}^{N}$, is a decreasing function of s.[4] In fact, the converse of this observation is also true. That is, if the announcement risk premium for any pro-cyclical payoff is positive, then $\left\{\frac{\partial \mathcal{I}}{\partial V_s}\right\}_{s=1}^{N}$ must be a decreasing function of s. This is the basic intuition of the Theorem of Generalized Risk Sensitivity in Ai and Bansal (2018). To formally state the theorem, we first provide a definition of generalized risk sensitivity.

Definition 1. (Generalized Risk Sensitivity)

A dynamic preference represented by the recursion (1) where both u and $\mathcal{I}$ are strictly increasing is said to satisfy (strict) generalized risk sensitivity if $\mathcal{I}$ is (strictly) increasing in second-order stochastic dominance. That is, for any two random variables, X and Y, if X (strictly) second-order stochastic dominates Y, then $\mathcal{I}\,[X] \geq \mathcal{I}\,[Y]$ $(\mathcal{I}\,[X] > \mathcal{I}\,[Y])$.

Theorem 1 is a version of the Theorem of Generalized Risk Sensitivity in Ai and Bansal (2018).

Theorem 1. *(Theorem of Generalized Risk Sensitivity)*

Assuming that both the utility function u and the certainty equivalent functional $\mathcal{I}$ are continuously differentiable, the following statements are equivalent:

1. The dynamic preference specified in (1) satisfies (strict) generalized risk sensitivity.

2. The vector of partial derivatives, $\left\{\frac{\partial \mathcal{I}}{\partial V_s}\right\}_{s=1}^{N}$ is a non-increasing (strictly decreasing) function of s.

3. For any vector of payoffs, $\{P_0\,(s)\}_{s=1}^{N}$ such that $P_0\,(s)$ is increasing in s, the announcement premium for $\{P_0\,(s)\}_{s=1}^{N}$ is non-negative (strictly positive).

[3]However, imposing discounting in this step will not affect the conclusion of Theorem 1 below.

[4]Recall that the risk premium of any asset depends on the covariance of its return with the stochastic discount factor, which $ASDF$ in our setup.

Intuitively, risk premium is informative about the properties of the stochastic discount factor. Because during the short period of a macroeconomic announcement, the movement in aggregate consumption is negligible, the announcement stochastic discount factor, (3), depends only on the properties of the vector of partial derivatives, $\left\{\frac{\partial \mathcal{I}}{\partial V_s}\right\}_{s=1}^{N}$. The Theorem of Generalized Risk Sensitivity implies that the sign of the announcement premium contains enough information that allows us to precisely pin down the property of $\mathcal{I}$, which is generalized risk sensitivity.

4 Implications of generalized risk sensitivity

Preferences in economic modeling Most economic modeling starts with assumptions on preferences. To make sense of many important economic questions, such as intertemporal consumption smoothing, the trade-off between inequality and efficiency, equity market risk compensation, and so on, one needs non-linear utility functions, or more precisely, one needs to assume certain concavity properties of preferences. The literature has entertained two ways of incorporating non-linearity into preferences. In expected utility models, the certainty equivalent functional, $\mathcal{I}$, is the expectation operator and therefore linear. The non-linearity in preferences comes from the concavity of the Bernoulli utility function $u(\cdot)$. In the context of asset pricing models, the habit formation model is an example of non-linearity in u.

The second way to introduce non-linearity is through the certainty equivalent functional $\mathcal{I}$. Many non-expected utility models, such as the recursive utility model (Kreps and Porteus (1978), Epstein and Zin (1989)), the maxmin expected utility model (Gilboa and Schmeidler (1989)), the robust control model (Hansen and Sargent (2007)), and the smooth ambiguity model (Klibanoff, Marinacci, and Mukerji (2005)), take this approach.[5] Theorem 1 implies that the curvature in the certainty equivalent functional $\mathcal{I}$ requires risk compensation upon macroeconomic announcements, where the curvature in the utility function u does not require any announcement premium. The fact that, quantitatively, most of the equity premium is announcement premium implies that the curvature in $\mathcal{I}$ must be quantitatively large, and the curvature in u is likely to be relatively small. Interpreted this way, the empirical fact of the announcement premium provides asset price based support for these non-expected utility models.

Connection to leading asset pricing models In the representative agent setup, there are several leading asset pricing models, including the habit model (Constantinides (1990), Abel (1990), Campbell and Cochrane (1999), Boldrin, Christiano, and Fisher (2001b)), the long-run risk model (Bansal and Yaron (2004), Hansen, Heaton, and Li (2008)), the rare disaster model (Rietz (1988), Barro (2006), Gabaix (2012), Wachter (2013)), and the robust control model of Hansen and Sargent

[5] Other examples include the multiplier preference of Strzalecki (2011); the variational ambiguity-averse preference of Maccheroni, Marinacci, and Rustichini (2006a,b); the smooth ambiguity model of Klibanoff, Marinacci, and Mukerji (2005, 2009); the disappointment aversion preference of Gul (1991); and the recursive smooth ambiguity preference of Hayashi and Miao (2011). See Ai and Bansal (2018) for a list of non-expected utility models that satisfy generalized risk sensitivity. See Puhl, Savor, and Wilson (2022) for an application of the smooth ambiguity model to study the macroeconomic announcement premium.

(2005, 2007). The asset pricing implications of these models are often hard to distinguish. For example, see Beeler and Campbell (2011) and Bansal and Yaron (2004). The empirical regularity of the macroeconomic announcement premium provides a test that can qualitatively distinguish these asset pricing models.

The external habit model is an additively separable expected utility model and, as a result, generates a zero announcement premium. As shown by Ai and Bansal (2018), the internal habit model of Constantinides (1990) and Boldrin, Christiano, and Fisher (2001a) produces a negative announcement premium. The consumption substitutability model of Dunn and Singleton (1986) and Heaton (1993) is consistent with a positive announcement premium, although this feature of the utility function smooths the marginal utility process and does not account for the asset market data, as highlighted in Gallant, Hansen, and Tauchen (1990).

The long-run risk model is based on the recursive utility of Kreps and Porteus (1978) and Epstein and Zin (1989). Ai and Bansal (2018) show that, within the class of recursive utility with constant risk aversion and constant intertemporal elasticity of substitution, the preference for early resolution of uncertainty (PER) is equivalent to GRS. As a result, the long-run risk model is consistent with a positive announcement premium. The robust control model of Hansen and Sargent (2007) also satisfies generalized risk sensitivity and generates a positive announcement premium.

The rare disaster models of Rietz (1988), Barro (2006), and Gabaix (2012) are based on the constant relative risk aversion (CRRA) expected utility and imply a zero announcement premium. The models of Wachter (2013), Tsai and Wachter (2016), and Tsai and Wachter (2018) incorporate recursive utility and are consistent with an announcement premium. Wachter and Zhu (2022) explicitly present a model with GRS preferences where macroeconomic announcements reveal the probability of disasters and generate an announcement premium in equilibrium.

In the context of recursive utility with constant elasticity—that is, constant risk aversion and constant intertemporal elasticity of substitution (IES)—GRS is equivalent to the preference for early resolution of uncertainty (PER). This is typically the assumption made in the long-run risk literature and in most recursive utility based asset pricing models. However, outside this special class of recursive utility, the equivalence between PER and GRS breaks down. Ai and Bansal (2018) show that PER is neither necessary nor sufficient for GRS. Ai, Bansal, Guo, and Yaron (2022) present a simple example of a GRS preference that displays a preference for either early or late resolution of uncertainty (PER or PLR) depending on the value of the discount rate.

The key property of preference that is responsible for the asset pricing implications of long-run risk models is GRS and not PER. In long-run risk models, news about the future affects continuation utility and gives rise to variations in marginal utility. This property is generalized risk sensitivity, as formalized in statement 2 in Theorem 1. GRS is responsible for long-run risk requiring a positive risk premium. Under the assumption of constant elasticity, GRS is equivalent to PER, but if one goes beyond the class of constant elasticity recursive utility models, long-run risk can be priced in a model with PER or PLR as long as the preference satisfies GRS. The Ai, Bansal, Guo, and Yaron

(2022) paper provides such an example.

Although Theorem 1 focuses on representative-agent models, its basic insight extends to more general setups. Models with heterogeneous agents but concave expected utility generate a zero announcement premium as long as markets are complete and each agent's subjective probability coincides with the objective probability under which the risk premium is evaluated. This is so because, under the assumption of complete markets, asset prices can be derived from a representative agent whose utility is a weighted average of all consumers' utility functions. A weighted average of expected utility is still an expected utility and therefore requires a zero announcement premium.

