The Causal Impact of Macroeconomic Uncertainty on Expected Returns

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Motivation

Does macroeconomic uncertainty **cause** time-variation in expected returns?

- Financial press often highlights macro uncertainty increases as causing negative stock returns.
- Theoretical evidence is mixed:
  - Long run risk models (Bansal & Yaron (2004)) imply expected returns increase in macro uncertainty.
  - Other models include opposing roles for "good" and "bad" uncertainty:
    - Pastor & Veronesi (2009), Segal, Shaliastovich & Yaron (2015), Bekaert, Engstrom & Xu (2020)
- Empirical evidence is mixed:
  - Kelly, Pastor & Veronesi (2016): Investors pay to hedge political uncertainty.
  - Dew-Becker, Giglio & Kelly (2016): Investors must be paid to hedge macroeconomic uncertainty.

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Fundamental issue: Identification is a Nightmare

Exogenous variation in uncertainty is rare

$$\Delta\mu_t = \lambda_{\sigma^2}\Delta\sigma_t^2 + \epsilon_t$$
$$Corr(\Delta\sigma_t^2, \epsilon_t) \neq 0$$

- Many macro variables correlate with uncertainty
  - Macro expectations, risk aversion, etc.

Rare exogenous variation $\rightarrow$ Identifying causal effects of uncertainty is difficult

This Paper: Clean Identification at High Frequency

Measure daily changes in macro uncertainty, expected returns

- Macro uncertainty: Options implied volatilities
- Expected returns: Function of realized returns

Use exogenous timing of macro announcements as instrument for uncertainty

- Announcements are prescheduled – conditional expectations cannot predictably move
- Higher moments can predictably move

The causal effect of macro uncertainty on expected returns

- One std. dev. rise in level of uncertainty raises long-run expected returns by 173 basis points.
- Macro uncertainty explains 10% (at most 32%) of variation in expected returns.

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What is Macro Uncertainty?

Start with usual risk premium expression

$$E_t[R_{t+1}] - R_t^f = -Cov_t(M_{t+1}, R_{t+1})$$
$$= -Cov_t(M_{t+1}, \text{ Discount Rate Shock}) - \underbrace{Cov_t(M_{t+1}, \text{ Dividend Growth Shock})}_{\text{Macro Uncertainty}}$$

- M_{t+1} is the SDF
- Second equality follows from Campbell (1991) return decomposition

Special case: Bansal & Yaron (2004)

- Physical conditional variance of common shock to consumption and dividend growth

In general: Conditional variance of common component of many macro series

- SDF & dividend growth may be functions of many macro variables
  - Macro uncertainty is variance of common component to all such variables
- Subjective variance may reflect physical macro volatility of posterior variance

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Identification Strategy: Setting

- Expected returns linear in two factors — macro uncertainty σ_t^2 and x_t (e.g. risk aversion)
- Representative agent learns about the latent state of the economy.
  - Prices assets based on conditional distributions over economic state variables.
  - One state variable: Next quarter's consumption growth ($Q(t)$ is quarter day t is in).

$$\Delta\mu_t = \lambda_{\sigma^2}\Delta\sigma_t^2 + \lambda_x \Delta x_t$$
$$\Delta\sigma_t^2 = \alpha_1 \Delta V_t[\Delta C_{Q(t)+1}] + \alpha_2 \Delta E_t[\Delta C_{Q(t)+1}] + \epsilon_{v,t+1}$$
$$\Delta x_t = \delta_1 \Delta V_t[\Delta C_{Q(t)+1}] + \delta_2 \Delta E_t[\Delta C_{Q(t)+1}] + \epsilon_{x,t+1},\ E_t[\epsilon_{v,t+1} \cdot \epsilon_{x,t+1}] = 0.$$

- Econometrician observes only:
  - Expected returns (μ_t) and macro uncertainty (σ_t^2)
  - **Not** other driver: x_t
- **Two identification problems:**
  1. Isolating effect of conditional variance through all channels from effect of conditional mean.
  2. Isolating effect of σ_t^2 from x_t.

Generalization

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Generalization

Identifying Assumptions to Solve Problem 1

1. **Timing of pre-scheduled announcements is uncorrelated with all other relevant shocks:**

$$E[\epsilon_{\cdot,t+1} \cdot 1(t = \text{announcement})] = 0,$$

   - BLS, BEA, Fed schedule announcements a year or more in advance on fixed schedule
   - Prior knowledge BEA will release the 2020 Q1 GDP estimate on April 29, 2020 is uncorrelated with other contemporaneous economic shocks (e.g. coronavirus news).

2. **Announcement timing does not systematically affect conditional expectations.** That is, $\boldsymbol{\theta_{2,1}=0}$

$$\Delta E_t[\Delta C_{Q(t)+1}] = \theta_{2,0} + \boldsymbol{\theta_{2,1}} 1(t = \text{announcement}) + \nu_{2,t}$$

   - Failure of this assumption violates **martingale property of conditional expectations**. Let $t^{'}$ be an announcement day. Then on any previous day $t^{'} - j$:

$$E_{t^{'}-j}\left[\Delta E_{t^{'}}[\Delta C_{Q(t^{'})+1}]\right] \neq 0.$$

3. **Macro uncertainty loads on announcement timing.** That is, $\boldsymbol{\beta_{\sigma^2,1} = \alpha_1 \theta_{1,1} \neq 0}$:

$$\Delta \sigma_t^2 = \beta_{\sigma^2,0} + \boldsymbol{\beta_{\sigma^2,1}} 1(t \text{ is announcement}) + \epsilon_t \textbf{ (Relevance Condition)}$$

