Macroeconomic News Announcements, Systemic Risk, Financial Market Volatility and Jumps

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Introduction

- Q1: Do financial markets respond to macroeconomic news announcements? If so, how?
  - Prices v.s. economic fundamentals
  - Response patterns: smooth (continuous) v.s. abrupt (discrete)
  - Different aspects of news: surprise v.s. disagreement & uncertainty
- Q2: Does market response change over the time?
  - Financial systemic risk
  - Monetary policy: zero lower bound

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- Q2: Does market response change over the time?
  - Financial systemic risk
  - Monetary policy: zero lower bound

Literature

- Early evidence of market responses based on monthly or daily data is mixed, and relatively weak for equity market.
- Factors contributing to the weak evidence of response:
  - Most responses are short-lived — need high-frequency data to detect. (Jain (1988), Ederington and Lee (1993))
  - Only the surprising component of news matter — responses seem weaker if considering only news itself. (Balduzzi, Elton, and Green (2001))
  - Cash flow and discount factor effects may cancel out for equity responses. (McQueen and Roley (1993))
  - Response direction may change during expansions and contractions — effects may cancel out if averaging over the full sample. (ABDV (2007))

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Contributions

- Focus on market 2nd moment responses: volatility and jump contribution to return variance.
- Use both 1st and 2nd moments of news: surprise, disagreement and uncertainty.
- Effect of recent financial crisis: financial systemic risk and ZLB policy.

Main findings

- Consistent with existing literature: Bond market is more responsive than equity market; NFPAY is most influential.
- Disentangle responses via 2nd moment: volatility and jumps.
  - More jumps on news days than on no-news days.
  - Different markets may respond to news in different patterns.
- Impacts of 1st and 2nd moments of news vary:
  - Both equity and bond jumps respond to NFPAY surprises.
  - Equity jumps and bond volatility respond to NFPAY disagreement, and its interaction with surprises and systemic risk.
- Market response to news is time varying:
  - ZLB constrains bond market responses.
  - Financial systemic risk reduces bond market jump occurrences.

Outline

- Theoretical background
  - Volatility and jumps
  - News surprises, disagreement and uncertainty
  - Financial stress: systemic risk indicator
- Empirical evidence
- Conclusion

Price and Return

- Dynamics of the log price process

$$p(t) = \int_0^t \mu(\tau)d\tau + \int_0^t \sigma(\tau)dw(\tau) + \sum_{i=0}^{N(t)} \kappa_i, \qquad (1)$$

where $t \in \mathbb{R}^+$.

- Within-day trading-time geometric returns

$$r_{t,j} = p(t-1+j/M) - p(t-1+(j-1)/M), \quad j = 1,2,\ldots,M \qquad (2)$$

where $j = 1,2,\ldots,M,\ t = 1,2,\ldots$.

Asymptotic Theory (Barndorff-Nielsen and Shephard (2004))

- Trading-time Quadratic Variation:

$$QV_t = \int_{t-1}^{t} \sigma^2(s)ds + \sum_{j=1}^{N_t} \kappa_{tj}^2 = IV_t + QVJ_t. \tag{3}$$

- Nonparametric measures of QV_t, IV_t and QVJ_t.
  - Realized Variance: $RV_t = \sum_{j=1}^{M} r_{tj}^2 \xrightarrow[M\to\infty]{P} QV_t$.
  - Realized Bipower Variation:

$$RBV_t = \frac{\pi}{2}\left(\frac{M}{M-2}\right)\sum_{j=3}^{M} |r_{t,j-2}||r_{t,j}| \xrightarrow[M\to\infty]{P} IV_t.$$

  - Jump contribution: $RV_t - RBV_t \xrightarrow[M\to\infty]{P} QVJ_t$.

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  - Jump contribution: $RV_t - RBV_t \xrightarrow[M\to\infty]{P} QVJ_t$.

Jump Test (BNS (2006) and HT (2005))

$$z_{RTQ,t} = \frac{\frac{RV_t - RBV_{1,t}}{RV_t}}{\sqrt{((\frac{\pi}{2})^2 + \pi - 5)\frac{1}{M}\max(1, \frac{RTQ_t}{RBV_t^2})}}, \quad (4)$$

where

$$RTQ_t = M\mu_{4/3}^{-3}\left(\frac{M}{M-6}\right)\sum_{j=}^{M}|r_{t,j-4}|^{4/3}|r_{t,j-2}|^{4/3}|r_{t,j}|^{4/3}. \quad (5)$$

- $z_{RTQ,t} \overset{a}{\sim} N(0,1)$.
- $z_{RTQ,t} > \Phi_\alpha$ signals a jump day at α level of significance.

Realized Measures of Jumps and Volatility (ABD(2006))

- Jumps

$$J_t = I(z_{RTQ,t} > \Phi_\alpha) \cdot (RV_t - RBV_{i,t}) \tag{6}$$

- Volatility

$$C_t = I(z_{RTQ,t} \leq \Phi_\alpha) \cdot RV_t + I(z_{RTQ,t} > \Phi_\alpha) \cdot RBV_t \tag{7}$$

News Measurements

- Standardized news surprise (Balduzzi, Elton, and Green (2001))

$$S_{k,t} = \frac{A_{k,t} - E_{k,t}}{\hat{\sigma}_k}$$

  - $A_{k,t}$: the released value for news k on day t,
  - $E_{k,t}$: the median or mean of survey or market-based forecast,
  - $\hat{\sigma}_k$: the sample standard deviation of surprise $A_{k,t} - E_{k,t}$.
- Disagreement: $SD^S_{k,t}$ is std dev of survey forecasts (MMS) for news k on day t, standardized by $\hat{\sigma}_k$.
- Uncertainty: $SD^{ED}_{k,t}$ is std dev from the implied distribution of economic derivative for news k on day t, standardized by $\hat{\sigma}_k$. (Oct. 2002 – Sep. 2006).