Incomplete markets are unlikely to change the conclusion of Theorem 1 either. For example, the incomplete market model of Mankiw (1986) and Constantinides and Duffie (1996) implies a zero announcement premium under expected utility. This is because incomplete markets do not change the fact that the stochastic discount factor must equal the marginal rate of substitution of marginal investors. In the Constantinides and Duffie (1996) model, the identity of marginal investors does not change over time and certainly does not change upon a macroeconomic announcement. As a result, as long as the aggregate resource constraint cannot change immediately upon announcements, the consumption of marginal investors does not respond to announcements. There will be no announcement premium under expected utility. The incomplete market model of Schmidt (2022), Constantinides and Ghosh (2017), and Ai and Bhandari (2021) will generate an announcement premium not because of incomplete markets but because these models feature recursive utility functions with GRS.

The intermediary-based asset pricing models may or may not generate an announcement premium. The next section presents an intermediary-based asset pricing model that generates an announcement premium under expected utility. The key insight is that in the model, the Lagrangian multiplier for the financial constraint becomes part of the stochastic discount factor. Because the Lagrangian multiplier is forward looking in the sense that news about the future affects the tightness of financial constraints, it acts like the partial derivatives with respect to continuation utility, $\left\{\frac{\partial \mathcal{I}}{\partial V_s}\right\}_{s=1}^{N}$ in Theorem 1 to produce an announcement premium. In general, intermediary-based asset pricing models in which marginal investors are constrained, such as the model of Gertler and Kiyotaki (2010) and Li and Xu (2022), can be consistent with an announcement premium without requiring consumption to respond immediately to the announcement. Intermediary models in which marginal investors are unconstrained, such as He and Krishnamurthy (2012) and He and Krishnamurthy (2013), do not generate an announcement premium unless the consumption of marginal investors responds immediately to announcements. As discussed earlier in this review, the notion that investors respond immediately and significantly to announcements is not empirically supported.

An example of an intermediary-based asset pricing model Here, we present a two-period version of the Gertler and Kiyotaki (2010) and Li and Xu (2022) model to demonstrate that these models can produce a positive announcement premium even though consumers have expected utility.[6] We continue with the setup discussed in Section 3. We modify the model to add financial intermediation, as in Gertler and Kiyotaki (2010). The model has two groups of investors: households and intermediaries. The household can only invest in a risk-free bond that the intermediary issues. The intermediary borrows from the household to invest in a dividend claim (i.e., stock). The key feature of the model is that the intermediary faces a limited-commitment constraint and, as a result, has limited borrowing capacity. The household takes the risk-free interest rate as given and maximizes discounted utility:

$$
\begin{aligned}
&\max_{\{C_{-1},C_0,C_1\},\{b_0,b_1\}} \left\{u\left(C_{-1}\right)+u\left(C_0\right)+\beta E\left[u\left(C_1\right)\right]\right\}\\
&C_{-1}+\frac{1}{R_{f,0}}b_0=Y_{-1}+W_{-1},\\
&C_0+\frac{1}{R_{f,1}}b_1=Y_0+b_0,\\
&C_1=e_1+b_1+N_1.
\end{aligned}
$$

Here, C_t is consumption at time t, b_t is a one-period risk-free bond that pays off one unit of consumption in period t, and $R_{f,t}$ is the risk-free interest rate on the bond. The household is endowed with an initial wealth, W_{-1}, and owns the aggregate output Y_{-1} and Y_0 directly. The ownership of the aggregate output in period 1, Y_1, is divided between the household and the intermediary: $e_1+D_1=Y_1$, where e_1 is household's endowment and D_1 is the part of the aggregate output that the household owns indirectly through the intermediary. Here, we allow $e_1\neq 0$ so that aggregate consumption can be different from aggregate dividends. The household is the ultimate owner of both the equity and the debt of the financial intermediary. First, it owns the equity of the financial intermediary, N_1, which pays out in period 1.[7] Second, the household also invests in a risk-free bond issued by the intermediary. Here, $W_{-1},Y_{-1},Y_0,Y_1,e_1,D_1$ are exogenous variables, and C_{-1},C_0,C_1,b_0,b_1 are endogenous choices of the household.

It is convenient to formulate the intermediary's problem recursively. In period 0, given the current-period net worth, n_0, the intermediary maximizes

$$
V\left(n_0,s\right)=\max_{\{\alpha_1,B_1,n_1\}}\left\{E_0\left[M^1n_1\middle|\,s\right]\right\} \tag{4}
$$

$$
\begin{aligned}
&\alpha_1Q_0=n_0+\frac{1}{R_{f,1}}B_1,\\
&n_1=\alpha_1D_1-B_1,
\end{aligned}
$$

$$
E_0\left[M^1n_1\middle|\,s\right]\geq\theta\alpha_1Q_0, \tag{5}
$$

[6] Ai, Li, Li, and Schlag (2020) and Ai, Li, and Yang (2020) also used similar models to study asset pricing problem but without announcements.

[7] Here, without loss of generality, we do not allow the intermediary to pay any dividend in period −1 and period 0. It is a standard result that the intermediary will not find it optimal to pay any dividend in period −1 or period 0 as long as it is constrained. Alternatively, we can allow a dividend payment in all periods and impose a non-negativity constraint on dividends.

where α_1 is the number of shares of the stock that the intermediary brings into period 1, and B_1 is the principal value of risk-free debt that the intermediary brings into period 1. In this setup, the financial intermediary takes the stochastic discount factor M^1, interest rates $R_{f,1}$, and the stock price Q_0 as given. It chooses the number of shares, α_1, and the amount of bonds to issue to the household, B_1, to maximize the present value of its equity. The stock is a claim to dividends D_1 that is paid in period 1. The constraint $E_s\left[M^1 n_1\right] \geq \theta\alpha_1 Q_0$ is the limited-commitment constraint. The interpretation is that at the end of period 0, the manager of the intermediary has an opportunity to default on its liabilities. Upon default, the manager takes away a fraction θ of total assets without repaying any debt back to the household. Such lack of commitment limits the intermediary's borrowing capacity. In equilibrium, the household will limit its lending to the intermediary so that inequality (5) holds, and the intermediary never has an incentive to default. In period 0, the announcement fully reveals the state s. The notation $E_0\left[\cdot|\, s\right]$ emphasizes that the expectation depends on the announcement s.

In period -1, the intermediary solves a similar problem:

$$V\left(n_{-1}\right) = \max_{\{\alpha_0, B_0, n_0\}} \left\{E_{-1}\left[M^0 V\left(n_0, s\right)\right]\right\} \tag{6}$$

$$\alpha_0 Q_{-1} = n_{-1} + \frac{1}{R_{f,0}} B_0,$$

$$n_0 = \alpha_0 Q_0 - B_0,$$

$$E_{-1}\left[M^0 n_0\right] \geq \theta\alpha_0 Q_0, \tag{7}$$

where $V\left(n_0\right)$ is the value function defined in (4).

The following market clearing conditions have to hold in equilibrium:

$$\begin{aligned}
&\alpha_t = 1; b_t = B_t; n_t = N_t,\ \textit{for all } t,\\
&C_t = Y_t, t = -1, 0\\
&C_1 = D_1 + e_1.
\end{aligned}$$

As in Gertler and Kiyotaki (2010), we require the stochastic discount factor to be consistent with household consumption: $M^0 = \frac{u'(C_0)}{u'(C_{-1})}$, and $M^1\left(s\right) = \beta\frac{u'(C_1(s))}{u'(C_0)}$. In addition, as before, we assume that the announcement at time 0 completely resolves all uncertainty about time 1, so that $C_1\left(s\right)$ is known at time 0.

We denote the present value of the firm dividend evaluated in period 0 using the stochastic discount factor M^1 as $\bar{P}_0\left(s\right)$. That is, $\bar{P}_0\left(s\right) = \beta\frac{u'(C_1(s))}{u'(C_0)} D_1\left(s\right)$. As we will see, $\bar{P}_0\left(s\right)$ is the equilibrium price of the claim to dividends whenever the intermediary is not constrained, but will be higher than the equilibrium price of dividends when the intermediary is constrained. We assume that $\bar{P}_0\left(s\right)$ is an increasing function of s, which is equivalent to assuming that the stock market is pro-cyclical. Because $\bar{P}_0\left(s\right)$ is a function of the parameters of the model, this allows us to provide a necessary and sufficient condition for the existence of an announcement premium.

Theorem 2. *Suppose $\bar{P}_0(s)$ is a strictly increasing function of s and the following condition holds:*

$$\frac{1}{1-\theta}B_0 > \bar{P}_0(1) > (1+\theta)B_0. \tag{8}$$

Then the announcement premium is strictly positive.

Proof. See appendix. □

In this economy, whenever the intermediary does not have enough initial net worth N_{-1}, it needs to borrow from the household in order to purchase the claim to D_1. As a result, one can think of B_0 as the initial condition of the economy. Equilibriums are indexed by B_0. Small values of B_0 imply that the intermediary has abundant equity and is therefore not constrained. Higher values of B_0 imply that the intermediary needs to borrow a large amount and that the limited-commitment constraints are more likely to be binding.