   - Higher moments ($\Delta V_t[\Delta C_{Q(t)+1}]$) can load on announcement timing. That is, $\boldsymbol{\theta_{1,1} \neq 0}$

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Announcement Resolution of Uncertainty Effect

- **Under Assumptions 1—3 can identify** (via reduced form regression):

$$\Delta\mu_t = \lambda_0 + \lambda_{ARU} 1(t \text{ is announcement}) + \epsilon_t$$

$$\text{"Announcement Resolution of Uncertainty Effect"} = \lambda_{ARU} = \lambda_{\sigma^2}\alpha_1\theta_{1,1} + \lambda_x\delta_1\theta_{1,1}$$

  - Causal effect of announcement-induced change in uncertainty about consumption growth on expected returns
  - Accounts for all channels through which changes in uncertainty affect expected returns
  - Not contaminated by effect of contemporaneous shifts in first moments.

Identifying Assumptions to Solve Problem 2

4. **Announcement timing does not systematically affect any driver of expected returns except macro uncertainty.** That is $\boldsymbol{\beta_{x,1} = 0}$

$$\Delta x_t = \beta_{x,0} + \boldsymbol{\beta_{x,1}} 1(t \text{ is announcement}) + \epsilon_t,$$

- $\boldsymbol{\beta_{x,1} = 0}$ implies Δx_t does not load on $\Delta V_t[\Delta C_{Q(t)+1}]$: $\delta_1 = 0$

Under additional assumption we can identify (via 2SLS)

$$\Delta \sigma_t^2 = \beta_{\sigma^2,0} + \beta_{\sigma^2,1} 1(t \text{ is announcement}) + \epsilon_t$$

$$\Delta \mu_{rt} = \lambda_0 + \lambda_{\sigma^2} \widehat{\Delta \sigma_t^2} + \nu_t$$

$$\text{“Effect of Macroeconomic Uncertainty”} = \frac{\lambda_{ARU}}{\beta_{\sigma^2,1}} = \frac{\lambda_{\sigma^2}\alpha_1\theta_{1,1} + \cancel{\lambda_x\delta_1\theta_{1,1}}}{\alpha_1\theta_{1,1}} = \lambda_{\sigma^2}$$

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Empirical Strategy

Estimate λ_{ARU} under Assumptions 1—3

- Take Assumptions 1 and 2 as given since they prove innocuous
- Empirically verify Assumption 3

Provide suggestive evidence of Assumption 4 and estimate λ_{σ^2}

- Verify other potential expected return drivers from theory don't move on announcements.
  - **Time-varying risk aversion:** Risk aversion index from Bekaert, Engstrom & Xu (2020) structural estimation of external habit model
  - **Disaster risk:** Options-implied crash probabilities from Bollerslev & Todorov (2011) (risk-neutral) and Martin (2017) (log-utility)
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High-Frequency Measurement

Daily measure of macro uncertainty

- Project monthly uncertainty index from Jurado, Ludvigson & Ng (2015) (JLN) onto daily implied volatilities of set of options (Dew-Becker, Giglio & Kelly (2019))
  - JLN index measures the common component of unforecastable variation in 132 macro series.
  - 7 underlyings: S&P 500, Crude Oil, Gold, Wheat, 10-Year Treasury Note, Corn, Soybean

High-Frequency Measurement

λ_{ARU}: announce. vs. non-announce. avg. diff. in changes in expected returns

- Use long-run expected returns (μ_{rt}):

$$p_t - d_t = \frac{k}{1-\rho} + \underbrace{\sum_{j\geq 0} \rho^j E_t \left[\Delta d_{t+1+j}\right]}_{\equiv \mu_{dt}} - \underbrace{\sum_{j\geq 0} \rho^j E_t \left[r_{t+1+j}\right]}_{\equiv \mu_{rt}}$$

- Change in long-run expected returns:

$$\Delta \mu_{r,t} = -E_{t-1}\left[r_t\right] + \mu_{rt} - \rho E_{t-1}\left[\mu_{rt}\right]$$

- By law of iterated expectations:

$$\begin{aligned}\mathbb{E}\left[\Delta \mu_{rt} \mid 1(t=\text{A})\right] &= -\mathbb{E}\left[r_t \mid 1(t=\text{A})\right] + (1-\rho)\mathbb{E}\left[\mu_{rt} \mid 1(t=\text{A})\right] \\ \leftrightarrow \lambda_{ARU} &= -\left(\mathbb{E}\left[r_t \mid t=\text{A}\right] - \mathbb{E}\left[r_t \mid t\neq\text{A}\right]\right) \\ &\quad + (1-\rho)\left(\mathbb{E}\left[\mu_{rt} \mid t=\text{A}\right] - \mathbb{E}\left[\mu_{rt} \mid t\neq\text{A}\right]\right)\end{aligned}$$

- Second term appears ≈ 0 since empirically Regression

$$(1-\rho)\left(\mathbb{E}\left[p_t - d_t \mid t=\text{A}\right] - \mathbb{E}\left[p_t - d_t \mid t\neq\text{A}\right]\right) \approx 0$$

- Hence: $\lambda_{ARU} \approx -\left(\mathbb{E}\left[r_t \mid t=\text{A}\right] - \mathbb{E}\left[r_t \mid t\neq\text{A}\right]\right)$

