Information Shocks, Liquidity Shocks, Jumps, and Price Discovery — Evidence from the U.S. Treasury Market

George J. Jiang

University of Arizona

Ingrid Lo

Bank of Canada

Adrien Verdelhan

Boston University

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Motivation

- Jumps: large discontinuous price changes
- Jumps are important: compared to continuous price changes, jumps have distinctly different implications for the valuation of derivative securities, risk management, as well as portfolio allocation.
- Bond price jumps (US Treasury market):
  - 2005-2006, 60 out of 477 trading days have jumps for 2-year note, 63 out of 477 trading days have jump for 10-year note
  - Size: Mean absolute jump 0.08% compared to return standard deviation 0.007% in 2-year note. The largest jump on the upside is 0.24% and the downside is -0.17%

This paper studies ...

- The relation between jumps in treasury bond prices and pre-scheduled news announcements/events
  - Step 1: Statistically identify jumps intradaily using jump detection test recently developed in the literature.
  - Step 2: Examine
    - ◇ to what extent jumps are driven by pre-scheduled events
    - ◇ whether jumps are also related to other market variables

This paper further studies ...

- What drives price jumps?
  - Liquidity withdrawal before announcements
  - Explanatory power: liquidity shock (e.g. order withdrawal) vs news surprise
- Post jump price discovery:
  - How do jumps affect price discovery process?
  - Compare post-jump price information of OF with price information of OF when there are no jumps at announcements

Summary of Findings

- Majority of jumps occur during pre-scheduled announcements/events
- Identify a more extensive list of announcements related to jumps
- Announcement surprise is an imperfect indicator of price jumps
- $\uparrow$ Liquidity shock $\longrightarrow$ more jumps, $\uparrow$ jump return
- Post jump: jumps serves as a dramatic form of price discovery and post jump order flow has less information

Data: Limit Order Book

- Almost all active issue treasuries goes through electronic limit order book since 2003
- US treasury bond data from BrokerTec (60-65% trading volume).
- No market maker: traders submit limit orders or marketable limit order. Limit order submitters could post "iceburg" (hidden) order. The orders remain in the market until matched or cancelled
- Market closes at 5:30 PM EST and then reopen at 7:00 PM EST. We use data from 7:30 a.m. EST to 5:00 p.m. EST. Sample period: Jan. 2, 2005 to Dec. 29, 2006. Exclude days with early closing.
- Consists of over 465.5 million observations and 10.9 million transactions

Sample Mean of Variables (Table I)

	$Volume$ (billion)	$Spread$ (tick)	$Depth^{Best}$ (million)	$Depth^{All}$ (million)
2-year note	27.45	1.06	637.72	5122.56
5-year note	24.69	1.18	119.30	1238.48
10-year note	22.76	1.13	120.93	1520.08

- Spread: tick size 1/128 for 2- and 5-year note, 1/64 for 10-year note

Data: Macroeconomic Data

- Expectations and realizations of 33 macroeconomic news announcements from Bloomberg, auction time of 2-, 3-, 5- and 10-year note and testimony of Semiannual Monetary Policy Report and Economic Outlook
- Expectation from median of market participants survey
- Standardized news surprise is defined as

$$S_{kt} = \frac{A_{kt} - E_{kt}}{\hat{\sigma}} \tag{1}$$

where

  - $A_{kt} =$ actual value of the announcement,
  - $E_{kt} =$ median of forecasts for news k on day t
  - $\hat{\sigma} =$ sample standard deviation of $A_{kt} - E_{kt}$

Data: Macroeconomic News

Business Inventories	Capacity Utilization	Nonfarm Payrolls
Chicago PMI	Construction Spending	Consumer Confidence
Consumer Credit	Consumer Price Index	Durable Goods Orders
Existing home sales	FOMC Rate Decision	Factory Orders
GDP Annualized Advance	GDP Annualized Final	GDP Annualized Preliminary
Housing Starts	ISM service	Industrial Production
Initial Jobless Claims	Leading Indicators	Minutes of FOMC Meeting
Monthly budget Statement	NAPM	NY Empire State Index
New Home Sales	Personal Consumption Exp.	Personal Income
Producer Price Index	Retail Sales	Trade balance
Philadelphia Fed Index	ADP Payrolls	Current Account

Statistical Test of Jumps: Identify Jump Days

- Employ 2 jump testing approaches: "bi-power variation" (hereafter BPV) approach by Barndorff-Nielsen, and Shephard (2004, 2006), and the "variance swap" (hereafter SWV) approach by Jiang and Oomen (2007).