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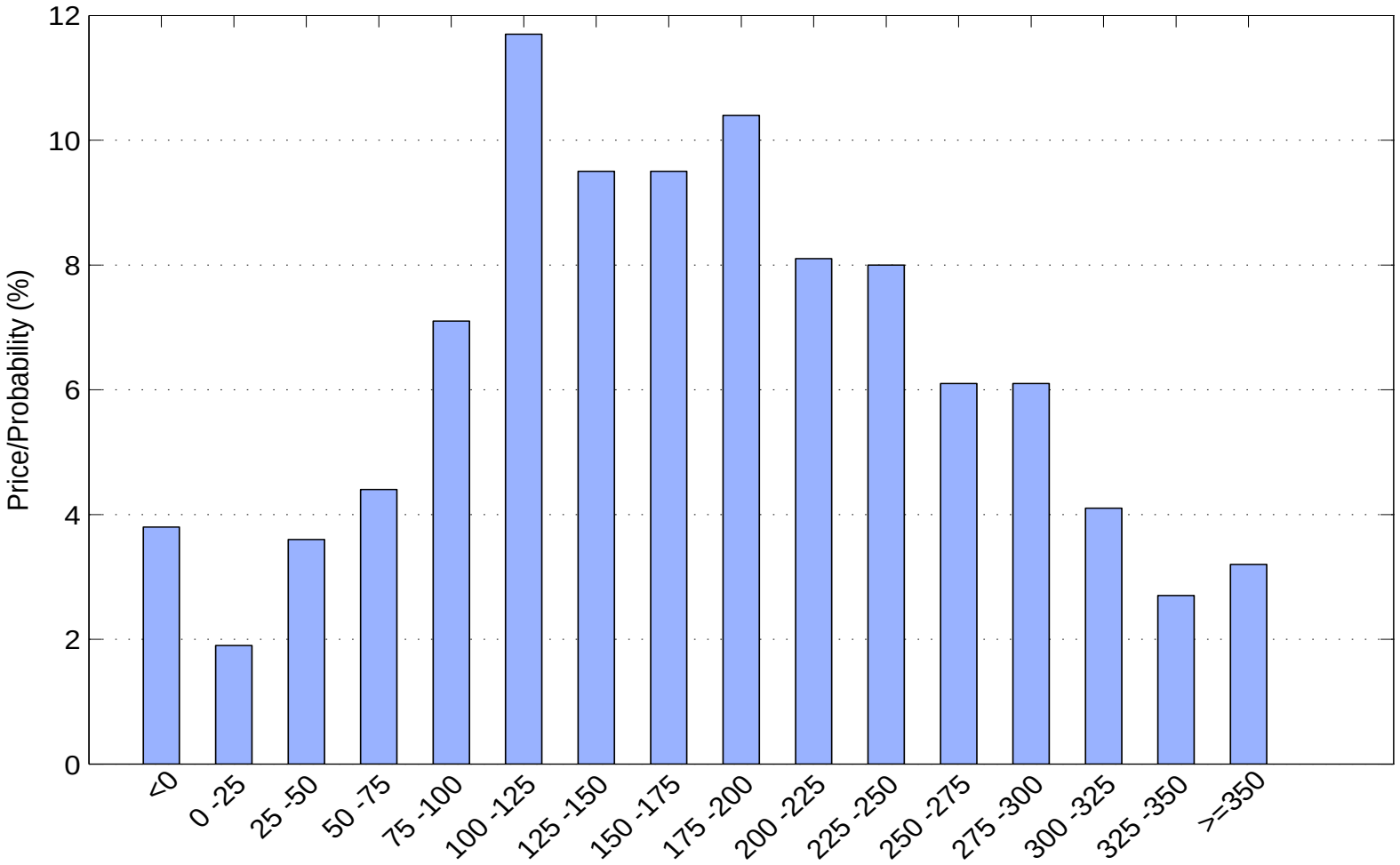
Economic Derivatives

- Goldman Sachs and Deutsche Bank launched Economic Derivatives (ED) in October 2002.
- ED was moved to CME in September 2006, and also traded in online markets.
- Most auctions take place on the announcement day before the data are released.
- Digital options whose payoff depends on news announcements:The digital call (put) pays $1 if the announcement value is above (below) the strike.
- Option prices can be used to construct a density for each release, so they provide richer information than MMS.