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Data

Macro Announcements	Macro Uncertainty	Asset Prices
○ BEA: - GDP ○ BLS: - CPI - PPI - Employment Cost Index - Unemployment ○ Fed: - FOMC	○ Monthly JLN index ○ Option implied volatilities from CME: - S&P 500 - Crude Oil - Gold - Wheat - 10-Year Treasury Note - Corn - Soybean	○ **CRSP market value-weighted portfolio** ○ Government bonds: CRSP Fixed Term Indexes ○ Corporate bonds: AAA and BAA yields (FRED) ○ Variance risk premium: NYSE TAQ data ○ TIPS: FRED ○ Exchange rates: Dollar exchange rates versus currency baskets (FRED)

Time Series: 1986 - 2016

Main Results: Macro Uncertainty Drives Expected Returns

$$\Delta\sigma_t^2 = \beta_0 + \beta_1 1(t = \text{ announcement}) + \epsilon_t$$

$$-r_t = \lambda_0 + \lambda_1 \widehat{\Delta\sigma_t^2} + \nu_t.$$

	OLS	First Stage	Reduced Form	2SLS
$\Delta\sigma_t^2$	0.2986***			0.3619***
	(0.0326)			(0.1380)
Announcement		-0.2158***	-0.0781**	
		(0.0269)	(0.0304)	
const	-0.0368***	0.0473***	-0.0196	-0.0367***
	(0.0125)	(0.0131)	(0.0148)	(0.0125)
N	7561	7561	7561	7561
R^2	0.07	0.01	0.00	-

Economic magnitudes

- Macro uncertainty increases by 1 $Std[\Delta\sigma_t^2] \rightarrow$ Expected returns increase by 36 bp
- Macro uncertainty increases by 1 $Std[\sigma_t^2] \rightarrow$ Expected returns increase by 173 bp
- **More aggressive:** Given Assumption 4 suggestive evidence, macro uncertainty explains 10% expected return variation.
- **Less aggressive:** Maybe still have OVB, macro uncertainty explains at most 32% expected return variation. First Stage ARU Robustness Other Asset Classes

Conclusion

Macro uncertainty causes significant expected return movement

1. Macro uncertainty significantly falls on macro announcements.
2. ARU effect estimates illustrate that resolution of uncertainty causes significant decreases in expected returns.
3. Macro uncertainty causes 10% (or up to 32%) of variation in expected returns.

Implications

1. Asset pricing: Models of time-varying expected returns should account for macro uncertainty.
2. Macro: Uncertainty shocks can cause reductions in investment via increases in discount rates.

Literature

- Identification in asset pricing and macrofinance
  - Shleifer (1986); Harris & Gurel (1986); Du, Tepper & Verdelhan (2018); Nakamura & Steinsson (2018); Hartzmark & Sussman (2019); Koijen & Yogo (2019); Cieslak & Pang (2020); Gabaix & Koijen (2020)
- Effects of macro uncertainty
  - In macro:
    - Bloom (2009); Alexopoulos & Cohen (2009); Baker, Bloom & Terry (2020); Leduc & Liu (2016); Caldara, Fuentes-Albero, Gilchrist & Zakrajesk (2016); Baker, Bloom & Davis (2016); Barrero, Bloom & Wright (2017)
  - In asset pricing:
    - Cross-sectional/unconditional: Bought & Kuehn (2013); Bali, Brown & Caglayan (2014); Bali & Zhou (2016); Kelly, Pastor & Veronesi (2016); Bali, Brown & Tang (2017); Della Corte & Krecetovs (2019); Xyngis (2017); Dew-Becker, Giglios & Kelly (2019); Heigermoser (2020)
    - Time series: Bekaert, Hoerova & Lo Duca (2013); Segal, Shaliastovich & Yaron (2014); Brogaard & Detzel (2015); Bekaert, Engstrom & Wing (2008); Law, Song & Yaron (2019); Bekaert, Engstrom & Xu (2020)
  - This paper: Achieve tight identification by moving to higher frequency.
- Drivers of time-varying expected returns
  - Campbell and Cochrane (1999); Bansal and Yaron (2004); Barro (2006); Wachter (2013); Bansal et al. (2014); Campbell et al. (2016); He & Krishnamurthy (2013)
  - This paper: Quantify effect of macro uncertainty.
- Asset pricing dynamics around macro announcements
  - Patterns in volatility:
    - Ederington & Lee (1996); Li & Engle (1998); Fornnari & Mele (2001); Beber & Brandt (2006, 2008); Vahamaa & Aijo (2010); Jian, Konstantinidi & Skiadopoulos (2012); Amengual & Xiu (2017)
  - Patterns in returns:
    - Jones, Lamont & Lumsdaine (1998); Savor & Wilson (2013, 2014); Lucca & Moench (2015), Mueller, Tahbaz-Salehi & Vedolin (2017); Balduzzi & Moneta (2017); Ai & Bansal (2018); Brooks, Katz & Lustig (2018); Law, Song & Yaron (2018); Laarits (2019); Hu, Pan, Wang & Zhu (2020)
  - This paper: Demonstrate resolution of uncertainty on announcements causes decreases in expected returns.

Appendix

Appendix: Generalization of Identification Model

- Can generalize this setup to include:
  - Multiple state variables
  - Higher moments
  - Multiple expected return drivers
- **Can still identify:**
  - Under Assumptions 1 and 2, the ARU effect.
  - Under Assumptions 1-3, the effect of macroeconmic uncertainty.
- Can use same model for expected cash flow growth and realized returns.