- Bi-power variation test:

$$\frac{V_{(0,1)}\sqrt{N}}{\sqrt{\Omega_{BPV}}}\left(1-\frac{BPV_N}{RV_N}\right) \xrightarrow{d} \mathcal{N}(0,1). \tag{2}$$

where

$$BPV_N = \frac{1}{\mu_1^2}\sum_{i=1}^{N-1}\left|r_{\delta,i+1}\right|\left|r_{\delta,i}\right|,$$

- Variance Swap Test

$$\frac{V_{(0,1)}N}{\sqrt{\Omega_{SwV}}}\left(1-\frac{RV_N}{SwV_N}\right)\xrightarrow{d}\mathcal{N}(0,1) \tag{3}$$

where

$$SwV_N = 2\sum_{j=1}^{N}\left(R_{\delta,j}-r_{\delta,j}\right) = 2\sum_{j=1}^{N}R_{\delta,j} - 2\ln\left(S_1/S_0\right), \tag{4}$$

- Identify jump days from 5-min. returns at 1% critical level i.e. if the tests statistics of both approaches are significant, we reject the null hypothesis of no jumps.

Statistical Test of Jumps: Identify Jump Returns

- Step 1: Let $\{r_1, r_2, \cdots r_N\}$ be return observations. If the jump test statistic JS_0 is significant, record JS_0 and continue to Step 2.
- Step 2: Replace each return observation by the median return (r_{md}), and perform jump test on return series $\{r_1, \cdots, r_{i-1}, r_{md}, r_{i+1}, \cdots, r_N\}$. $JS^{(i)}, i = 1, 2, \cdots, N$ are recorded.
- Step 3: Compute the differences of the test statistic in Step 1 and Step 2, i.e., $JS_0 - JS^{(i)}, i = 1, 2, \cdots, N$. Return j is identified as a jump return if $JS_0 - JS^{(j)}$ has the highest value among all returns [likelihood criterion]
- Step 4: Replace the identified jump, r_j, by the median, $\{r_1, \cdots, r_{j-1}, r_{md}, r_{j+1}, \cdots, r_N\}$. Go to Step 1.
- Bid-ask bounce: Jumps have to be larger than twice the tick size.