Economic Derivative Implied PDF for NFPAY, 6/3/2005

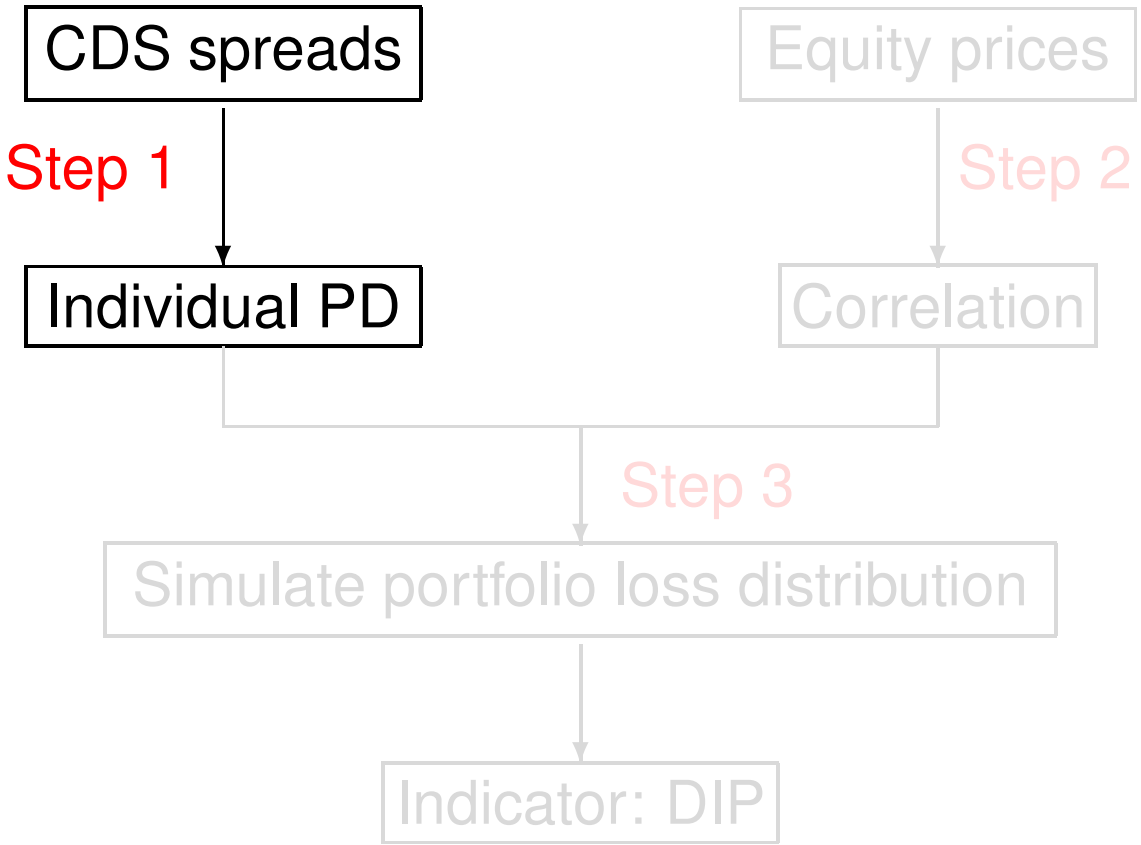


Financial System Stress

- Measured by systemic risk indicator — Distress insurance premium (DIP) (HZZ 2009, 2012(a,b)).
- Suppose that a hypothetic insurance contract is issued to protect distressed losses in a financial system (at least a significant portion of total liabilities in default), what is the fair insurance premium?

$$\text{DIP} = E^{Q}[L \times 1(L \geq L_{\min})]$$

DIP Calculation



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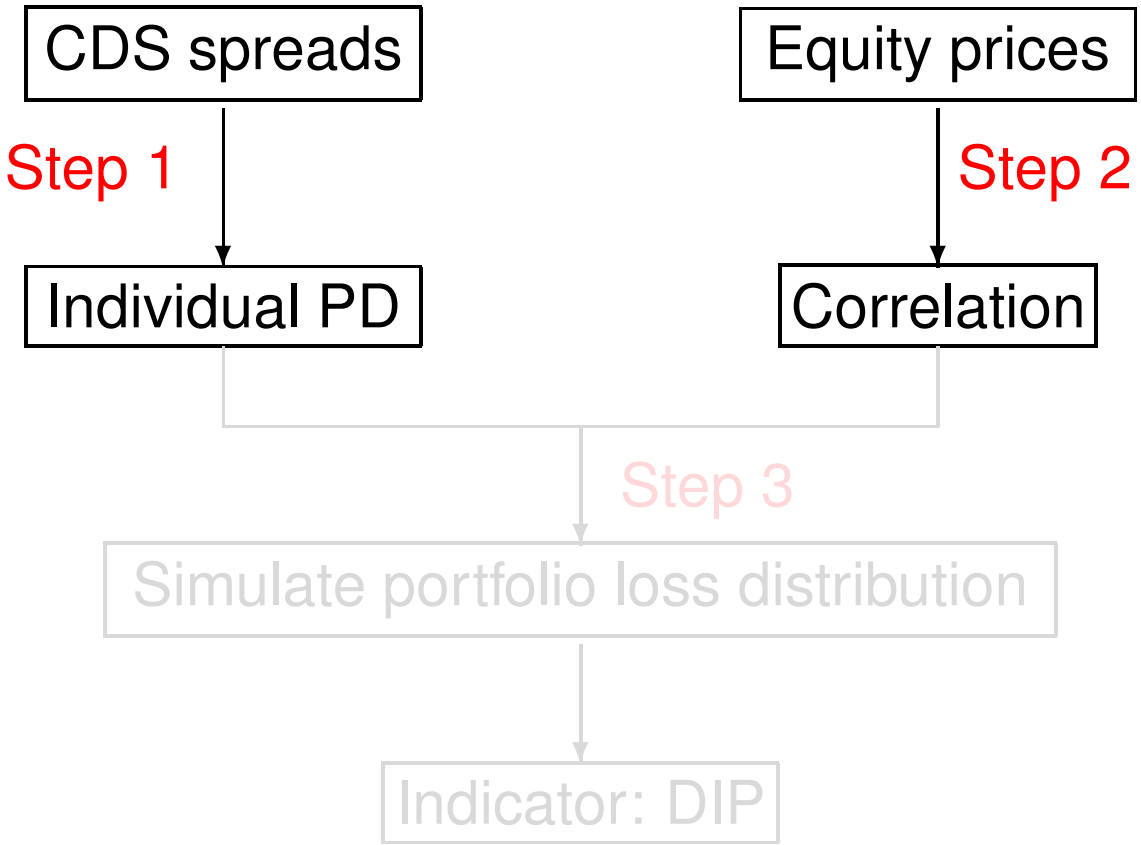