The condition $\bar{P}_0(1) > (1+\theta)B_0$ implies that the intermediary's net worth is positive even upon the lowest realization of s and guarantees the existence of equilibrium. The condition $\frac{1}{1-\theta}B_0 > \bar{P}_0(1)$ ensures that the limited-commitment constraint, $E_{-1}\left[M^0 N_0\right] \geq \theta\left[\alpha_{-1}Q_0\right]$, will be binding for some realizations of s, and as a result, generates an announcement premium that would otherwise be zero because of the additively separable expected utility.

To understand Theorem 2, we set up the Lagrangian for the period 0 maximization problem:

$$\begin{aligned} V(n_0, s) = \max &\left\{E_s\left[M^1\left\{\alpha_1 D_1 - R_{f,1}\left[\alpha_1 Q_0 - n_0\right]\right\}\right]\right. \\ &\left.+\lambda(s)\left\{E_s\left[M^1\left\{\alpha_1 D_1 - R_{f,1}\left[\alpha_1 Q_0 - n_0\right]\right\}\right] - \theta\left[\alpha_1 Q_0\right]\right\}\right\}. \end{aligned} \tag{9}$$

The envelope condition implies $V'(n_0) = 1+\lambda(s)$, where the Lagrangian multiplier λ is a function of the announcement s in period 0. It is also clear that $V(n_0, s)$ is linear in n_0 because of homogeneity of the objective function and the constraints. As a result, we can write $V(n_0, s) = [1+\lambda(s)]\,n_0$. In the appendix, we show that λ is a non-increasing function of s and is non-zero at least for some s under the condition (8).

To derive an expression for the announcement premium, it is convenient to assume that the limited-commitment constraint (7) does not bind.[8] In this case, using the optimality condition for the period -1 problem, we have

$$E\left[M^0\left\{1+\lambda(s)\right\}\frac{Q_0}{Q_{-1}}\right] = E\left[M^0\left\{1+\lambda(s)\right\}R_{f,0}\right]. \tag{10}$$

Clearly, $M^0\{1+\lambda(s)\}$ is the stochastic discount factor that prices announcement returns and the

[8] This assumption simplifies the asset pricing equation, but as we will show in the appendix, it does not affect the conclusion in Theorem 2.

announcement premium can be written as:

$$\frac{E\left[\frac{Q_0}{Q_{-1}}\right] - R_{f,0}}{R_{f,0}} = -Cov\left(\frac{M^0\left\{1+\lambda\left(s\right)\right\}}{E\left[M^0\left\{1+\lambda\left(s\right)\right\}\right]}, \frac{Q_0}{Q_{-1}}\right).$$

As a result of expected utility, $M^0 = \frac{u'(C_0)}{u'(C_{-1})}$ does not depend on the content of the announcement. However, $\lambda\left(s\right)$ does whenever the constraint (5) binds. The assumption $\frac{1}{1-\theta}B_0 > \bar{P}_0\left(1\right)$ guarantees that $\lambda\left(s\right)$ will be strictly positive at least in some states of the world. Because lower realizations of s are associated with a tighter limited-commitment constraint, the variations in $\lambda\left(s\right)$ generate an announcement premium despite the expected utility.

This model features a positive announcement premium despite the expected utility. In the case in which the borrowing constraint (5) might be binding in some states in the future, the marginal benefit of the intermediary's net worth in those states is increasing in the tightness of the borrowing constraint. As a result, the Lagrangian multiplier on the constraint acts like a stochastic discount factor: returns that are negatively correlated with the tightness of the borrowing constraint require a premium. Upon a macroeconomic announcement, even though aggregate consumption does not react immediately, news about the future forecasts the tightness of the borrowing constraint. As a result, returns correlated with the tightness of this constraint require a risk compensation prior to the announcement. Although this mechanism does not require generalized risk sensitivity in preferences, the economic intuition is similar: it requires the marginal utility of marginal investors to vary with the context of the announcement. In the case of generalized risk sensitivity, this variation originates from information about continuation utility. In this financial intermediary model, this variation originates from the information about the tightness of the borrowing constraint. Both mechanisms add a forward-looking component, as $\frac{\partial \mathcal{I}}{\partial V_s}$ in Equation (3), to the stochastic discount factor that prices the risk associated with announcements.

It is worth noting that the Lagrangian multiplier being part of the pricing kernel typically does not occur in models with deeper micro-foundations. As shown by Ai and Bhandari (2021), in models in which financial constraints arise as a result of agency frictions, the marginal rate of substitution of constrained agents is typically not a valid stochastic discount factor. It is the marginal rate of substitution of unconstrained agents that prices assets in their model. In these setups, GRS will still be important for modeling announcement premiums. In addition, Ai, Bansal, Guo, and Yaron (2022) present an additional set of tests for GRS and PER. It is not clear that the pricing kernel in this financial intermediary mode can pass these additional tests.

Incorporating generalized risk sensitivity into economic analysis The empirical fact of a macroeconomic announcement premium highlights the importance of incorporating preferences with GRS into dynamic economic models. Several classes of models with GRS have been widely applied to economic analysis. See Ilut and Schneider (2022) for a review of the application of the multiple prior expected utility model in economic analysis. See Hansen and Sargent (2007) for a textbook treatment of robust control models and their applications in economics. The defining property of GRS preferences is that marginal utility is decreasing in continuation utility. This section reviews papers that demonstrate the importance of this property of GRS preferences in economic analysis.

The property of GRS that marginal utility is decreasing in continuation utility is perhaps best highlighted in the long-run risk literature. In expected utility based asset pricing models, variations in marginal utility must be associated with changes in current-period consumption. The equity premium puzzle arises in expected utility based asset pricing models because the volatility in the growth rate of aggregate consumption is small, roughly on the order of 2% per year in U.S. post-war data. As a result, the variations in the marginal rate of substitution of investors are too small to generate a sizable equity premium under expected utility unless one is willing to assume implausibly high levels of risk aversion. Furthermore, an expected utility based model, when calibrated to match the overall level of equity premium, will be inconsistent with the pattern of the realization of an equity premium documented in Table 1. Virtually all equity premium will be realized on non-announcement days in expected utility based asset pricing models, and the announcement premium will be zero.

The key mechanism in long-run risk models is that information about future consumption and continuation utility affects marginal utility as a result of GRS. This can be information about the future growth rate, as in Case I of the Bansal and Yaron (2004) model, or information about the volatility of future consumption, as in Case II of the Bansal and Yaron (2004) model, or information about higher moments of consumption growth, as in recursive utility based rare disaster models—for example, Wachter (2013). Most other non-expected utility based asset pricing models generate a high equity premium for the same reason. See, for example, the recursive multiple prior model of Chen and Epstein (2002), the robust control model of Hansen and Sargent (2010), and the smooth ambiguity based asset pricing model of Ju and Miao (2012). Many authors have applied GRS preferences to study production and asset pricing in a unified setup (Croce (2006), Kaltenbrunner and Lochstoer (2010), Ai, Croce, and Li (2013)), carry trade (Lustig and Verdelhan (2007), Lustig and Verdelhan (2011), Ilut (2012)), CDS spreads and sovereign debt spreads (Boyarchenko (2012), Pouzo and Presno (2016), Seo and Wachter (2018)), and option pricing and the variance risk premium (Drechsler and Yaron (2011), Drechsler (2013), Miao, Wei, and Zhou (2019), Seo and Wachter (2019)).

The fact that under GRS, marginal utility is affected by information about the future also has important implications for modeling exchange rates and international risk sharing. Expected utility based models have many counterfactual implications on exchange rate dynamics. Under the assumption of complete markets, real exchange rates between any two currencies must be equal to the ratio of marginal utilities of investors from their respective countries. If both investors have expected utility, the ratio of marginal utility must be perfectly correlated with the ratio of consumption growth. This observation has two implications. First, recessions in the home country, which lead to drops in home country consumption relative to foreign countries, must be associated with simultaneous appreciations of the home currency. Second, the low correlation of consumption growth rates across countries also implies that the stochastic discount factor across countries cannot be highly correlated. The first implication leads to the Backus and Smith (1993) puzzle, which is the empirical fact that recessions are often associated with currency depreciation, not appreciation. The second implication leads to the Brandt, Cochrane, and Santa-Clara (2006) puzzle, which is the observation that the high volatility of the stochastic discount factor and the relatively low volatility of exchange rates cannot be consistent with each other unless stochastic discount factors across countries are highly correlated.

Colacito and Croce (2011) demonstrate that these two puzzles can be reconciled in models with recursive utility in which news about the future affects marginal utilities. In their model, news about continuation utility drives most of the volatility in the stochastic discount factor, which breaks the link between current-period consumption growth and the exchange rate variations and resolves the Backus-Smith puzzle. In addition, because of international risk sharing, long-run consumption across countries is highly correlated and accounts for the high correlation between the stochastic discount factors across countries. Furthermore, the failure of uncovered interest rate parity (Fama (1984)) and the profitability of carry trade (Lustig, Roussanov, and Verdelhan (2011) and Lustig, Roussanov, and Verdelhan (2014)) imply that risk premium variations are important in understanding exchange rate dynamics. Colacito and Croce (2013) and Colacito, Croce, Ho, and Howard (2018) develop recursive preference based asset pricing models in which GRS plays an important role in accounting for the risk premium dynamics in exchange rates.