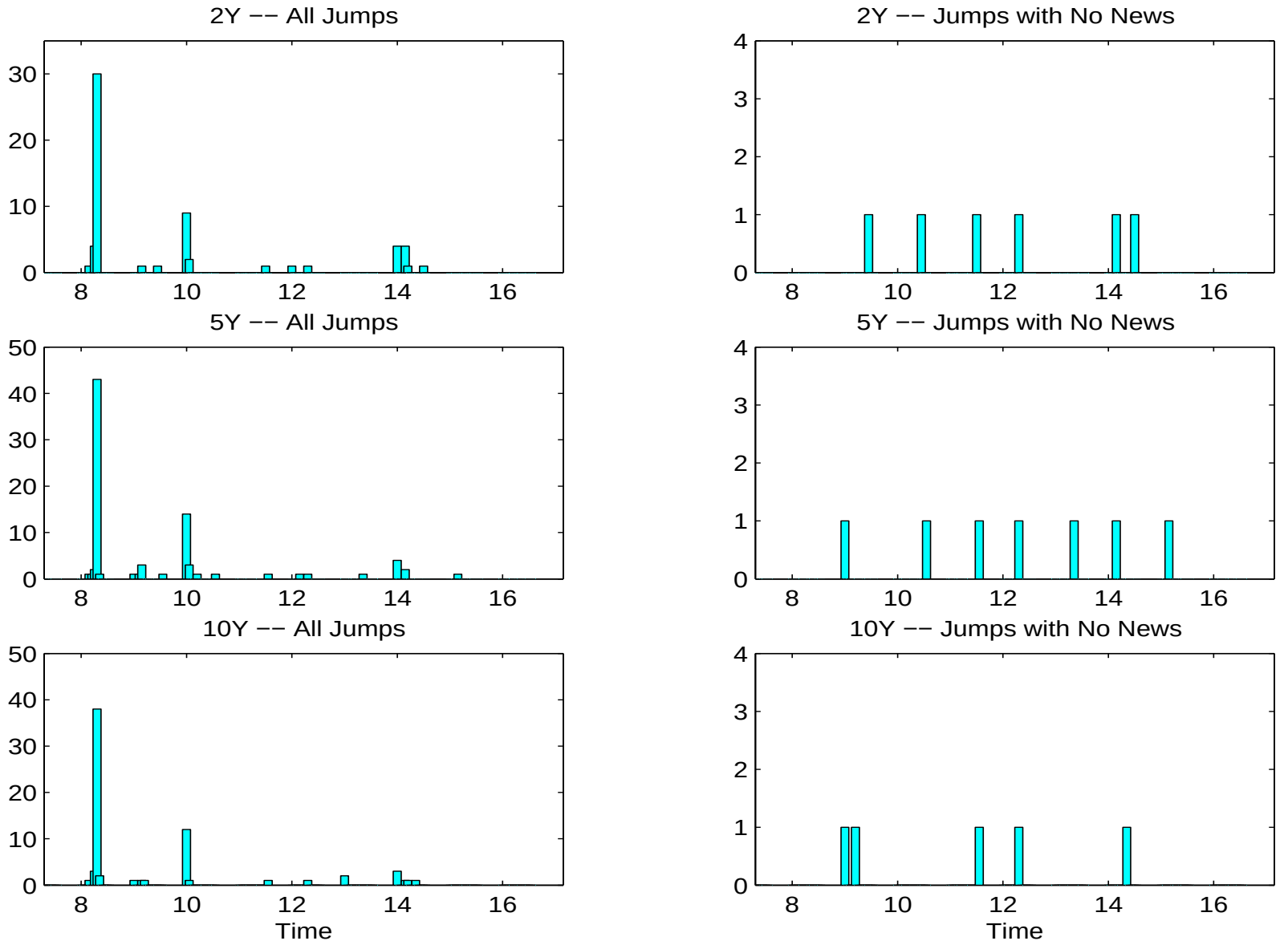
Jumps at Announcement vs Other Jumps (Table IV)

Bond	N	Mean (abs.)	Median (abs.)	Max	Min	StdDev
Panel A: Jumps Associated with Pre-Scheduled Announcement						
2-year note	63	0.08	0.07	0.24	-0.17	0.09
3-year note	70	0.13	0.11	0.28	-0.28	0.14
5-year note	65	0.17	0.14	0.40	-0.41	0.19
10-year note	58	0.28	0.24	0.70	-0.64	0.31
30-year note	59	0.47	0.42	0.94	-1.01	0.51
Panel B: Jumps Not Associated with Pre-Scheduled Announcement						
2-year note	6	0.05	0.05	0.07	-0.07	0.05
3-year note	4	0.09	0.09	0.12	-0.09	0.09
5-year note	7	0.11	0.10	0.18	-0.12	0.10
10-year note	5	0.24	0.24	0.26	-0.35	0.25
30-year note	17	0.61	0.27	2.13	-3.55	1.04