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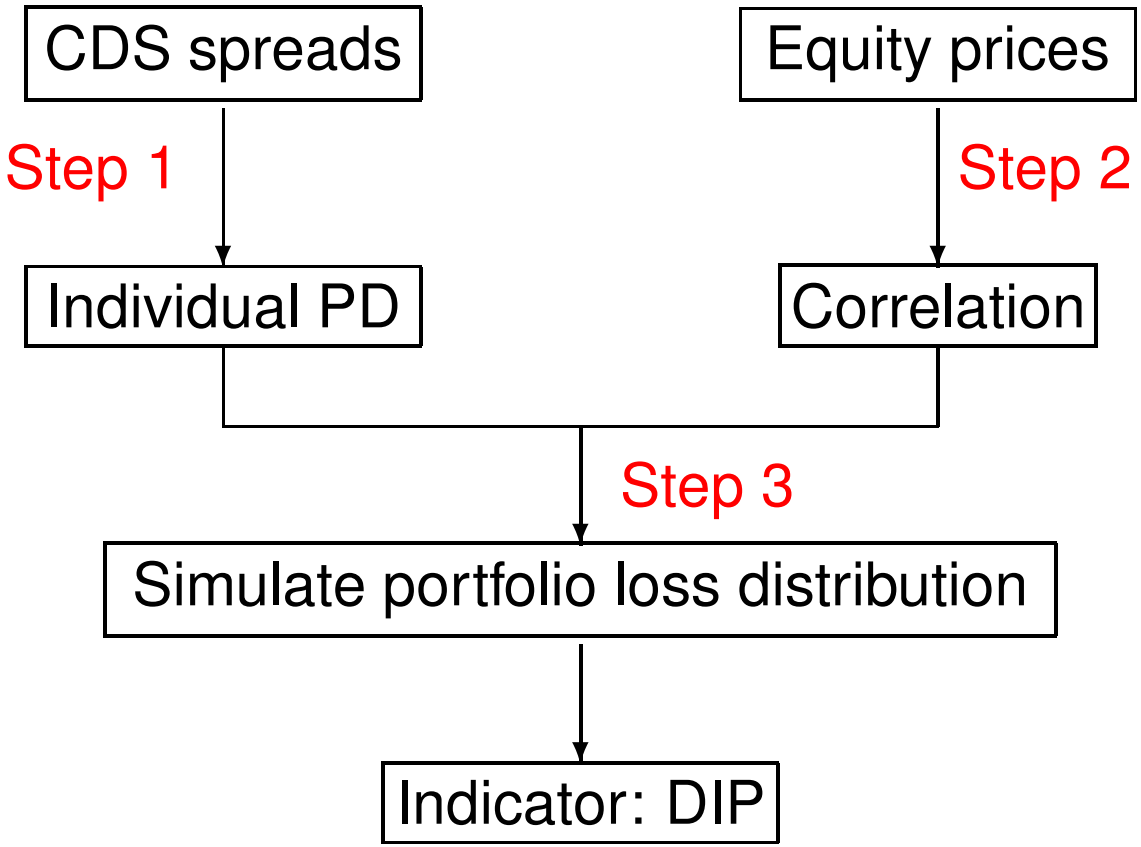
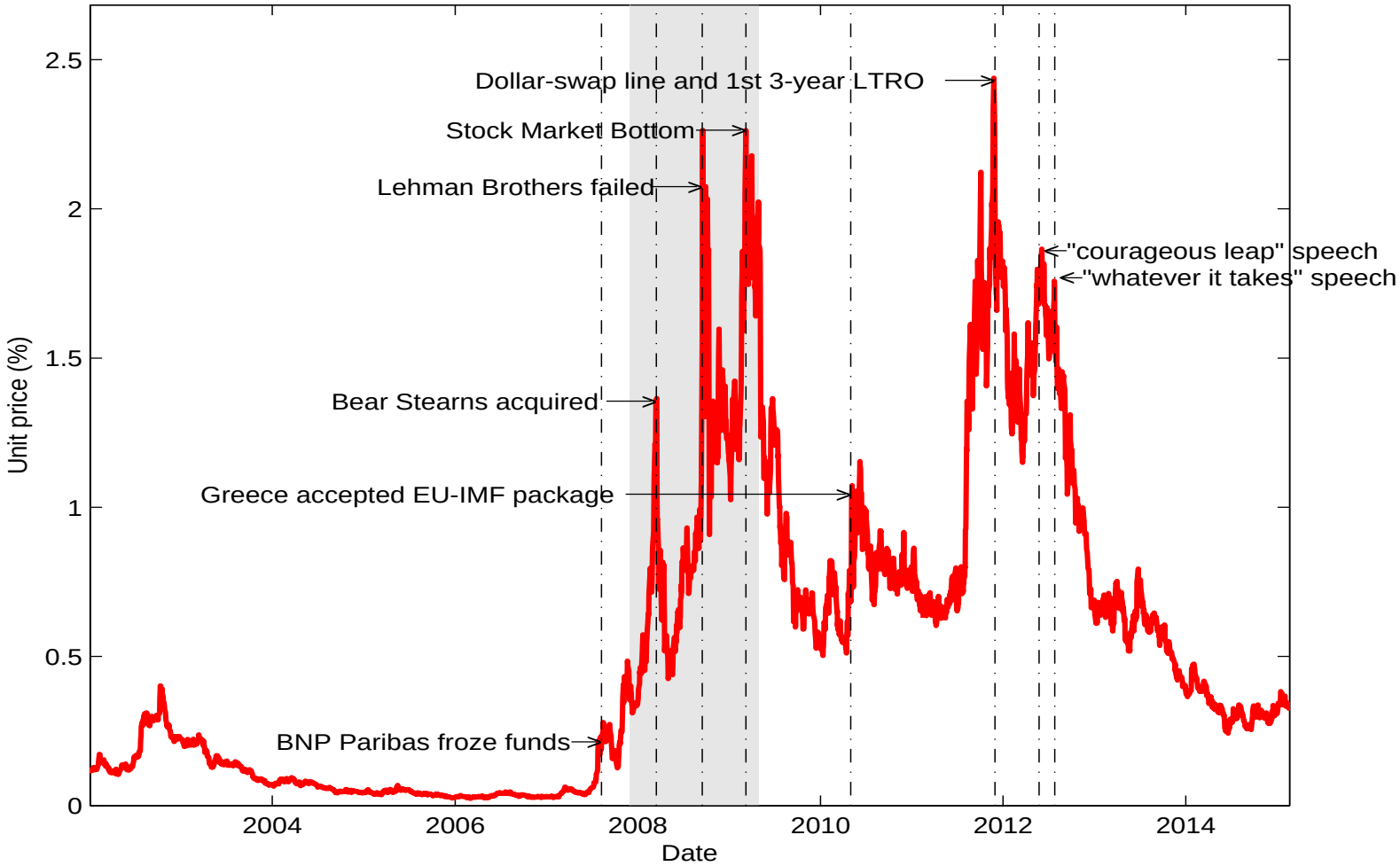


DIP


Dollar-swap line and 1st 3-year LTRO
Stock Market Bottom
Lehman Brothers failed
"courageous leap" speech
"whatever it takes" speech
Bear Stearns acquired
Greece accepted EU-IMF package
BNP Paribas froze funds
Unit price (%)
Date
0
0.5
1
1.5
2
2.5
2004
2006
2008
2010
2012
2014