GRS also plays an important role in the study of climate finance. Risk preferences have significant qualitative and quantitative implications for the Social Cost of Carbon (SCC) and therefore for the optimal policy response to climate change. Examples of this include Bansal, Kiku, and Ochoa (2016), Lemoine and Traeger (2014), and Barnett, Brock, and Hansen (2020, 2022). Risk-sensitive preferences typically raise the SCC as the long-run climate change path introduces greater long-term uncertainty, ambiguity, or both. In empirical implementations of some of these models with recursive preferences that satisfy the property of GRS, the long-run climate uncertainty affects the short-run risk-return trade-offs in asset prices; this feature of specific versions of risk-sensitive preferences is exploited in Bansal, Kiku, and Ochoa (2016) and Barnett (2023) to study the impact of climate change on asset prices.

Preferences with the GRS property have also been demonstrated to be relevant for the study of optimal policy and optimal contracting. Kwon and Miao (2019) study robust taxation problems in a linear-quadratic framework. In a Ramsey taxation problem with recursive utility, Karantounias (2018) demonstrates that the fact that marginal utility depends on continuation utility implies that a benevolent government has an incentive to introduce intertemporal distortions that can lead to an ex ante capital subsidy. Karantounias (2020) provides a review of the literature on optimal policy design under preferences that features model uncertainty, a subclass of preferences that satisfy GRS. Woodford (2010) studies optimal monetary policy under robustness preferences. Kwon and Miao (2019) extend Woodford (2010)'s analysis to a general linear quadratic framework. Miao and Rivera (2016) study an optimal dynamic contracting problem with ambiguity-averse preferences.

5 Information and asset market reactions

The central theme of the theory and evidence on the macroeconomic announcement premium is that information about macroeconomic uncertainty affects asset market returns and requires risk compensation. This section reviews recent literature that provides theory and evidence for how asset markets respond to information in macroeconomic announcements.

Asset market response to macroeconomic announcements Many authors have studied how asset markets respond to monetary policy announcements. Examples include Kuttner (2001), Gürkaynak, Sack, and Swanson (2005), Bernanke and Kuttner (2005), Hanson and Stein (2015), Cieslak and Schrimpf (2019), Swanson (2021), Hillenbrand (2021), Gürkaynak, Karasoy-Can, and Lee (2022), Bianchi, Lettau, and Ludvigson (2022), and Bianchi, Ludvigson, and Ma (2022). Bernanke and Kuttner (2005) document that an unanticipated 25-basis-point cut in the Federal Funds Rate target is associated with a 1% increase in the stock index, highlighting the impact that the Fed has on the risk premium of the stock market. Hanson and Stein (2015) demonstrate that a 100-basis-point increase in the two-year nominal yield on an FOMC announcement day is typically associated with a 42-basis-point increase in the 10-year forward real rate. Focusing on major macroeconomic announcements, which include all five announcements used to calculate the announcement premium in Table 1, Elenev, Law, Song, and Yaron (2022) document that the sensitivity of the stock market reaction to major macroeconomic news announcements (MNAs) is countercyclical and depends on the expectation of monetary policy. Using using stock returns and Treasury yield changes, Cieslak and Pang (2021) decompose economic shocks into monetary, growth, and risk premium news and examine investors' responses to news from the Fed and key macro announcements. Gomez Cram and Olbert (2023) use asset price changes within minutes of a major global tax reform announcement to estimate its impact on shareholder value.

Many authors advocate using asset returns during short FOMC announcement windows to identify unexpected monetary policy shocks. Examples include Cook and Hahn (1989), Cochrane and Piazzesi (2002), Nakamura and Steinsson (2018a), and Nakamura and Steinsson (2018b). The advantage of this approach is that during a short time interval—for example, a half-hour window—the announcement is likely to be the only significant event that affects investor expectations. Nakamura and Steinsson (2018a) document a "Fed information effect"—that is, the fact that the FOMC has private information about economic fundamentals, and announcements reveal the private information.[9] Jarociński and Karadi (2020) decompose FOMC announcements into a monetary policy surprise component and a central bank information component. Bauer and Swanson (2023) challenge the "Fed information effect" by arguing that it may actually arise from a "Fed responds to news" effect. They show that the "Fed information effect" can be attributed to the predictability of the high-frequency asset market responses to FOMC announcements. The predictability of

[9] Romer and Romer (2000) are the first to document a Fed information effect. Faust, Swanson, and Wright (2004) and Campbell, Evans, Fisher, and Justiniano (2012) also study the Fed information effect, although none of them use high-frequency market reactions to FOMC announcements.

the high-frequency identified shocks complicates their interpretations and weakens their validity as measures of shocks to expectations.

Information and risk compensation If macroeconomic announcements require risk compensation because they resolve uncertainty, it is natural to ask whether a higher uncertainty reduction is associated with a larger magnitude of the announcement premium. Theoretically, Ai, Han, and Xu (2022) show that under a slightly stronger condition than GRS, which they call strong generalized risk sensitivity, the magnitude of the announcement premium increases with the informativeness of announcements.

To test this implication, a natural measure of the informativeness of announcements is the drop in implied volatility upon the announcements. Intuitively, option-implied volatility reflects the market's expected forward-looking volatility during the maturity of the option. Rational expectation implies that the drop in implied volatility upon the announcement represents the market's expectation of the uncertainty reduction associated with the announcement. In the data, as shown by Ghaderi and Seo (2021), larger drops in implied volatility are typically associated with higher realizations of announcement returns. However, Ghaderi and Seo (2021) argue that such a relation between an implied volatility drop and announcement returns may simply be due to the well-known "leverage effect," the fact that stock returns and implied volatility are highly negatively correlated. Testing the relation between the informativeness of announcements and the announcement premium requires an-ex ante measure of informativeness. Several papers have developed ex ante measures that relate FOMC announcement returns to uncertainty and uncertainty reduction. Fisher, Martineau, and Sheng (2022) put forth a novel macroeconomic attention index and show that attention to macroeconomic news increases before major macroeconomic announcements. They demonstrate that announcements with greater ex ante attention earn higher risk premiums and experience larger declines in VIX. Hu, Pan, Wang, and Zhu (2022) demonstrate that elevated uncertainty before FOMC announcements is associated with higher realizations of announcement returns. Jacobs, Ke, and Pan (2022) demonstrate that option-implied volatility ahead of announcements predicts pre-FOMC announcement drift and option-implied higher moments predict post-FOMC announcement returns. Liu, Tang, and Zhou (2022) provide an option price based measure of the FOMC announcement premium. They show that their measure predicts the FOMC announcement premium with an R^2 of about 7.51%. Ai, Han, and Xu (2022) develop an option price based measure of informativeness and demonstrate that their measure of informativeness also predicts FOMC announcement returns. Zhang and Zhao (2022) show that the risk premium is high when the risk is high, as in standard asset pricing models, but the risk premium is low when information uncertainty is high. The findings are consistent with the notion that information uncertainty hampers the effectiveness of learning.

Many authors have also documented other return predictability patterns around announcements. Boguth, Grégoire, and Martineau (2019) show that for a period of a few years, half of the FOMC announcements are accompanied by a post-announcement press conference, and the FOMC announcement premium moves to fully concentrate on these announcements. They argue that this effect occurs because the Fed endogenously announces more important decisions when they know they can elaborate on them in a follow-up press conference. Gomez-Cram and Grotteria (2022) show that for several asset classes, price movements around the post-FOMC meeting statement release are strong predictors of price movements around the subsequent press conference. Boguth, Fisher, Gregoire, and Martineau (2023) document a pattern of return reversal after announcements. They show that a high announcement-day return is often associated with a lower realized return afterward. This phenomenon is potentially consistent with the interpretation that a higher uncertainty reduction on an announcement day is associated with a higher announcement premium and lower uncertainty and a lower average return afterward. Savor and Wilson (2014) and Gafka, Savor, and Wilson (2021) demonstrate that realized variance at the quarterly level positively predicts next-quarter returns on announcement days but not those on non-announcement days.

Several authors have provided evidence for the link between information and risk compensation from the cross section of expected returns. Ben-Rephael, Carlin, Da, and Israelsen (2021) demonstrate that firms that are more sensitive to macroeconomic information receive a higher premium on earnings announcement days and macroeconomic announcement days. Ai, Han, Pan, and Xu (2022) demonstrate that firms that are more sensitive to monetary policy announcements receive a high premium on FOMC announcement days. Guo, Hung, Kontonikas, and Zeng (2020) show that the pre-FOMC announcement drifts are more pronounced on lottery-like stocks.