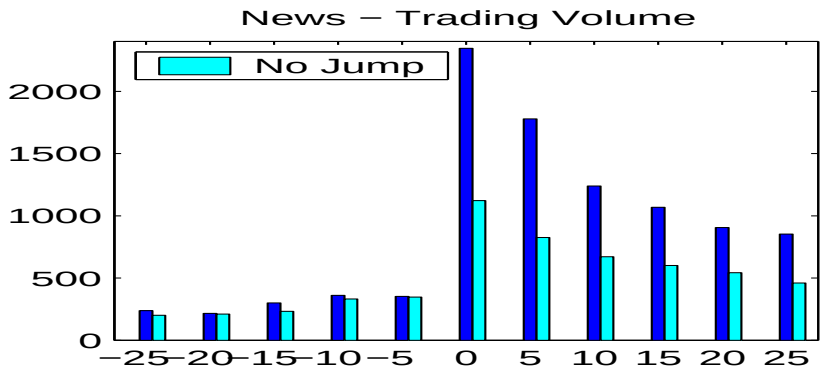
Overlapping Jumps: Announcement Jumps vs Other Jumps (Table IV)

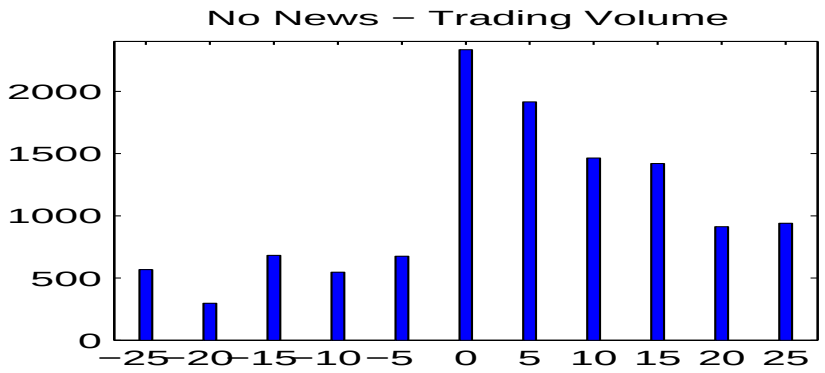
	2-year note	3-year note	5-year note	10-year note	30-year bond
Panel C: Overlapping Jumps Associated with Pre-Scheduled Announcement					
2-year note	63				
3-year note	46	70			
5-year note	41	47	65		
10-year note	35	41	42	58	
30-year bond	29	32	37	41	59
Panel D: Overlapping Jumps Not Associated with Pre-Scheduled Announcement					
2-year note	6				
3-year note	2	4			
5-year note	2	3	7		
10-year note	1	1	2	5	
30-year bond	1	1	2	6	17