Data

- Financial Markets: Five-minute returns on S&P 500 (SP) and US 30-year T-Bond (US) futures.
  - Sample periods
    - SP: 1/3/1994 – 9/30/2014.
    - US: 11/7/1988 – 9/30/2014.
  - Trading time
    - SP: 9:30 - 16:15 (EST) (extended to 8:20 by Globex).
    - US: 8:20 - 15:00 (EST).
- Macroeconomic news announcements and forecasts.
  - Survey forecasts: Money Market Services (MMS) or Action Economics. News sample periods vary.
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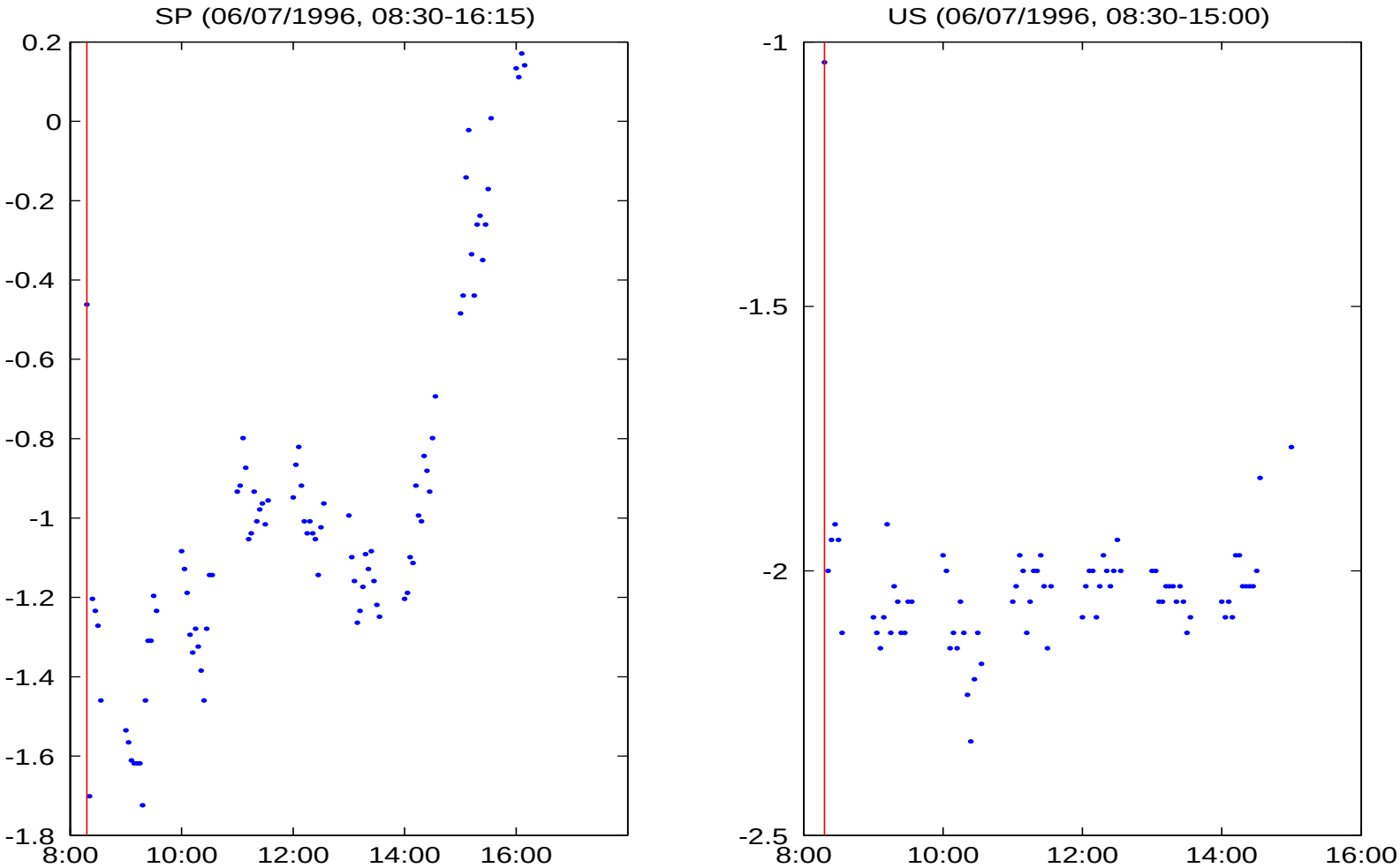

Figure 1: Log price plot on 6/7/1996. NFPAY (8:30am): announcement 340, expectation 170, std. dev. 56.5.

Table 1: Proportion of Jump Days in Important Announcement Days

Announcement	SP	US	Cojump
NFPAY	0.393< 247>(6.810)[0.000]**	0.526< 308>(10.661)[0.000]**	0.231< 247>(7.238)[0.000]**
ICLM	0.221<1034>(3.060)[0.001]**	0.262<1163>(3.443)[0.000]**	0.074<1034>(4.263)[0.000]**
CPI	0.245< 249>(2.532)[0.006]**	0.326< 310>(4.183)[0.000]**	0.096< 249>(3.240)[0.001]**
PPI	0.263< 247>(3.086)[0.001]**	0.344< 308>(4.765)[0.000]**	0.126< 247>(4.243)[0.000]**
CREDIT	0.286< 241>(3.739)[0.000]**	0.333< 303>(4.383)[0.000]**	0.124< 241>(4.160)[0.000]**
RETLS	0.250< 248>(2.685)[0.004]**	0.330< 309>(4.317)[0.000]**	0.101< 248>(3.398)[0.000]**
RSXAUT	0.254< 248>(2.811)[0.002]**	0.327< 300>(4.150)[0.000]**	0.105< 248>(3.545)[0.000]**
BUSINV	0.220< 227>(1.657)[0.049]**	0.340< 288>(4.501)[0.000]**	0.088< 227>(2.793)[0.003]**
FFR	0.151< 205>(-0.790)[0.785]	0.290< 338>(3.107)[0.001]**	0.049< 205>(0.934)[0.175]
News	0.209<3546>	0.279<4397>	0.072<3546>
No-news	0.172<1730>	0.209<2148>	0.034<1699>
Total	0.197<5276>	0.256<6545>	0.034<1699>

Disagreement v.s. Uncertainty

- Individual news regressions:

$$y_{k,t} = \alpha_k + \beta_k SD^{ED}_{k,t} + \gamma_k SD^{S}_{k,t} + \epsilon_{k,t}$$

- Joint news regressions:

$$y_t = \alpha + \sum_{k \in \text{News Announcements}} (\beta_k SD^{ED}_{k,t} + \gamma_k SD^{S}_{k,t}) + \epsilon_t$$

where y_t is either $log(C_t + 1)$ or $log(J_t + 1)$.