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Appendix: Generalization of Identification Model

- Can relax the assumption that current quarter GDP growth is only relevant macro variable:

$$\Delta\sigma_t^2 = \boldsymbol{\alpha}_1' \Delta \boldsymbol{H}_t + \boldsymbol{\alpha}_2' \Delta \boldsymbol{E}_t + \rho_v \epsilon_{f,t} + \sigma_v \epsilon_{v,t}$$
$$\Delta\check{\mu}_t = \delta_1' \Delta \boldsymbol{H}_t + \delta_2' \Delta \boldsymbol{E}_t + \rho_x \epsilon_{f,t} + \sigma_r \epsilon_{r,t},$$

  where $V_{i,t}$ and $E_{i,t}$ are the conditional variance and mean of variable i.

- **Under Assumptions 1 and 2, we can still identify the ARU effect:**

$$\lambda_{ARU} = \lambda_{\sigma^2} \boldsymbol{\alpha}_1' \boldsymbol{\theta}_{1,1} + \delta_1' \boldsymbol{\theta}_{1,1}$$

- **Under Assumptions 1-3, we can still identify the effect of macroeconmic uncertainty:**

$$\lambda_{\sigma^2}.$$

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Appendix: Only Macro Uncertainty Moves on Announcements

No other variable significantly loads on announcement indicator.

- Regression:

$$\Delta y_t = \gamma + \alpha 1(t = \text{ announcement }) + \nu_t$$

$$y_t \in \left\{ (\textit{Intermediary Leverage Ratio})^2, \textit{Crash Probability}_t, \textit{RA}_t, \textit{Daily JLN} \right\}$$

  - All LHS variables scaled to mean zero and standard deviation one

Source	Expected Return Driver	α	F-Stat
HKM (2017)	Squared Intermediary Leverage	-0.0022	0.01
BT (2017)	Left Tail Vol	0.0554	3.40
	Down 10% Prob	0.0015	0.0022
Martin (2017)	1M Crash Prob	-0.0104	0.10
	2M Crash Prob	-0.0244	0.45
	3M Crash Prob	-0.0387	1.20
	6M Crash Prob	-0.0360	0.86
	12M Crash Prob	-0.0422	1.45
BEX (2020)	Risk Aversion	0.0012	0.0024
This Paper	Daily JLN	-0.2158	64.26

- **Negative results provide suggestive evidence in support of Assumption 3**

Appendix: Original JLN Index Construction

1. Specify dynamics of high-dimensional macroeconmic time series as following a factor-augmented VAR
   1.1 Conditioning variables specified by econometrician
   1.2 Latent factors following VAR(1)
2. Both shocks to the state vector and to predictors have time-varying variance
   2.1 Log conditional vaiances follow AR(1) processes.
   2.2 **Shocks to log conditional variance are independent of shocks to state vector or predictors**
      2.2.1 Distinct from e.g. VAR model with error term modeled as GARCH process
3. Four components of h-period ahead uncertainty:
   3.1 Autoregressive component of variance
   3.2 Predictor uncertainty term (from both latent factors and explicit predictors)
   3.3 Term due to stochastic volatility in state vector
   3.4 Covariance term
4. Macroeconomic uncertainty = average uncertainty across all series

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Appendix: Measuring Daily Macro Uncertainty

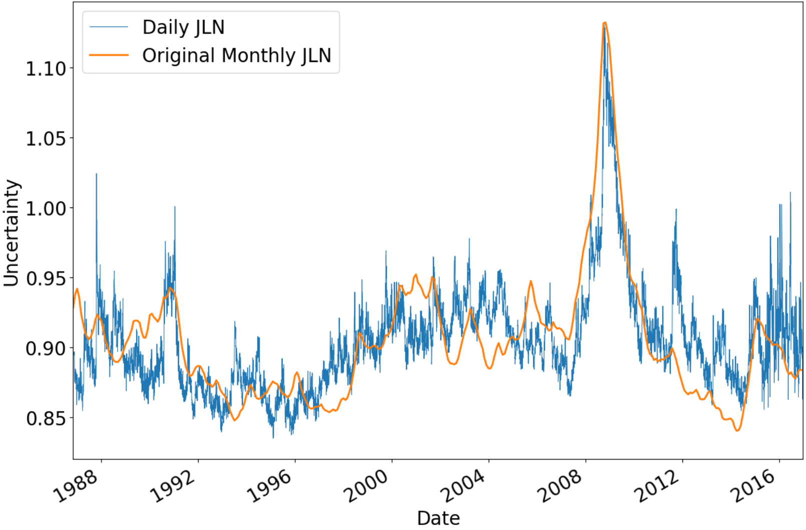
- JLN index measures the common component of unforecastable variation in 132 macroeconomic series.
  - Analogous to time-varying volatility of common shock to consumption and dividend growth in Bansal & Yaron (2004).
- Daily implied volatilities for options on 7 underlyings from CME
  - S&P 500, Crude Oil, Gold, Wheat, 10-Year Treasury Note, Corn, Soybean
- Regress monthly JLN index onto average monthly implied volatility of each option:

$$JLN_t = \alpha + \sum_{i=1}^{N} \beta_i \overline{IV}_{it} + \epsilon_t.$$

- Apply estimated coefficients to daily implied volatilities to obtain daily measure