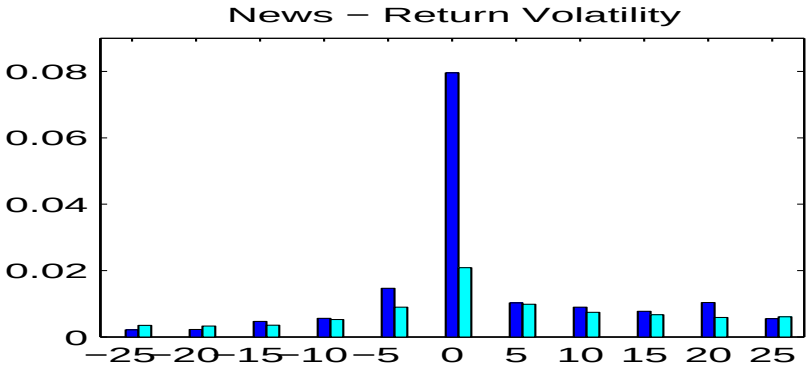
Intra-day Jump Distribution

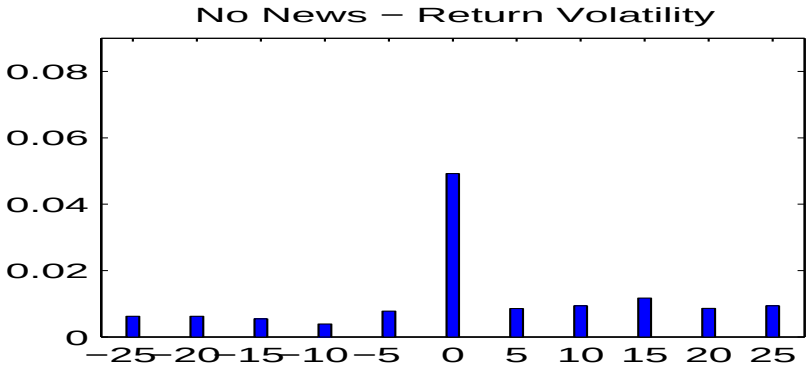


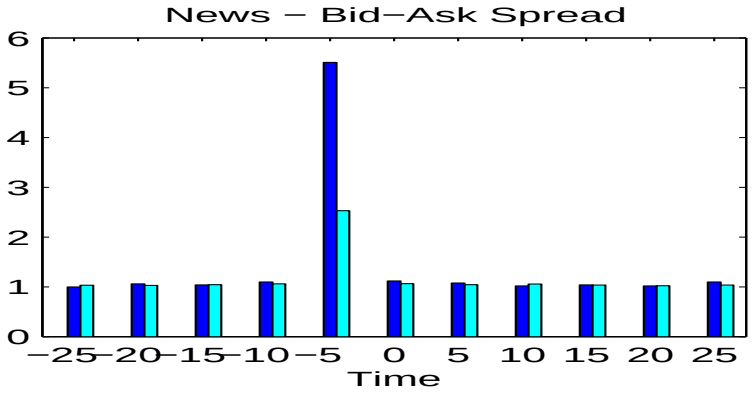
Market Activities around Jumps(1)