Earnings announcements Like macroeconomic announcements, firm earnings announcements are (mostly) pre-scheduled events that resolve important uncertainty for investors. This section does not attempt to review the full set of literature on every aspect of earnings announcements (e.g., we will leave the important topics of PEAD and ERC out). Rather, we focus on the particular branch studying the average stock returns around the earnings announcements. Beaver (1968) and Ball and Kothari (1991) are among the early papers to document the high average excess stock returns around the issuing firms' earnings announcement. This feature seems robust, present in both the U.S. and the global market (Barber, De George, Lehavy, and Trueman (2013)). Earlier works, explicitly or implicitly, relate this premium to investors' (in)attention (e.g., Frazzini and Lamont (2007)), market frictions (e.g., Berkman, Dimitrov, Jain, Koch, and Tice (2009), So and Wang (2014)), biased information (e.g., Kothari, Shu, and Wysocki (2009)), and idiosyncratic risks (e.g., Barber, De George, Lehavy, and Trueman (2013), Barth and So (2014)).

Patton and Verardo (2012) and Savor and Wilson (2016) link earnings announcements to the resolution of systematic risks and provide a general equilibrium interpretation of the earnings announcement premium. Savor and Wilson (2016) present a formal asset pricing model in which individual firms' earnings share a common, aggregate component and investors rationally learn about aggregate cash flow news from individual earnings announcements. They, like many other researchers, use multiple days around the (expected) earnings announcement dates as the announcement window. Using the precise announcement dates and times, Barber, De George, Lehavy, and

Trueman (2013) and Johnson and So (2018) document that high earnings announcement returns occur only before the actual announcement day and in fact partially reverse afterward. In other words, there is also a pre-announcement drift for earnings announcements. Liu, Wang, Yu, and Zhao (2020) further show that the size of the drift is linked to a few lottery-like features of the stocks. Akey, Grégoire, and Martineau (2022) examine stock market behaviors before hacked earnings announcements over a five-year episode. Heitz, Narayanamoorthy, and Zekhnini (2020) show that the earnings announcement premium is disappearing in the U.S. in recent years, even though it remains robust in the international markets. Chen, Cohen, and Wang (2020) show that the evenings in which a group of famous, large firms announce their earnings in close temporal proximity, which they call earnings clusters, carry a pre-announcement drift in the aggregate stock market.

6 Conclusion and open questions

The macroeconomic announcement premium provides empirical support for general equilibrium macro asset pricing models as well as the study of non-expected utility. The basic premise of macro asset pricing models is that the equity premium reflects compensation for macroeconomic risk. The fact that most of the equity market risk premium is realized on days where uncertainty about the macroeconomy is resolved provides strong evidence for the importance of macroeconomic risk in affecting equity market risk compensation. However, not all macro asset pricing models are consistent with the macroeconomic announcement premium. The Theorem of Generalized Risk Sensitivity implies that expected utility based models leads to a zero announcement premium. To generate a positive announcement premium, one needs generalized risk sensitivity. GRS is a property of preference that is satisfied in many non-expected utility models. The evidence of an announcement premium highlights the need for incorporating non-expected utility analysis in economic modeling. Several directions for future research are promising.

Decision theoretic foundations for GRS GRS is a property of preferences derived from asset prices. What does it imply for the choice behavior of decision making under uncertainty? What is the relationship between GRS and behavioral violations of expected utility theory, such as the Ellsberg paradox (Ellsberg (1961))? Understanding these questions requires the development of an axiomatic foundation for GRS in terms of choice behavior. Such development will also help unify the study of asset pricing and decision making under uncertainty.

Using asset prices to infer properties of preferences The basic idea of the Theorem of Generalized Risk Sensitivity is to infer properties of preferences from asset prices. The approach taken by Ai and Bansal (2018) is to use asset prices to identify properties of marginal utilities and use the property of marginal utilities to recover the property of preferences. GRS provides a particularly useful tool to identify preferences from asset prices. As shown in Theorem 1 under the assumption of GRS, the order of utility level is exactly the inverse of the order of marginal utilities. Because asset prices can be used to identify the order of marginal utilities, GRS provides a promising approach to link properties of preferences to asset prices. Given the evidence of the macroeconomic announcement premium, GRS also seems to be a reasonable starting point for such analysis.

Ai, Bansal, Guo, and Yaron (2022) is an example of using asset prices to identify a property of preference, namely, preference for the timing of resolution of uncertainty, by taking advantage of the assumption of GRS. They provide a characterization of PER in terms of asset prices and use evidence from financial markets to identify investors' preference for the timing of resolution of uncertainty. The decision theoretical literature has emphasized the importance of many other properties of choice behavior under uncertainty, such as uncertainty aversion and various notions of the independence axiom (the certainty independence axiom of Gilboa and Schmeidler (1989) and the weak certainty independence axiom of Maccheroni, Marinacci, and Rustichini (2006a), for example). Theorem 1 can potentially be used to link these properties of preferences to asset prices.

Monetary policy and stock market reactions Of all macroeconomic announcements, the FOMC announcement is arguably the most important one. It accounts for the largest fraction of the announcement premium out of all macroeconomic announcements. According to Theorem 1, under generalized risk sensitivity, the FOMC announcement requires a premium because it resolves uncertainty about the future of the macroeconomy. Quantitatively, to generate a significant FOMC announcement premium, FOMC announcements need to have a long-run impact on the economy. Why do FOMC announcements have a long-run impact on the economy? Is this because monetary policy itself has a long-run impact on the economy and the announcements resolve uncertainty about the monetary policy? An alternative hypothesis is the "Fed information effect." That is, monetary policy announcements reveal the FOMC's private information about the growth prospect of the macroeconomy. Understanding the micro-foundation for the FOMC announcement premium requires the development of asset pricing models with a non-trivial monetary component and requires the incorporation of the FOMC announcement premium, together with other macro and asset pricing facts, into a coherent general equilibrium framework.

References

Abdi, Farshid, and Botao Wu, 2018, Pre-FOMC Information Asymmetry, Working paper.

Abel, Andrew, 1990, Asset Prices Under Habit Formation And Catching Up With The Joneses, *American Economic Review* 80, 38–42.

Ai, Hengjie, and Ravi Bansal, 2018, Risk Preferences and the Macroeconomic Announcement Premium, *Econometrica* 86, 1383–1430.

Ai, Hengjie, Ravi Bansal, Hongye Guo, and Amir Yaron, 2022, Identifying preference for early resolution from asset prices, Working paper.

Ai, Hengjie, Ravi Bansal, and Leyla Han, 2022, information acquisition and the pre-announcement drift, *Unpublished Working Paper*.

Ai, Hengjie, and Anmol Bhandari, 2021, Asset Pricing With Endogenously Uninsurable Tail Risk, *Econometrica* 89, 1471–1505.

Ai, Hengjie, Mariano Massimiliano Croce, and Kai Li, 2013, Toward a Quantitative General Equilibrium Asset Pricing Model with Intangible Capital, *The Review of Financial Studies* 26, 491–530.

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

Ai, Hengjie, Leyla Jianyu Han, and Lai Xu, 2022, Information-Driven Volatility, Working paper.

Ai, Hengjie, Jun E Li, Kai Li, and Christian Schlag, 2020, The Collateralizability Premium, *The Review of Financial Studies* 33, 5821–5855.

Ai, Hengjie, Kai Li, and Fang Yang, 2020, Financial intermediation and capital reallocation, *Journal of Financial Economics* 138, 663–686.

Akey, Pat, Vincent Grégoire, and Charles Martineau, 2022, Price revelation from insider trading: Evidence from hacked earnings news, *Journal of Financial Economics* 143, 1162–1184.

Andrei, Daniel, Julien Cujean, and Mungo Wilson, 2023, The Lost Capital Asset Pricing Model, *The Review of Economic Studies*.

Backus, David K., and Gregor W. Smith, 1993, Consumption and real exchange rates in dynamic economies with non-traded goods, *Journal of International Economics* 35, 297–316.

Ball, Ray, and S. P. Kothari, 1991, Security Returns around Earnings Announcements, *The Accounting Review* 66, 718–738.

Bansal, Ravi, Dana Kiku, and Marcelo Ochoa, 2016, Price of Long-Run Temperature Shifts in Capital Markets, Working paper.

Bansal, Ravi, and Amir Yaron, 2004, Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles, *The Journal of Finance* 59, 1481–1509.

Barber, Brad M., Emmanuel T. De George, Reuven Lehavy, and Brett Trueman, 2013, The earnings announcement premium around the globe, *Journal of Financial Economics* 108, 118–138.

Barnett, Michael, 2023, Climate Change and Uncertainty: An Asset Pricing Perspective, *Management Science*.

Barnett, Michael, William Brock, and Lars Peter Hansen, 2020, Pricing Uncertainty Induced by Climate Change, *The Review of Financial Studies* 33, 1024–1066.

Barnett, Michael, William Brock, and Lars Peter Hansen, 2022, Climate Change Uncertainty Spillover in the Macroeconomy, *NBER Macroeconomics Annual* 36, 253–320.

Barro, Robert J., 2006, Rare Disasters and Asset Markets in the Twentieth Century, *The Quarterly Journal of Economics* 121, 823–866.