Original JLN Index Construction

Appendix: Daily Series of Macroeconomic Uncertainty



Regression Results

Appendix: Price-Dividend Level Regressions

	$p_t - d_t$ (Quarterly Smooth 240)	$p_t - d_t$ (Daily Smooth 240)	$p_t - d_t$ (Daily Smooth 120)	$p_t - d_t$ (Daily Smooth 60)
const	7.726e-05***	7.823e-05***	9.185e-05***	1.056e-04***
	(8.051e-08)	(8.033e-08)	(8.072e-08)	(8.195e-08)
Announcement	2.360e-08	3.099e-08	2.945e-09	1.699e-08
	(1.718e-07)	(1.708e-07)	(1.716e-07)	(1.738e-07)
N	7561	7561	7561	7561
R^2	0.00	0.00	0.00	0.00
Date Range	1986 - 2016	1986 - 2016	1986 - 2016	1986 - 2016

Regression of the end-of-day daily price-dividend ratio multiplied by $(1-\rho)$ (daily $\rho = 0.99998$ from Pettenuzzo, Sabbatucci & Timmermann (2019) and alternative smoothing horizons (in days) to calculate the level of dividends) on announcement timing:

$$(1-\rho)(p_t - d_t) = b_0 + b_1 1(t = \text{announcement}) + \epsilon_t.$$

The time period is 1986-11-20:2016-12-22.

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Appendix: Stylized Example of Announcement Day Risk Premium

- Assume day t is the only announcement with ex-ante known risk premium of p:

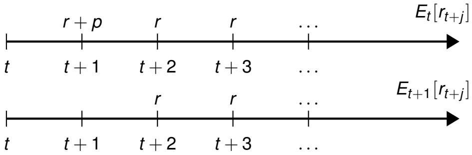
$$E_t\left[r_{t+1}\right] = r + p.$$

- All other days have constant conditional expected returns at times t and $t+1$:

$$E_t\left[r_{t+1+j}\right] = E_{t+1}\left[r_{t+1+j}\right] = r, j \geq 1$$

$$\begin{aligned}
\Delta\mu_{rt+1} &= \sum_{j\geq 0} \rho^j E_{t+1}\left[r_{t+2+j}\right] - \sum_{j\geq 0} \rho^j E_t\left[r_{t+1+j}\right] \\
&= \sum_{j\geq 0} \rho^j r - \sum_{j\geq 1} \rho^j r - (r+p) \\
&= -p
\end{aligned}$$

- **So $\Delta\mu_{rt+1}$ captures decrease in long-run expected returns from day t to $t+1$.**



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Appendix: Summary Statistics

	r_t	$\Delta\sigma_t^2$	$1(t = \text{announcement})$
Count	7561	7561	7561
Mean	0.0369	-2.9953e-06	.22100
Std	1.1230	7.8697e-03	.41495
Min	-18.7956	-8.0745e-02	0
Median	0.0813	-1.1239e-04	0
Max	10.8749	9.8578e-02	1

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Appendix: Monthly JLN Regresssion Results

- Regression:

$$JLN_t = \alpha + \sum_{i=1}^{N} \beta_i \overline{IV}_{it} + \epsilon_t$$

	Monthly JLN
const	0.7654***
	(0.0074)
S&P 500	0.1126***
	(0.0319)
Crude Oil	0.1057***
	(0.0177)
Gold	0.2512***
	(0.0361)
Wheat	-0.0249
	(0.0403)
10-year Note	0.2829**
	(0.1240)
Corn	-0.0919*
	(0.0520)
Soybean	0.2235***
	(0.0400)
N	362
R2	0.62

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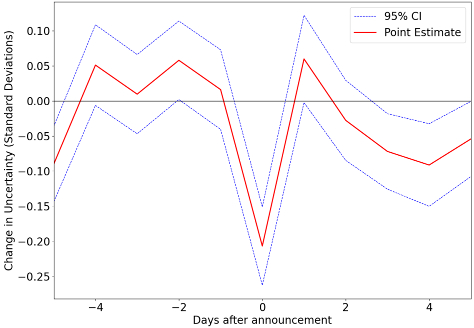
Appendix: Macro Uncertainty Falls on Announcements

Macro uncertainty decreases 0.21 standard deviations on announcements

- First-Stage Regression:

$$\Delta\sigma_t^2 = \gamma + \sum_{j=-5}^{5} \alpha_j 1(t - j = \text{ announcement }) + \epsilon_t.$$

  - Standardize $\Delta\sigma_t^2$ to have mean 0 and standard deviation 1
  - -0.21 standard deviation decrease in macro uncertainty on announcement days



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Appendix: ARU Causes Expected Returns to Fall

$$y_t = \lambda_0 + \lambda_{ARU} 1(t \text{ is announcement}) + \epsilon_t$$
$$y_t = r_{t,} \Delta\mu_{dt}, \text{ or } \Delta\mu_{rt}$$

	$-r_t$
Announcement	-0.0781**
	(0.0304)
const	-0.0196
	(0.0148)
N	7561
R^2	0.00

- **ARU causes $\lambda_{ARU} = 7.8$ basis points decline in expected returns.**

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Appendix: First-Stage Results

- Regression:

$$\Delta \text{ Daily } JLN_t = \gamma + \sum_{j=-5}^{5} \alpha_j 1(t-j = \text{ announcement }) + \epsilon_t$$

	$\Delta\sigma_t^2$
const	0.0774**
	(0.0333)
-5	-0.0903***
	(0.0275)
-4	0.0510*
	(0.0293)
-3	0.0095
	(0.0288)
-2	0.0578**
	(0.0286)
-1	0.0160
	(0.0289)
0	-0.2071***
	(0.0285)
1	0.0597*
	(0.0318)
2	-0.0279
	(0.0291)
3	-0.0722***
	(0.0275)
4	-0.0916***
	(0.0300)
5	-0.0544**
	(0.0273)
N	7608
R^2	0.01