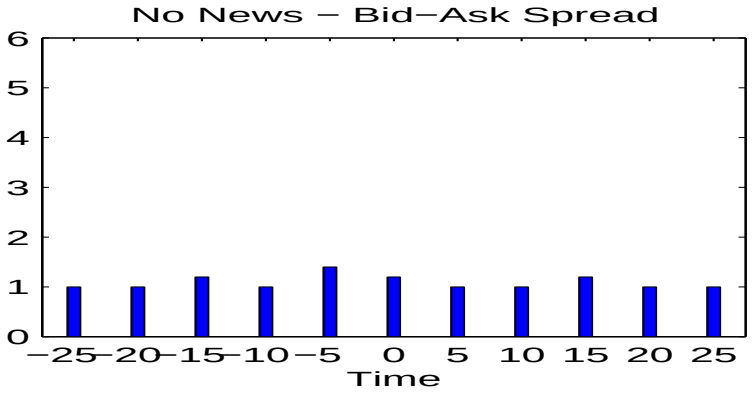




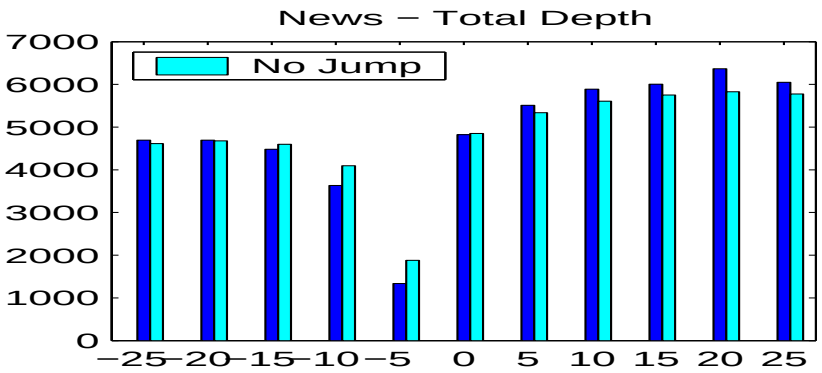


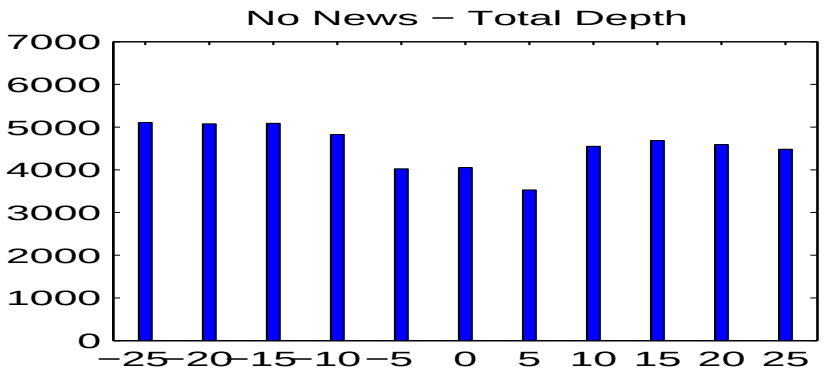


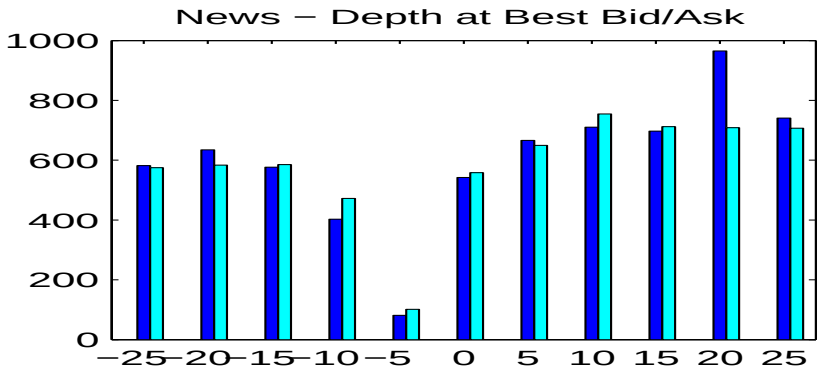


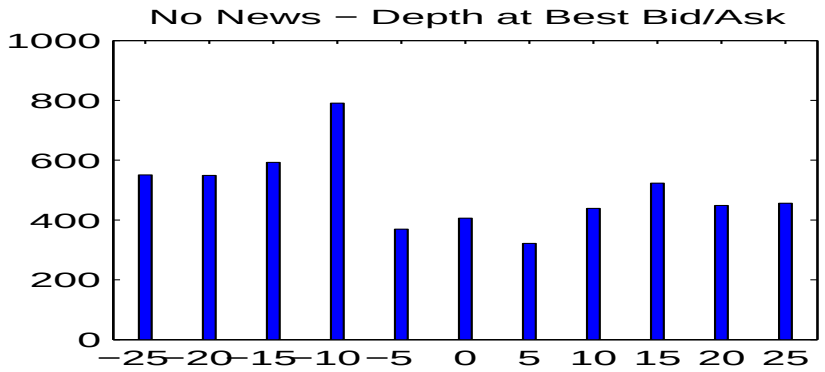


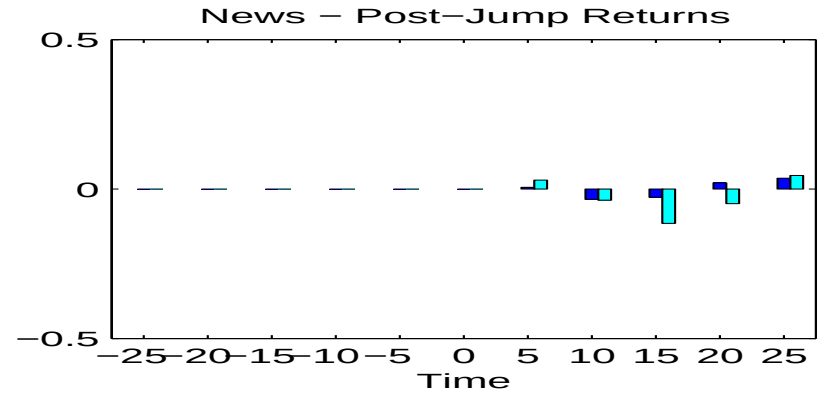
Market Activities around Jumps(2)