Barth, Mary E., and Eric C. So, 2014, Non-Diversifiable Volatility Risk and Risk Premiums at Earnings Announcements, *The Accounting Review* 89, 1579–1607 Publisher: American Accounting Association.

Bauer, Michael D., and Eric T. Swanson, 2023, An Alternative Explanation for the "Fed Information Effect", *American Economic Review* 113, 664–700.

Beaver, William H., 1968, The Information Content of Annual Earnings Announcements, *Journal of Accounting Research* 6, 67–92.

Beeler, Jason, and John Y. Campbell, 2011, The Long-Run Risks Model and Aggregate Asset Prices: An Empirical Assessment, *Critical Finance Review* 1, 141–182.

Ben-Rephael, Azi, Bruce I. Carlin, Zhi Da, and Ryan D. Israelsen, 2021, Information Consumption and Asset Pricing, *The Journal of Finance* 76, 357–394.

Berkman, Henk, Valentin Dimitrov, Prem C. Jain, Paul D. Koch, and Sheri Tice, 2009, Sell on the news: Differences of opinion, short-sales constraints, and returns around earnings announcements, *Journal of Financial Economics* 92, 376–399.

Bernanke, Ben S., and Kenneth N. Kuttner, 2005, What Explains the Stock Market's Reaction to Federal Reserve Policy?, *The Journal of Finance* LX, 1221–1257.

Bernile, Gennaro, Jianfeng Hu, and Yuehua Tang, 2016, Can information be locked up? Informed trading ahead of macro-news announcements, *Journal of Financial Economics* 121, 496–520.

Bianchi, Francesco, Martin Lettau, and Sydney C. Ludvigson, 2022, Monetary Policy and Asset Valuation, *The Journal of Finance* 77, 967–1017.

Bianchi, Francesco, Sydney C. Ludvigson, and Sai Ma, 2022, Monetary-Based Asset Pricing: A Mixed-Frequency Structural Approach, Working paper.

Boguth, Oliver, Adlai Fisher, Vincent Gregoire, and Charles Martineau, 2023, Price Informativeness and FOMC Return Reversals, *Unpublished Working Paper*.

Boguth, Oliver, Vincent Grégoire, and Charles Martineau, 2019, Shaping Expectations and Coordinating Attention: The Unintended Consequences of FOMC Press Conferences, *Journal of Financial and Quantitative Analysis* 54, 2327–2353.

Boldrin, Michele, Lawrence Christiano, and Jonas Fisher, 2001a, Habit persistence, asset returns, and the business cycle, *American Economic Review* 91, 149–166.

Boldrin, Michele, Lawrence J. Christiano, and Jonas D. M. Fisher, 2001b, Habit Persistence, Asset Returns, and the Business Cycle, *American Economic Review* 91, 149–166.

Boyarchenko, Nina, 2012, Ambiguity shifts and the 2007–2008 financial crisis, *Journal of Monetary Economics* 59, 493–507.

Brandt, Michael W., John H. Cochrane, and Pedro Santa-Clara, 2006, International risk sharing is better than you think, or exchange rates are too smooth, *Journal of Monetary Economics* 53, 671–698.

Breeden, Douglas T., 1979, An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities, *Journal of Financial Economics* 7, 265–296.

Brusa, Francesca, Pavel Savor, and Mungo Wilson, 2020, One Central Bank to Rule Them All, *Review of Finance* 24, 263–304.

Campbell, Jeffrey, Charles Evans, Jonas Fisher, and Alejandro Justiniano, 2012, Macroeconomic Effects of Federal Reserve Forward Guidance, *Brookings Papers on Economic Activity* 43, 1–80.

Campbell, John Y., and John H. Cochrane, 1999, By Force of Habit: A Consumption-based Explanation of Aggregate Stock Market Behavior, *Journal of Political Economy* 107, 205–255.

Chen, Yixin, Randolph B. Cohen, and Zixuan (Kevin) Wang, 2020, Famous Firms, Earnings Clusters, and the Stock Market, Working paper.

Chen, Zengjing, and Larry Epstein, 2002, Ambiguity, Risk, and Asset Returns in Continuous Time, *Econometrica* 70, 1403–1443.

Cieslak, Anna, Adair Morse, and Annette Vissing-Jorgensen, 2019, Stock Returns over the FOMC Cycle, *The Journal of Finance* 74, 2201–2248.

Cieslak, Anna, and Hao Pang, 2021, Common shocks in stocks and bonds, *Journal of Financial Economics* 142, 880–904.

Cieslak, Anna, and Andreas Schrimpf, 2019, Non-monetary news in central bank communication, *Journal of International Economics* 118, 293–315.

Cochrane, John H., and Monika Piazzesi, 2002, The Fed and Interest Rates - A High-Frequency Identification, *American Economic Review* 92, 90–95.

Cocoma, Paula, 2018, Explaining the Pre-Announcement Drift, Working paper.

Colacito, Riccardo, and Mariano Massimiliano Croce, 2011, Risks for the Long Run and the Real Exchange Rate, *The Journal of Political Economy* 119, 153–181.

Colacito, Riccardo, and Mariano M. Croce, 2013, International Asset Pricing with Recursive Preferences, *The Journal of Finance* 68, 2651–2686.

Colacito, Riccardo, Mariano M. Croce, Steven Ho, and Philip Howard, 2018, BKK the EZ Way: International Long-Run Growth News and Capital Flows, *The American Economic Review* 108, 3416–3449.

Constantinides, George, and Darrell Duffie, 1996, Asset Pricing with Heterogeneous Consumers, *Journal of Political Economy* 104, 219–40.

Constantinides, George M., 1990, Habit Formation: A Resolution of the Equity Premium Puzzle, *The Journal of Political Economy* 98, 519–543.

Constantinides, George M., and Anisha Ghosh, 2017, Asset Pricing with Countercyclical Household Consumption Risk, *The Journal of Finance* 72, 415–460.

Cook, Timothy, and Thomas Hahn, 1989, The effect of changes in the federal funds rate target on market interest rates in the 1970s, *Journal of Monetary Economics* 24, 331–351.

Croce, Mariano M., 2006, Welfare Costs, Long Run Consumption Risk, and a Production Economy, *2006 Meeting Papers* Number: 582 Publisher: Society for Economic Dynamics.

Drechsler, Itamar, 2013, Uncertainty, Time-Varying Fear, and Asset Prices, *The Journal of Finance* 68, 1843–1889.

Drechsler, Itamar, and Amir Yaron, 2011, What's Vol Got to Do with It, *Review of Financial Studies* 24, 1–45.

Dunn, Kenneth, and Kenneth Singleton, 1986, Modeling The Term Structure of Interest Rates under Non-Separable Utility and Durability of Goods, *Journal of Financial Economics* 17, 27–55.

Elenev, Vadim, Tzuo Hann Law, Dongho Song, and Amir Yaron, 2022, Fearing the Fed: How Wall Street Reads Main Street, Working paper.

Ellsberg, Daniel, 1961, Risk, Ambiguity, and the Savage Axioms, *The Quarterly Journal of Economics* 75, 643–669.

Epstein, Larry, and Stanley E. Zin, 1989, Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework, *Econometrica* 57, 937–969.

Ernst, Rory, Thomas Gilbert, and Christopher M. Hrdlicka, 2019, More Than 100% of the Equity Premium: How Much Is Really Earned on Macroeconomic Announcement Days?, Working paper.

Fama, Eugene F., 1984, Forward and spot exchange rates, *Journal of Monetary Economics* 14, 319–338.

Faust, Jon, Eric Swanson, and Jonathan Wright, 2004, Identifying VARS based on high frequency futures data, *Journal of Monetary Economics* 51, 1107–1131.

Fisher, Adlai, Charles Martineau, and Jinfei Sheng, 2022, Macroeconomic Attention and Announcement Risk Premia, *The Review of Financial Studies* 35, 5057–5093.

Frazzini, Andrea, and Owen A. Lamont, 2007, The Earnings Announcement Premium and Trading Volume, Working paper.

Gabaix, Xavier, 2012, Variable Rare Disasters: An Exactly Solved Framework for Ten Puzzles in Macro-Finance, *The Quarterly Journal of Economics* 127, 645–700.

Gafka, Beata, Pavel G. Savor, and Mungo Ivor Wilson, 2021, Sources of Return Predictability, .

Gallant, A. Ronald, Lars Peter Hansen, and George Tauchen, 1990, Using Conditional Moments of Asset Payoffs to Infer The Volatility of Intertemporal Marginal Rates of Substitution, *Journal of Econometrics* 45, 141–179.

Gertler, Mark, and Nobuhiro Kiyotaki, 2010, Chapter 11 - Financial Intermediation and Credit Policy in Business Cycle Analysis, in Benjamin M. Friedman, and Michael Woodford, eds.: *Handbook of Monetary Economics* (Elsevier,).

Ghaderi, Mohammad, and Sang Byung Seo, 2021, Is There a Macro-Announcement Premium?, Working paper.