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Appendix: Resolution of Uncertainty by Horizon

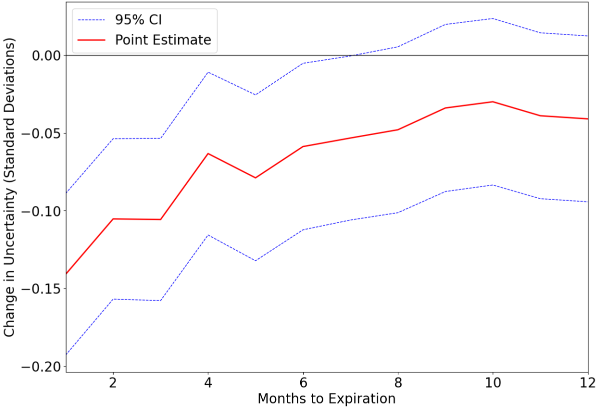

Figure: Coefficients and 95% confidence intervals for $\beta_{h,1}$ from the regression:

$$\Delta Daily\ JLN_{h,t} = \beta_{h,0} + \beta_{h,1} 1(t = \text{ announcement}) + \epsilon_t.$$

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Appendix: Correlations Among Expected Return Drivers

	ILR^2	LTV	-10% Prob	1MO CP	2MO CP	3MO CP	6MO CP	12MO CP	RA	σ_t^2
ILR^2	1.000	0.115	0.083	0.053	0.032	0.059	0.070	0.025	0.341	0.152
LTV	0.115	1.000	0.148	0.055	0.085	0.104	0.065	0.028	0.183	0.117
-10% Prob	0.083	0.148	1.000	0.024	0.042	0.045	0.016	0.005	0.038	0.068
1MO CP	0.053	0.055	0.024	1.000	0.321	0.054	0.186	0.044	-0.120	0.059
2MO CP	0.032	0.085	0.042	0.321	1.000	0.531	0.204	0.109	0.110	0.042
3MO CP	0.059	0.104	0.045	0.054	0.531	1.000	0.259	0.135	0.108	0.051
6MO CP	0.070	0.065	0.016	0.186	0.204	0.259	1.000	0.146	0.067	0.090
12MO CP	0.025	0.028	0.005	0.044	0.109	0.135	0.146	1.000	0.038	0.006
RA	0.341	0.183	0.038	-0.120	0.110	0.108	0.067	0.038	1.000	0.131
σ_t^2	0.152	0.117	0.068	0.059	0.042	0.051	0.090	0.006	0.131	1.000

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Robustness Checks

Alternative expected return measures
Alternative Expected Return Measures 2SLS Results

- Options-implied lower bounds from Martin (2017) and Gao & Martin (2019)

Expected cash flow meausures
Expected Cash Flow Growth Measures 2SLS Results

- Subjective expected log divided growth lower bound from Gao & Martin (2019) Derivation
- Options-implied dividend strip prices as in van Binsbergen, Brandt & Koijen (2012) Derivation

Alternative macroeconomic uncertainty measures
Alternative Macro Uncertainty Measures 2SLS Results

- Alternative JLN index horizons (1 and 3 months)
- Rolling out-of-sample daily index construction
- S&P 500 implied volatility

Heterogeneity across announcements
2SLS Results

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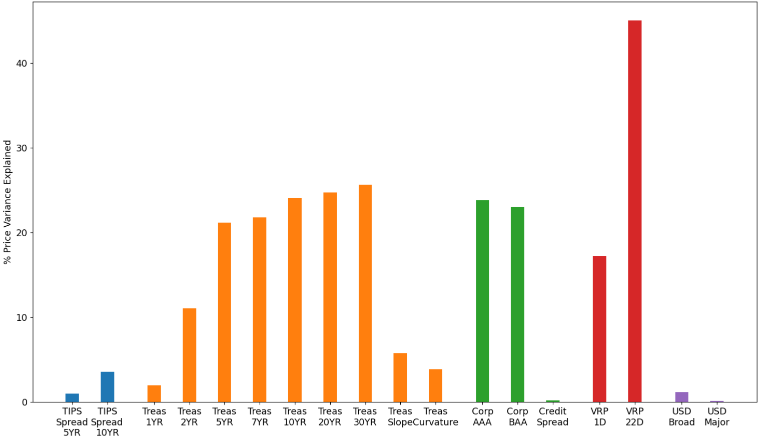
Uncertainty Explains Significant Price Variation in Other Asset Classes

$$\Delta \mathit{Daily\ JLN}_t = \beta_0 + \beta_1 1(t = \text{ announcement}) + \epsilon_t$$

$$\Delta P_t = \lambda_0 + \lambda_1 \widehat{\Delta \mathit{Daily\ JLN}_t} + \nu_t$$



Back Full Results

Appendix: 2SLS Results - Other Assets

- 2SLS Regression:

$$\Delta \textit{Daily JLN}_t = \beta_0 + \beta_1 1(t = \text{ announcement}) + \epsilon_t$$

$$\Delta P_t = \lambda_0 + \lambda_1 \widehat{\Delta \textit{Daily JLN}_t} + \epsilon_t,$$