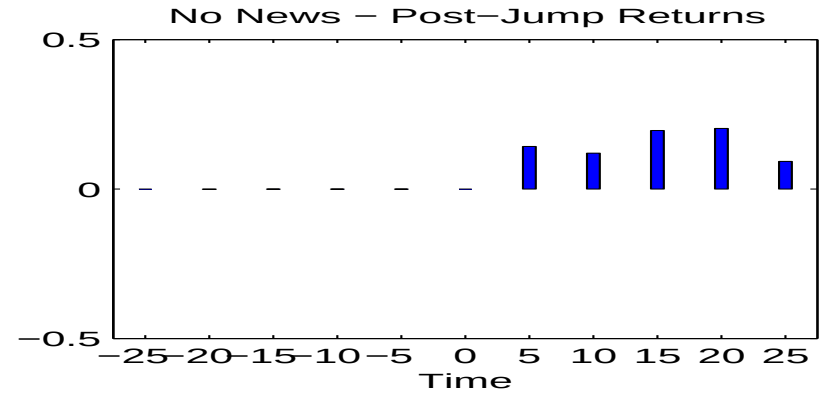












Liquidity Shocks vs News Surprise (1) (Table VI)

	2-year note				5-year note				10-year note			
shk	shk	$\|sur\|$	$\|ret\|$	N_j	shk	$\|sur\|$	$\|ret\|$	N_j	shk	$\|sur\|$	$\|ret\|$	N_j
1(low)	0.739	0.168	0.012	1	0.898	0.176	0.035	3	0.852	0.192	0.056	0
	0.694	0.647	0.023	3	0.841	0.629	0.059	5	0.832	0.685	0.069	1
	0.695	1.635	0.030	6	0.762	1.531	0.063	4	0.863	1.728	0.099	4
2	1.412	0.193	0.014	1	1.631	0.203	0.034	1	1.484	0.203	0.056	5
	1.441	0.682	0.017	3	1.618	0.720	0.045	4	1.484	0.654	0.086	5
	1.424	1.751	0.023	7	1.646	1.792	0.061	6	1.500	1.541	0.089	5
3 (high)	2.872	0.176	0.026	8	3.045	0.162	0.058	8	2.748	0.140	0.087	5
	2.899	0.653	0.028	7	3.055	0.657	0.069	11	2.744	0.623	0.106	8
	2.747	1.421	0.029	5	2.952	1.495	0.072	8	2.795	1.524	0.133	13

- Shk: depth shock

$$shk = \frac{depth_{t-1}^{overall} - \frac{1}{5}\sum_{j=2}^{6} depth_{t-j}^{overall}}{\sigma_{depth}}, \tag{5}$$

- N_j number of jumps

Liquidity Shocks vs News Surprise (2)

- Control for announcements surprise in Probit model for jumps

$$P(jump_t|annou) = f(\alpha + \beta_{vola} V_{t-1} + \beta_{Sprdshk} Sprdshk_{t-1} + \beta_{Hidshk} Hidshk_{t-1} + \beta_{Dpthshk} Dpthshk_{t-1} + \beta_{OF}|OF_{t-1}| + \beta_{OB}|OB_{t-1}| + \Sigma_{j=1}^{J} \gamma_j |Sur_{j,t}|) \quad (6)$$

where

- $V_{t-1} = \sum_{i=1}^{6} (\ln p_{t-i} - \ln p_{t-(i+1)})^2$
- $Sprdshk_{t-1} = (spread_{t-1} - \frac{\sum_{j=2}^{6} spread_{t-j}}{5}) / \sigma_{sprd}$
- $|OB_{t-1}| = |depth^{overall}_{ask,t-1} - depth^{overall}_{bid,t-1}| / \mu_{|OB|}$
- $|OF_{t-1}| = |buytrades - selltrades| / \mu_{|OF|}$