Gilboa, Itzhak, and David Schmeidler, 1989, Maxmin expected utility with non-unique prior, *Journal of Mathematical Economics* 18, 141–153.

Gomez-Cram, Roberto, and Marco Grotteria, 2022, Real-time price discovery via verbal communication: Method and application to Fedspeak, *Journal of Financial Economics* 143, 993–1025.

Gomez Cram, Roberto, and Marcel Olbert, 2023, Measuring the Expected Effects of the Global Tax Reform, Working paper.

Gul, Faruk, 1991, A Theory of Disappointment Aversion, *Econometrica* 59, 667–686.

Guo, Haifeng, Chi-Hsiou Daniel Hung, Alexandros Kontonikas, and Yeqin Zeng, 2020, Flight to Lottery Ahead of FOMC Announcements, Working paper.

Guo, Rui, Dun Jia, and Xi Sun, 2022, Information Acquisition, Uncertainty Reduction, and Pre-Announcement Premium in China, *Review of Finance* pp. 1–42.

Gürkaynak, Refet, Hatice Gokçe Karasoy-Can, and Sang Seok Lee, 2022, Stock Market's Assessment of Monetary Policy Transmission: The Cash Flow Effect, *The Journal of Finance* 77, 2375–2421.

Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson, 2005, Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements, *International Journal of Central Banking* 1.

Hansen, Lars Peter, John C. Heaton, and Nan Li, 2008, Consumption Strikes Back? Measuring Long-Run Risk., *Journal of Political Economy* 116, 260–302.

Hansen, Lars Peter, and Thomas J. Sargent, 2005, Robust Estimation and Control under Commitment, *Journal of Economic Theory* 124, 258–301.

Hansen, Lars Peter, and Thomas J. Sargent, 2007, Recursive Robust Estimation and Control without Commitment, *Journal of Economic Theory* 136, 1–27.

Hansen, Lars Peter, and Thomas J. Sargent, 2010, Fragile beliefs and the price of model uncertainty, *Quantitative Economics* 1, 129–162.

Hanson, Samuel G., and Jeremy C. Stein, 2015, Monetary policy and long-term real rates, *Journal of Financial Economics* 115, 429–448.

Hayashi, Takashi, and Jianjun Miao, 2011, Intertemporal Substitution and Recursive Smooth Ambiguity Preferences, *Theoretical Economics* 121, 496–520.

He, Zhiguo, and Arvind Krishnamurthy, 2012, A Model of Capital and Crises, *The Review of Economic Studies* 79, 735–777.

He, Zhiguo, and Arvind Krishnamurthy, 2013, Intermediary Asset Pricing, *American Economic Review* 103, 732–770.

Heaton, John, 1993, The Interaction between Time-Nonseparable Preferences and Time Aggregation, *Econometrica* 61, 353–385.

Heitz, Amanda, Ganapathi S. Narayanamoorthy, and Morad Zekhnini, 2020, The Disappearing Earnings Announcement Premium, Working paper.

Hillenbrand, Sebastian, 2021, The Fed and the Secular Decline in Interest Rates, Working paper.

Hu, Grace Xing, Jun Pan, Jiang Wang, and Haoxiang Zhu, 2022, Premium for Heightened Uncertainty: Explaining Pre-announcement Market Returns, *Journal of Financial Economics* 145, 909–936.

Ilut, Cosmin, 2012, Ambiguity Aversion: Implications for the Uncovered Interest Rate Parity Puzzle, *American Economic Journal: Macroeconomics* 4, 33–65.

Ilut, Cosmin, and Martin Schneider, 2022, Modeling Uncertainty as Ambiguity: A Review, Working paper.

Jacobs, Kris, Sai Ke, and Xuhui (Nick) Pan, 2022, Tail Risk around FOMC Announcements, Working paper.

Jarociński, Marek, and Peter Karadi, 2020, Deconstructing Monetary Policy Surprises—The Role of Information Shocks, *American Economic Journal: Macroeconomics* 12, 1–43.

Johnson, Travis L., and Eric C. So, 2018, Asymmetric Trading Costs Prior to Earnings Announcements: Implications for Price Discovery and Returns, *Journal of Accounting Research* 56, 217–263.

Ju, Nengjiu, and Jianjun Miao, 2012, Ambiguity, Learning, and Asset Returns, *Econometrica* 80, 559–591.

Kaltenbrunner, Georg, and Lars A. Lochstoer, 2010, Long-Run Risk through Consumption Smoothing, *The Review of Financial Studies* 23, 3190–3224.

Karantounias, Anastasios G., 2018, Optimal Fiscal Policy with Recursive Preferences, *Review of Economic Studies* 85, 2283–2317.

Karantounias, Anastasios G., 2020, Model uncertainty and policy design, *Federal Reserve Bank of Atlanta's Policy Hub*.

Klibanoff, Peter, Massimo Marinacci, and Sujoy Mukerji, 2005, A Smooth Model of Decision Making under Ambiguity, *Econometrica* 73, 1849–1892.

Klibanoff, Peter, Massimo Marinacci, and Sujoy Mukerji, 2009, Recursive Smooth Ambiguity Preferences, *Journal of Economic Theory* 144, 930–976.

Kothari, S. P., Susan Shu, and Peter D. Wysocki, 2009, Do Managers Withhold Bad News?, *Journal of Accounting Research* 47, 241–276.

Kreps, David M., and Evan L. Porteus, 1978, Temporal Resolution of Uncertainty and Dynamic Choice Theory, *Econometrica* 46, 185–200.

Kurov, Alexander, Marketa Halova Wolfe, and Thomas Gilbert, 2021, The disappearing pre-FOMC announcement drift, *Finance Research Letters* 40, 101781.

Kuttner, Kenneth N, 2001, Monetary policy surprises and interest rates: Evidence from the Fed funds futures market, *Journal of Monetary Economics* 47, 523–544.

Kwon, Hyosung, and Jianjun Miao, 2019, Woodford's Approach to Robust Policy Analysis in a Linear-Quadratic Framework, *Macroeconomic Dynamics* 23, 1895–1920.

Lemoine, Derek, and Christian Traeger, 2014, Watch Your Step: Optimal Policy in a Tipping Climate, *American Economic Journal: Economic Policy* 6, 137–166.

Li, Kai, and Chenjie Xu, 2022, Asset pricing with a financial sector, *Financial Management*.

Liu, Bibo, Huijun Wang, Jianfeng Yu, and Shen Zhao, 2020, Time-varying demand for lottery: Speculation ahead of earnings announcements, *Journal of Financial Economics* 138, 789–817.

Liu, Hong, Xiaoxiao Tang, and Guofu Zhou, 2022, Recovering the FOMC Risk Premium, Working paper.

Liu, Yang, and Ivan Shaliastovich, 2021, Government Policy Announcement Return, Working paper.

Lucas, Robert, 1978, Asset Prices in an Exchange Economy, *Econometrica* 46, 1429–1446.

Lucca, David O, and Emanuel Moench, 2015, The Pre-FOMC Announcement Drift, *The Journal of finance* 70, 329–371.

Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan, 2011, Common Risk Factors in Currency Markets, *The Review of Financial Studies* 24, 3731–3777.

Lustig, Hanno, Nikolai Roussanov, and Adrien Verdelhan, 2014, Countercyclical currency risk premia, *Journal of Financial Economics* 111, 527–553.

Lustig, Hanno, and Adrien Verdelhan, 2007, The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk, *American Economic Review* 97, 89–117.

Lustig, Hanno, and Adrien Verdelhan, 2011, The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk: Reply, *The American Economic Review* 101, 3477–3500.

Maccheroni, Fabio, Massimo Marinacci, and Aldo Rustichini, 2006a, Ambiguity Aversion, Robustness, and the Variational Representation of Preferences, *Econometrica* 74, 1447–1498.

Maccheroni, Fabio, Massimo Marinacci, and Aldo Rustichini, 2006b, Dynamic variational preferences, *Journal of Economic Theory* 128, 4–44.

Mankiw, N. Gregory, 1986, The Equity Premium and The Concentration of Aggregate Shocks, *Journal of Financial Economics* 17, 211–219.

Miao, Jianjun, and Alejandro Rivera, 2016, Robust Contracts in Continuous Time, *Econometrica* 84, 1405–1440.

Miao, Jianjun, Bin Wei, and Hao Zhou, 2019, Ambiguity Aversion and the Variance Premium, *Quarterly Journal of Finance* 09, 1–36.

Morse, Adair, and Annette Vissing-Jorgensen, 2020, Information Transmission from the Federal Reserve to the Stock Market: Evidence from Governors' Calendars, .

Mueller, Philippe, Alireza Tahbaz-Salehi, and Andrea Vedolin, 2017, Exchange Rates and Monetary Policy Uncertainty, *The Journal of Finance* 72, 1213–1252.

Nakamura, Emi, and Jon Steinsson, 2018a, High-Frequency Identification of Monetary Non-Neutrality: The Information Effect, *The Quarterly Journal of Economics* 133, 1283–1330.