Table 2: Disagreement v.s. Uncertainty

	NFPAY	NAPM	RSXAUT	ICLM	Joint
			Panel 1: S&P 500, C		
Econ. Deriv.	-0.459*	0.386	-0.078	-0.019	0.537
	(0.249)	(0.256)	(0.380)	(0.039)	
Survey	0.371	0.120	-0.203	0.041	0.283
	(0.307)	(0.161)	(0.353)	(0.043)	
			Panel 2: S&P 500, J		
Econ. Deriv.	-0.261	0.058	0.114	0.002	0.533
	(0.239)	(0.118)	(0.169)	(0.003)	
Survey	0.201	0.038	-0.127	-0.008**	0.467
	(0.300)	(0.095)	(0.162)	(0.003)	
			Panel 3: US 30-Year TB, C		
Econ. Deriv.	-0.153	0.108	-0.113	0.018*	0.021**
	(0.329)	(0.186)	(0.152)	(0.011)	
Survey	-0.056	0.151	-0.228	-0.013	0.514
	(0.327)	(0.103)	(0.211)	(0.010)	
			Panel 4: US 30-Year TB, J		
Econ. Deriv.	0.718**	0.246	-0.003	-0.006	0.000**
	(0.341)	(0.184)	(0.074)	(0.004)	
Survey	-0.686	-0.097	0.041	0.002	0.030**
	(0.440)	(0.108)	(0.102)	(0.004)	

Constant Response Model

Model 1 :

$$y_{k,t} = \alpha_{C,k} + \beta_{k,S,p}|S_{k,t}|I(S_{k,t} \geq 0) + \beta_{k,S,n}|S_{k,t}|I(S_{k,t} < 0) + \beta_{k,D}SD_{k,t}$$
$$+\beta_{k,SD,p}|S_{kt}|I(S_{kt} \geq 0) \cdot SD_{kt} + \beta_{k,SD,n}|S_{kt}|I(S_{kt} < 0) \cdot SD_{kt} + \epsilon_{k,t}$$

- Differs from the literature of market first-moment response to news:
  - Take absolute values of news surprise.
  - Separate news surprise into positive and negative ones.
  - Include disagreement and interaction of surprise and disagreement.

Modeling Time-varying Responses

Goldberg and Grisse (2013):

$$y_t = \sum_{k=1}^{K} \beta_{k,t} x_{k,t} + \epsilon_t \tag{8}$$

$$\beta_{k,t} = \tau_{0,k} + \tau_{1,k} z_t \tag{9}$$

Substitute Equation (9) into Equation (8):

$$y_t = \sum_{k=1}^{K} (\tau_{0,k} + \tau_{1,k} z_t) x_{k,t} + \epsilon_t = \sum_{k=1}^{K} \tau_{0,k} x_{k,t} + \sum_{k=1}^{K} \tau_{1,k} z_t x_{k,t} + \epsilon_t \tag{10}$$

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Time-varying Response Model

Model 2 :

$$
\begin{aligned}
y_{k,t} = {} & \alpha_k + \beta_{k,S,p}|S_{kt}|I(S_{kt} \geq 0) + \beta_{k,S,n}|S_{kt}|I(S_{kt} < 0) + \beta_{k,D}SD_{kt} \\
& + \beta_{k,SD,p}|S_{kt}|I(S_{kt} \geq 0) \cdot SD_{kt} + \beta_{k,SD,n}|S_{kt}|I(S_{kt} < 0) \cdot SD_{kt} \\
& + \beta_{k,DIP}DIP_t + \tau_{k,S,p}|S_{kt}|I(S_{kt} \geq 0) \cdot DIP_t + \tau_{k,S,n}|S_{kt}|I(S_{kt} < 0) \cdot DIP_t \\
& + \tau_{k,D}SD_{kt} \cdot DIP_t + \tau_{k,SD,p}|S_{kt}|I(S_{kt} \geq 0) \cdot SD_{kt} \cdot DIP_t \\
& + \tau_{k,SD,n}|S_{kt}|I(S_{kt} < 0) \cdot SD_{kt} \cdot DIP_t + \epsilon_{k,t}.
\end{aligned}
$$

Table 3: Time-varying Response (SP,C)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	0.193	0.140	-0.192	0.074	0.537
		(0.268)	(0.222)	(0.252)	(0.052)	
	Neg.	0.136	0.424*	-0.695**	0.088	0.600
		(0.324)	(0.243)	(0.328)	(0.075)	
Disagreement		-0.172	0.210	-1.145**	0.035	0.696
		(0.592)	(0.372)	(0.420)	(0.058)	
Surpr * Disagr	Pos.	-0.184	-0.214	0.527	-0.052	0.873
		(0.716)	(0.409)	(0.461)	(0.033)	
	Neg.	-0.090	-0.569	1.507**	-0.043	0.784
		(0.986)	(0.487)	(0.590)	(0.043)	
Surprise * DIP	Pos.	-0.556	0.182	-0.110	-0.110	0.100*
		(0.547)	(0.436)	(0.298)	(0.132)	
	Neg.	0.016	-0.070	0.463	-0.079	0.653
		(0.598)	(0.280)	(0.322)	(0.123)	
Disagreement * DIP		1.067	1.522**	1.536**	0.462**	0.073*
		(0.979)	(0.699)	(0.385)	(0.209)	
Surpr * Disagr * DIP	Pos.	1.562	-0.438	-0.133	0.246	0.054*
		(1.436)	(0.828)	(0.421)	(0.164)	
	Neg.	0.210	0.248	-0.936*	-0.017	0.737
		(1.684)	(0.732)	(0.489)	(0.105)	

Table 4: Time-varying Response (SP,J)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	-0.328*	0.158	0.203	-0.002	0.055*
		(0.193)	(0.148)	(0.236)	(0.023)	
	Neg.	-0.705**	0.247	-0.063	-0.042*	0.333
		(0.187)	(0.174)	(0.089)	(0.024)	
Disagreement		-1.174**	0.224	-0.314*	0.000	0.391
		(0.350)	(0.178)	(0.163)	(0.021)	
Surpr * Disagr	Pos.	1.151**	-0.324	-0.252	-0.002	0.378
		(0.488)	(0.252)	(0.398)	(0.012)	
	Neg.	2.694**	-0.466	0.113	0.023	0.112
		(0.625)	(0.307)	(0.165)	(0.018)	
Surprise * DIP	Pos.	0.563*	-0.169	-0.108	-0.006	0.041**
		(0.289)	(0.182)	(0.221)	(0.032)	
	Neg.	0.892**	-0.213	0.219*	0.022	0.330
		(0.235)	(0.139)	(0.131)	(0.044)	
Disagreement * DIP		1.485**	-0.256	0.793**	-0.022	0.021**
		(0.474)	(0.216)	(0.330)	(0.042)	
Surpr * Disagr * DIP	Pos.	-1.625**	0.399	0.026	-0.008	0.247
		(0.800)	(0.333)	(0.340)	(0.030)	
	Neg.	-2.642**	0.497	-0.375*	-0.014	0.291
		(0.743)	(0.326)	(0.214)	(0.030)	