Information Shocks vs Liquidity Shocks - 2-year note (Table VII)

	Without news surprise		With news surprise	
	Estimate	P-Value	Estimate	P-Value
$\beta_{volatility}$	1.9022	0.0277	2.3463	0.0141
$\beta_{sprdshk}$	0.1319	0.2767	0.2267	0.1459
$\beta_{\|OF\|}$	0.1647	0.1814	0.2067	0.1255
$\beta_{\|OB\|}$	-0.1351	0.2880	-0.0071	0.9592
$\beta_{dpthshk}$	-0.4327	0.0625	-0.4999	0.0700
β_{hidshk}	0.1275	0.3851	0.2651	0.1202
Consumer Price Index			0.9283	0.0038
Retail Sales			20.9118	0.0075
New Home Sales			0.7584	0.0723
Joint	13.29	0.04	17.02	0.01

Information Shocks vs Liquidity Shocks - 5-year note (Table VII)

	Without news surprise		With news surprise	
	Estimate	P-Value	Estimate	P-Value
$\beta_{volatility}$	0.8525	0.0025	1.2545	0.0001
$\beta_{sprdshk}$	0.2101	0.0499	0.1395	0.3748
$\beta_{\|OF\|}$	0.0035	0.9771	-0.3693	0.0574
$\beta_{\|OB\|}$	-0.0411	0.7820	-0.0759	0.6560
$\beta_{dpthshk}$	-0.4160	0.0672	-0.9294	0.0012
β_{hidshk}	0.0564	0.6559	0.1010	0.4982
ISM index			0.6835	0.0563
Change in Nonfarm Payrolls			1.2072	0.0070
Retail Sales			14.7421	0.0693
Joint	14.76	0.03	24.85	0.00

Information Shocks vs Liquidity Shocks - 10-year note (Table VII)

	Without news surprise		With news surprise	
$\beta_{volatility}$	0.7883	$<$.0001	0.8383	$<$.0001
$\beta_{sprdshk}$	0.2497	0.0341	0.1600	0.3397
$\beta_{\|OF\|}$	0.0065	0.9677	0.0286	0.8806
$\beta_{\|OB\|}$	-0.3822	0.0303	-0.4453	0.0437
$\beta_{dpthshk}$	-0.4570	0.0520	-0.8180	0.0064
β_{hidshk}	0.0310	0.7981	0.0213	0.8798
ISM index			0.9075	0.0314
Change in Nonfarm Payrolls			1.0169	0.0276
Retail Sales			21.6375	0.0064
Joint	37.56	0.00	34.01	0.00

Price Discovery after Jumps

- Literature compares the the impact of order flow on announcement vs non-announcement days (Balduzzi, Elton and Green (2001), Green (2004), Pasquariello and Vega (2007), Menkveld, Sarkar and van de Wel (2008))
- Extend the literature:
  - ◇ Compare the informational role of order flow after announcement with jumps to that without jumps
  - ◇ Relatively silent on how informative order flow is after a significant price change

Price Discovery:

Announcement with Jumps vs Announcement No Jumps (Table VIII)

	15-min		30-min		1-hour	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
2-year note						
α	0.223	0.680	0.032	0.920	0.214	0.242
α_{jump}	-0.002	0.999	-0.497	0.497	-0.250	0.549
β^{OF}	0.019	$<$.0001	0.018	$<$.0001	0.016	$<$.0001
β^{OF}_{jump}	-0.007	0.016	-0.005	0.013	-0.004	0.002
$adj - R^2$	0.124		0.145		0.151	

Conclusion

- We examine price jumps using the high frequency data of the U.S. Treasury securities market from 2005 to 2006. Majority of jumps occur during prescheduled announcements
- Announcement surprise is not always indicative of price jumps
- Liquidity shock is predictive of price jumps, even after controlling for announcement surprises
- Post jump price process: jumps serve as a dramatic form of price discovery and post jump OF carries less information