Nakamura, Emi, and Jón Steinsson, 2018b, Identification in Macroeconomics, *Journal of Economic Perspectives* 32, 59–86.

Ozdagli, Ali K., and Mihail Velikov, 2020, Show Me the Money: The Monetary Policy Risk Premium, *Journal of Financial Economics* 135, 320–339.

Patton, Andrew J., and Michela Verardo, 2012, Does Beta Move with News? Firm-Specific Information Flows and Learning about Profitability, *The Review of Financial Studies* 25, 2789–2839.

Pouzo, Demian, and Ignacio Presno, 2016, Sovereign Default Risk and Uncertainty Premia, *American Economic Journal: Macroeconomics* 8, 230–266.

Rietz, Thomas A., 1988, The equity risk premium a solution, *Journal of Monetary Economics* 22, 117–131.

Romer, Christina D., and David H. Romer, 2000, Federal Reserve Information and the Behavior of Interest Rates, *American Economic Review* 90, 429–457.

Savor, Pavel, and Mungo Wilson, 2013, How Much Do Investors Care About Macroeconomic Risk? Evidence from Scheduled Economic Announcement, *Journal of Financial and Quantitative Analysis* 48, 343–375.

Savor, Pavel, and Mungo Wilson, 2014, Asset Pricing: A Tale of Two Days, *Journal of Financial Economics* 113, 171–201.

Savor, Pavel, and Mungo Wilson, 2016, Earnings Announcements and Systematic Risk, *The Journal of Finance* 71, 83–138.

Schmidt, Lawrence, 2022, Climbing and Falling Off the Ladder: Asset Pricing Implications of Labor Market Event Risk, *Unpublished Working Paper*.

Seo, Sang Byung, and Jessica A. Wachter, 2018, Do Rare Events Explain CDX Tranche Spreads?, *The Journal of Finance* 73, 2343–2383.

Seo, Sang Byung, and Jessica A. Wachter, 2019, Option Prices in a Model with Stochastic Disaster Risk, *Management Science* 65, 3449–3469.

So, Eric C., and Sean Wang, 2014, News-driven return reversals: Liquidity provision ahead of earnings announcements, *Journal of Financial Economics* 114, 20–35.

Strzalecki, Tomasz, 2011, Axiomatic Foundations of Multiplier Preferences, *Econometrica* 79, 47–73.

Swanson, Eric T., 2021, Measuring the effects of federal reserve forward guidance and asset purchases on financial markets, *Journal of Monetary Economics* 118, 32–53.

Tsai, Jerry, and Jessica A. Wachter, 2016, Rare Booms and Disasters in a Multisector Endowment Economy, *The Review of Financial Studies* 29, 1113–1169.

Tsai, Jerry, and Jessica A. Wachter, 2018, Pricing long-lived securities in dynamic endowment economies, *Journal of Economic Theory* 177, 848–878.

Wachter, Jessica, 2013, Can Time-Varying Risk of Rare Disasters Explain Aggregate Stock Market Volatility?, *The Journal of Finance* 68, 987–1035.

Wachter, Jessica A, and Yicheng Zhu, 2022, A Model of Two Days: Discrete News and Asset Prices, *The Review of Financial Studies* 35, 2246–2307.

Woodford, Michael, 2010, Robustly Optimal Monetary Policy with Near-Rational Expectations, *American Economic Review* 100, 274–303.

Zhang, Chu, and Shen Zhao, 2022, The Macroeconomic Announcement Premium and Information Uncertainty, Working paper.

7 Appendix (for online publication)

Proof. Proof for Theorem 2

We first provide a more general definition of equilibrium by allowing interbank loans. This extension does not affect the equilibrium allocation but does help pin down the market rate of interbank loans. The financial intermediary's problem in period 0 is

$$V(n_0, s) = \max_{\{\alpha_1, B_1, n_1\}} \left\{ E_0 \left[M^1 n_1 \right] \right\} \tag{11}$$

$$\alpha_1 Q_0 = n_0 + \frac{1}{R_{f,1}} B_1 + \frac{1}{R_{I,1}} B_{I,1},$$

$$n_1 = \alpha_1 D_1 - B_1 - B_{I,1},$$

$$E_s \left[M^1 n_1 \right] \geq \theta \left(\alpha_1 Q_0 - B_{I,1} \right), \tag{12}$$

where $B_{I,1}$ is the amount of interbank loan and $R_{I,1}$ is the interest rate on interbank loans. As in Gertler and Kiyotaki (2010), the limited commitment constraint (12) reflects the fact that the intermediary can default on household loans but not interbank loans. Peer banks have the technology to perfectly enforce loan contracts. Similarly, the intermediary's optimization problem in period -1 is

$$V(n_{-1}) = \max_{\{\alpha_0, B_0, n_0\}} \left\{ E_{-1} \left[M^0 V(n_0, s) \right] \right\} \tag{13}$$

$$\alpha_0 Q_{-1} = n_{-1} + \frac{1}{R_{f,0}} B_0 + \frac{1}{R_{I,0}} B_{I,0},$$

$$n_0 = \alpha_0 Q_0 - B_0,$$

$$E_{-1} \left[M^0 n_0 \right] \geq \theta \left(\alpha_0 Q_0 - B_{I,0} \right). \tag{14}$$

Because all intermediaries are identical, in equilibrium $B_{I,t} = 0$ for all t.

To solve for the equilibrium prices and allocations in period 0, we focus on the optimality condition for (9). The first order condition with respect to α_1 implies

$$E_s \left[M^1 \left\{ \frac{D_1}{Q_0} - R_{f,1} \right\} \right] (1 + \lambda(s)) = \theta \lambda(s). \tag{15}$$

Because M^1 is the marginal rate of substitution of households and because the announcement fully reveals uncertainty, $M^1 R_{f,1} = 1$. This condition implies that i) if $\lambda(s) = 0$, then $Q_0 = \frac{1}{R_{f,1}} D_1$, and constraint (12) is not binding: $n_0 \geq \theta Q_0$; and ii) if $\lambda(s) = 0$, then Q_0 is determined by the binding limited commitment constraint (12), that is,

$$\left(1 + \theta - E \left[M^1 \frac{D_1}{Q_0} \right] \right) Q_0 = n_0, \tag{16}$$

which imples $Q_0 = \frac{1}{1+\theta} \left[n_0 + \frac{1}{R_{f,1}} D_1 \right]$.

The first order condition (15) implies that $\lambda(s) = \frac{E\left[M^1 \frac{D_1}{Q_0}\right] - 1}{1+\theta - E\left[M^1 \frac{D_1}{Q_0}\right]}$, or

$$1 + \lambda(s) = \frac{\theta}{1 + \theta - E\left[M^1 \frac{D_1}{Q_0}\right]}. \tag{17}$$

Combining this equation with (16), it follows that in equilibrium,

$$1 + \lambda(s) = \frac{\theta}{1 + \theta - E\left[M^1 \frac{D_1}{Q_0}\right]} = \frac{\theta Q_0}{n_0} = \frac{\theta\left(n_0 + \frac{1}{R_{f,1}} D_1\right)}{(1+\theta) n_0}$$

whenever the constraint is binding.

Consider the intermediary's maximization problem in period -1. Using the linearity of $V(n_0, s)$, the optimality conditions imply

$$E_0\left[M^0 \{1 + \lambda(s)\} \frac{Q_0}{Q_{-1}}\right] = E_0\left[M^0 \{1 + \lambda(s)\} R_{I,0}\right]. \tag{18}$$

Because $M^0 = \frac{u'(C_0)}{u'(C_0)}$ is a constant, equation 18 can be simplified to $E_0\left[\{1 + \lambda(s)\} \frac{Q_0}{Q_{-1}}\right] = E_0\left[\{1 + \lambda(s)\}\right] R_{I,0}$. Clearly, the sign of the announcement premium depends on the covariance of $1 + \lambda(s)$ and $Q_0(s)$. Note that in equilibrium, $n_0 = Q_0 - B_0$. Combining this equation with (16), we have, whenever the limited commitment constraint (12) is binding,

$$Q_0 = \frac{1}{\theta}\left[\bar{P}(s) - B_0\right], \tag{19}$$

and

$$n_0 = \frac{1}{\theta}\left[\bar{P}(s) - (1+\theta) B_0\right].$$

Clearly, because $\bar{P}(s)$ is strictly increasing in s, $\bar{P}(1) > (1+\theta) B_0$ insures that n_0 is always positive for all realizations of s. In addition, equation (17) implies that $\lambda(s) > 0$ if and only if $\frac{\bar{P}(s)}{Q_0} > 1$, which, using (19), is equivalent to $\frac{1}{1-\theta} B_0 > \bar{P}_0(s)$. Finally, note that $\frac{1}{1-\theta} > 1 + \theta$ because $\theta \in (0, 1)$. As a result, $\left((1+\theta) B_0, \frac{1}{1-\theta} B_0\right)$ is a non-empty set. This completes the proof for Theorem 2. □