Table 5: Time-varying Response (US,C)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	0.749**	0.169	-0.107	0.016	0.000**
		(0.238)	(0.160)	(0.101)	(0.018)	
	Neg.	0.259	-0.105	-0.338**	0.043*	0.088*
		(0.165)	(0.138)	(0.113)	(0.024)	
Disagreement		0.553**	0.141	-0.480**	-0.018	0.007**
		(0.269)	(0.251)	(0.137)	(0.013)	
Surpr * Disagr	Pos.	-1.547**	-0.252	0.275	0.011	0.001**
		(0.482)	(0.296)	(0.186)	(0.008)	
	Neg.	-0.579	0.150	0.685**	-0.017	0.354
		(0.444)	(0.274)	(0.211)	(0.014)	
Surprise * DIP	Pos.	-0.759**	-0.156	0.119	-0.055	0.005**
		(0.303)	(0.219)	(0.119)	(0.040)	
	Neg.	-0.150	0.101	0.310**	-0.061*	0.379
		(0.235)	(0.143)	(0.117)	(0.036)	
Disagreement * DIP		-0.576*	0.192	0.744**	0.154**	0.003**
		(0.338)	(0.354)	(0.144)	(0.067)	
Surpr * Disagr * DIP	Pos.	2.323**	0.189	-0.280	0.028	0.003**
		(0.776)	(0.420)	(0.169)	(0.049)	
	Neg.	0.662	-0.086	-0.613**	0.006	0.957
		(0.568)	(0.373)	(0.185)	(0.030)	

Table 6: Time-varying Response (US,J)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	0.814**	0.068	0.085	-0.002	0.000**
		(0.273)	(0.094)	(0.071)	(0.006)	
	Neg.	0.432*	0.134**	0.025	0.015	0.000**
		(0.234)	(0.059)	(0.061)	(0.013)	
Disagreement		0.013	0.038	0.045	0.001	0.140
		(0.396)	(0.092)	(0.091)	(0.006)	
Surpr * Disagr	Pos.	-0.962	-0.072	-0.165	-0.003	0.000**
		(0.674)	(0.161)	(0.135)	(0.003)	
	Neg.	-0.756	-0.224**	-0.085	-0.012*	0.003**
		(0.823)	(0.103)	(0.104)	(0.007)	
Surprise * DIP	Pos.	-0.271	-0.025	-0.019	0.027**	0.269
		(0.378)	(0.094)	(0.073)	(0.013)	
	Neg.	-0.181	-0.064	0.002	0.008	0.391
		(0.300)	(0.046)	(0.066)	(0.018)	
Disagreement * DIP		0.101	-0.032	-0.054	0.051**	0.607
		(0.391)	(0.100)	(0.083)	(0.022)	
Surpr * Disagr * DIP	Pos.	0.024	0.039	0.113	-0.031*	0.897
		(0.891)	(0.163)	(0.114)	(0.016)	
	Neg.	0.247	0.110	0.066	-0.009	0.828
		(0.821)	(0.096)	(0.098)	(0.013)	

Table 7: Time-Varying Responses during Zero Lower Bound (SP,C)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	-0.471	-0.834	0.219	0.028	0.589
		(0.753)	(0.523)	(0.476)	(0.180)	
	Neg.	-0.348	0.537	-0.132	-0.579**	0.461
		(0.420)	(0.794)	(0.310)	(0.266)	
Disagreement		-3.381**	-0.892	-0.624	-1.571**	0.083*
		(1.021)	(0.619)	(0.646)	(0.418)	
Surpr * Disagr	Pos.	2.263	2.253**	-0.019	0.209	0.556
		(3.585)	(1.084)	(0.732)	(0.360)	
	Neg.	2.478	-0.970	0.640	1.640**	0.559
		(1.626)	(1.961)	(0.530)	(0.660)	
Surprise * DIP	Pos.	0.599	1.084	-0.541	-0.083	0.459
		(0.921)	(0.752)	(0.538)	(0.203)	
	Neg.	0.549	-0.266	-0.126	0.496*	0.300
		(0.476)	(1.111)	(0.386)	(0.280)	
Disagreement * DIP		5.221**	2.252**	0.834	1.799**	0.002**
		(0.960)	(0.727)	(0.845)	(0.359)	
Surpr * Disagr * DIP	Pos.	-2.157	-2.456*	0.432	-0.068	0.648
		(3.795)	(1.355)	(0.741)	(0.307)	
	Neg.	-3.578**	0.725	-0.144	-1.484**	0.649
		(1.545)	(2.764)	(0.557)	(0.620)	

Table 8: Time-Varying Responses during Zero Lower Bound (SP,J)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	-1.109**	0.029	-0.028	0.033	0.422
		(0.326)	(0.207)	(0.079)	(0.062)	
	Neg.	-0.647*	0.571**	-0.086	0.061	0.514
		(0.359)	(0.284)	(0.081)	(0.103)	
Disagreement		-0.546	-0.000	-0.137	0.203	0.441
		(0.734)	(0.213)	(0.099)	(0.148)	
Surpr * Disagr	Pos.	5.477**	-0.369	0.035	-0.088	0.103
		(1.419)	(0.503)	(0.106)	(0.109)	
	Neg.	2.271	-1.671**	0.052	-0.317	0.401
		(1.750)	(0.591)	(0.112)	(0.226)	
Surprise * DIP	Pos.	1.193**	0.110	0.038	-0.027	0.328
		(0.398)	(0.258)	(0.074)	(0.069)	
	Neg.	0.759**	-0.637**	0.114	-0.062	0.451
		(0.372)	(0.303)	(0.077)	(0.106)	
Disagreement * DIP		0.459	-0.030	0.091	-0.226*	0.193
		(0.675)	(0.236)	(0.094)	(0.136)	
Surpr * Disagr * DIP	Pos.	-5.201**	0.204	-0.036	0.075	0.093*
		(1.434)	(0.533)	(0.095)	(0.097)	
	Neg.	-1.485	2.191**	-0.090	0.294	0.410
		(1.736)	(0.739)	(0.098)	(0.211)	