	ARU	1 STD Effect	1 Level STD Effect	% Variance Explained	Upper Bound % Variance Explained
TIPS Spread (5YR)	-0.0012 (0.0021)	0.0055 (0.0099)	0.1343	0.96	19.78
TIPS Spread (10YR)	-0.0014 (0.0015)	0.0067 (0.0075)	0.1653	3.56	36.04
1YR Treas	-0.0016 (0.0017)	0.0078 (0.0082)	0.0626	1.92	17.96
2YR Treas	-0.0042** (0.0019)	0.0198** (0.0091)	0.1594	11.01	39.77
5YR Treas	-0.0061*** (0.002)	0.0288*** (0.01)	0.2323	21.14	59.72
7YR Treas	-0.0063*** (0.002)	0.0299*** (0.0101)	0.2411	21.75	60.22
10YR Treas	-0.0063*** (0.0019)	0.03*** (0.0097)	0.2416	24.03	64.26
20YR Treas	-0.0059*** (0.0017)	0.0279*** (0.0088)	0.2246	24.74	64.82
30YR Treas	-0.0059*** (0.0017)	0.0279*** (0.0087)	0.2244	25.61	66.3
Treas Slope	-0.0022* (0.0012)	0.0102* (0.0059)	0.0822	5.77	26.36
Treas Curvature	-0.0008 (0.0006)	0.0039 (0.0028)	0.0318	3.85	21.9
AAA Corp Bond	-0.0046*** (0.0015)	0.0238*** (0.0083)	0.9251	23.77	67.29
BAA Corp Bond	-0.0044*** (0.0014)	0.023*** (0.0081)	0.8941	22.97	65.71
Credit Spread	0.0002 (0.0007)	-0.0008 (0.0034)	-0.031	0.14	7.75
VRP (1)	-5.2685*** (1.9759)	25.7762** (10.861)	190.732	17.24	57.49
VRP (22)	-1.3785*** (0.311)	6.7954*** (1.7145)	50.1419	45.01	100.53
USD (Broad)	-0.0001 (0.0001)	0.0003 (0.0005)	0.0015	1.12	16.8
USD (Major Currencies)	-0.0 (0.0001)	0.0002 (0.0006)	0.0007	0.12	8.43

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Appendix: 2SLS Results for Alternate Expected Return Series

$$\Delta Daily\ JLN_t = \beta_0 + \beta_1 1(t = \text{ announcement}) + \epsilon_t$$

$$\Delta ER_t = \lambda_0 + \lambda_1 \widehat{\Delta Daily\ JLN_t} + \nu_t$$

	ARU	1 STD Effect	1 Level STD Effect	% Variance Explained	Upper Bound % Variance Explained
EP Lower Bound - 1	-0.0188*** (0.0045)	0.0884*** (0.0228)	0.4083	42.36	95.87
EP Lower Bound - 2	-0.0162** (0.0071)	0.0764** (0.0332)	0.3528	12.42	42.57
EP Lower Bound - 3	-0.0138* (0.0082)	0.065* (0.038)	0.3	6.91	31.81
EP Lower Bound - 6	-0.0192** (0.0087)	0.0906** (0.0402)	0.4184	10.56	36.96
EP Lower Bound - 12	-0.0504*** (0.0139)	0.2374*** (0.0681)	1.096	29.71	72.49
LVIX - 1	-0.0327*** (0.0052)	0.154*** (0.0314)	0.7111	80.15	156.95
LVIX - 2	-0.0086** (0.0038)	0.0405** (0.018)	0.1871	11.39	39.8
LVIX - 3	-0.0084** (0.0043)	0.0396** (0.0198)	0.183	9.19	35.95
LVIX - 6	-0.0091* (0.0047)	0.0429** (0.0216)	0.1982	8.48	33.39
LVIX - 12	-0.0245*** (0.0071)	0.1152*** (0.0345)	0.5319	27.02	67.98

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Appendix: 2SLS Results for Expected Cash Flow Growth Series

- Regression:

$$\Delta \text{ Expected Cash Flow Growth }_t = \beta_0 + \beta_1 1(t = \text{ announcement }) + \epsilon_t$$

	Reduced Form
μ_{dt}^{PST}	0.0006
	(0.0012)
μ_{dt}^{GM} - 12M (y)	-0.0188***
	(0.0061)
μ_{dt}^{GM} - 12M (dp)	-0.0154**
	(0.0061)
μ_{dt}^{GM} - 12M (y, Version 2)	-0.015**
	(0.0061)
μ_{dt}^{GM} - 12M (dp, Version 2)	-0.009
	(0.0073)
Div Strip - 12M	0.1332*
	(0.0704)
Div Strip - 24M	-0.0256
	(0.0954)

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Appendix: Gao & Martin (2020) $E_t[g_{t+1}]$ Lower Bound

$$
\begin{aligned}
E_t[r_{t+1}] - r_{f,t+1} &\geq LVIX_t \\
\leftrightarrow E_t[g_{t+1}] &\geq r_{f,t+1} + LVIX_t - E_t[r_{t+1} - g_{t+1}] \\
&= r_{f,t+1} + LVIX_t - (a_0^h + a_1^h h_t) \equiv \mu_{dt}^{GM} \\
h_t &= \log(D_t/P_t) \text{ or } \log(1 + D_t/P_t)
\end{aligned}
$$

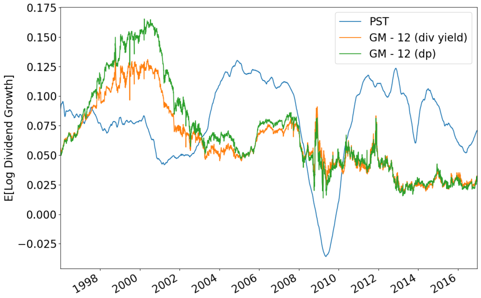

Figure: Expected dividend growth from PST (2019) and expected log dividend growth lower bounds from GM (2020). Y-axis units are in absolute terms (i.e. 0.10 is an annual expected growth rate of 10%).