Table 9: Time-Varying Responses during Zero Lower Bound (US,C)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	-0.145	0.234	0.096	-0.005	0.830
		(0.416)	(0.228)	(0.241)	(0.072)	
	Neg.	-0.302	0.471	-0.324*	-0.188**	0.145
		(0.281)	(0.322)	(0.170)	(0.080)	
Disagreement		-0.993**	0.351	-0.376	-0.335*	0.161
		(0.394)	(0.319)	(0.299)	(0.178)	
Surpr * Disagr	Pos.	1.396	-0.415	0.075	0.112	0.995
		(1.645)	(0.521)	(0.369)	(0.161)	
	Neg.	1.027	-1.537**	0.891**	0.564**	0.011**
		(0.971)	(0.746)	(0.376)	(0.208)	
Surprise * DIP	Pos.	0.210	-0.247	-0.135	-0.048	0.817
		(0.455)	(0.302)	(0.257)	(0.075)	
	Neg.	0.350	-0.621	0.164	0.148*	0.453
		(0.296)	(0.450)	(0.179)	(0.080)	
Disagreement * DIP		1.069**	-0.186	0.500	0.424**	0.055*
		(0.368)	(0.431)	(0.406)	(0.154)	
Surpr * Disagr * DIP	Pos.	-0.734	0.467	-0.019	-0.062	0.992
		(1.846)	(0.629)	(0.357)	(0.139)	
	Neg.	-0.951	2.068*	-0.599*	-0.513**	0.027**
		(0.887)	(1.061)	(0.321)	(0.192)	

Table 10: Time-Varying Responses during Zero Lower Bound (US,J)

		NFPAY	NAPM	RSXAUT	ICLM	Joint
Surprise	Pos.	-0.205	-0.067	0.068	0.021	0.505
		(0.630)	(0.157)	(0.116)	(0.039)	
	Neg.	-0.079	0.080	0.100	-0.005	0.078*
		(0.393)	(0.100)	(0.083)	(0.039)	
Disagreement		-0.914	0.035	0.172**	0.044	0.328
		(0.641)	(0.132)	(0.084)	(0.101)	
Surpr * Disagr	Pos.	2.329	0.196	-0.240	-0.088	0.888
		(2.243)	(0.389)	(0.192)	(0.081)	
	Neg.	0.716	-0.119	-0.164	-0.006	0.398
		(1.355)	(0.221)	(0.123)	(0.120)	
Surprise * DIP	Pos.	0.714	0.092	-0.014	0.010	0.690
		(0.625)	(0.124)	(0.123)	(0.041)	
	Neg.	0.349	0.022	-0.078	0.028	0.900
		(0.446)	(0.147)	(0.092)	(0.035)	
Disagreement * DIP		0.915	0.007	-0.232**	0.026	0.697
		(0.628)	(0.102)	(0.109)	(0.091)	
Surpr * Disagr * DIP	Pos.	-3.079	-0.186	0.188	0.029	0.566
		(2.140)	(0.275)	(0.172)	(0.068)	
	Neg.	-1.051	-0.060	0.169	-0.018	0.837
		(1.353)	(0.322)	(0.119)	(0.109)	

Jump Hazard Rate – ACD/ACH model (ER 1998, HJ 2002)

- Jumps are characterized by random size and stochastic arrival.
- Hazard rate: $h_t = P[N(t) \neq N(t-1)|\mathcal{F}_{t-1}]$
- Expected duration ACD(1,1): $\psi_{N(t)} = \omega + \alpha_1 d_{N(t)-1} + \beta_1 \psi_{N(t)-1}$
- Simple ACH(1,1): $h_t = 1/\psi_{N(t-1)}$
- Augmented ACH(1,1) with news updates between jump days:

$$\begin{aligned} h_t &= 1/(\psi_{N(t-1)} + \delta' z_{t-1}) \\ \delta' z_t &= \delta_0 + \sum_{k \in \text{Economic series}} [\delta_{k,p} |S^S_{k,t}| 1(S^S_{k,t} \geq 0) \\ &\quad + \delta_{k,n} |S^S_{k,t}| 1(S^S_{k,t} < 0)] + \delta_{DIP} DIP_t \end{aligned}$$

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Table 11: ACH Model Estimates

	ACH(1,1)		Augmented ACH(1,1)	
	SP	US	SP	US
ω	0.018(0.019)	0.034(0.024)	–	–
α_1	0.056(0.013)**	0.056(0.014)**	0.058(0.014)**	0.020(0.011)
β_1	0.940(0.015)**	0.936(0.017)**	0.929(0.018)**	0.938(0.027)**
δ_0	–	–	0.899(0.368)**	2.048(0.301)**
NFPAY(+)	–	–	-1.976(0.609)**	-3.587(0.321)**
NAPM(+)	–	–	-0.157(0.721)	-0.618(0.050)**
RSXAUT(+)	–	–	-1.280(0.083)**	-0.838(0.079)**
ICLM(+)	–	–	-0.125(0.396)	-0.100(0.397)
NFPAY(-)	–	–	1.499(0.103)**	2.127(0.220)**
NAPM(-)	–	–	-0.109(0.824)	-0.054(0.964)
RSXAUT(-)	–	–	-0.787(1.401)	0.677(0.527)
ICLM(-)	–	–	0.282(0.473)	0.313(0.294)
DIP	–	–	-0.030(0.324)	2.472(0.504)**

Conclusions

- Disentangle market continuous and discrete responses to news announcements via 2nd moment: continuous volatility and discrete jumps.
  - More jumps on news days than no-news days.
  - Different markets may respond to news in different patterns.
- Consider both the 1st and 2nd moments of news forecasts.
  - Both equity and bond jumps respond to NFPAY surprises.
  - Equity jumps and bond volatility respond to NFPAY disagreement, and its interaction with surprises and systemic risk.
- Market responses to news is time-varying.
  - ZLB constrains bond market responses.
  - The higher the financial systemic risk is, the less likely the bond market will jump.