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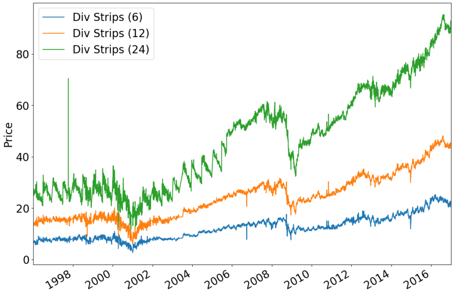
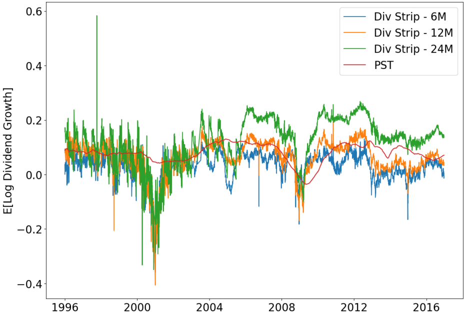
Appendix: Put-Call Parity Implied Dividend Strip Prices





Left: Daily time series of prices for 6, 12, and 24-month dividend strips on the S&P 500, extracted from S&P 500 index options and put-call parity:

$$\mathcal{P}_{t,T} = p_{t,T} - c_{t,T} + S_t - Xe^{-r_{t,T}(T-T)}.$$

Right: Fitted expected dividend growth using equity yield $e_t^{(h)} = \frac{1}{h} \ln\left(\frac{D_t}{\mathcal{P}_t^{(h)}}\right)$:

$$\Delta_{(h)} D_t = \beta_0^{(h)} + \beta_1^{(h)} e_t^{(h)} + \epsilon_t^{(h)}.$$

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Appendix: 2SLS Results - Dividend Forecasting Regressions

- Regression:

$$\Delta_{(h)} D_t = \beta_0^{(h)} + \beta_1^{(h)} e_t^{(h)} + \epsilon_t^{(h)}.$$

	12 Months	24 Months
$e_t^{(1.0)}$	-0.4858***	
	(0.1423)	
$e_t^{(2.0)}$		-1.0021***
		(0.1976)
const	0.0722***	0.1658***
	(0.0156)	(0.0343)
N	83	79
R^2	0.36	0.38
Date Range	1996 - 2016	1996 - 2015

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Appendix: Return Betas on Expected Dividend Growth

- Regression:

$$r_t = \beta_0^{(h)} + \beta_1^{(h)} \Delta g_t^{(h)} + \epsilon_t^{(h)}.$$

	Returns	Returns
$\Delta g_t^{(1)}$	0.1008***	
	(0.0117)	
$\Delta g_t^{(2)}$		0.0939***
		(0.0132)
const	0.0195	0.0194
	(0.0166)	(0.0170)
N	5155	4943
R^2	0.03	0.04

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Appendix: 2SLS Results for Alternative Macroeconomic Uncertainty Series

- Regression:

$$\Delta \text{ Macro Uncertainty }_t = \beta_0 + \beta_1 1(t = \text{ announcement }) + \epsilon_t$$

$$-r_t = \lambda_0 + \lambda_1 \widehat{\Delta \text{ Macro Uncertainty }} + \nu_t.$$

	OLS	First Stage	Reduced Form	2SLS
$\sigma^2_{12,t}$	0.2986***	-0.2158***	-0.0781**	0.3619***
	(0.0326)	(0.0269)	(0.0304)	(0.138)
$\sigma^2_{1,t}$	0.2708***	-0.191***	-0.0781**	0.4088***
	(0.0304)	(0.0272)	(0.0304)	(0.1582)
$\sigma^2_{3,t}$	0.2891***	-0.197***	-0.0781**	0.3964***
	(0.0315)	(0.0272)	(0.0304)	(0.1523)
$\sigma^2_{SP500,t}$	0.4008***	-0.1918***	-0.0781**	0.4071***
	(0.037)	(0.0285)	(0.0304)	(0.1522)
$\sigma^2_{OOS,t}$	0.195***	-0.098***	-0.0908***	0.9266**
	(0.031)	(0.0296)	(0.0339)	(0.4264)

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Appendix: Heterogeneity Across Announcement Types

	OLS	First Stage	Reduced Form	2SLS
Output Announcements	0.2986***	-0.1471***	-0.0660	0.4486
(GDP and Unemployment)	(0.0326)	(0.0356)	(0.0412)	(0.2748)
Price Announcements	0.2986***	-0.2281***	-0.0434	0.1902
(CPI, PPI, and ECI)	(0.0326)	(0.0383)	(0.0423)	(0.1815)
Monetary Policy Announcements	0.2986***	-0.1512***	-0.2269***	1.5006**
(FOMC)	(0.0326)	(0.0580)	(0.0703)	(0.6724)
All but Monetary Policy Announcements	0.2986***	-0.2186***	-0.0635**	0.2906**
(GDP, Unemployment, CPI, PPI, ECI)	(0.0326)	(0.0283)	(0.0319)	(0.1424)

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