Order Flow Segmentation and the Role of Dark Pool Trading in the Price Discovery of U.S. Treasury Securities

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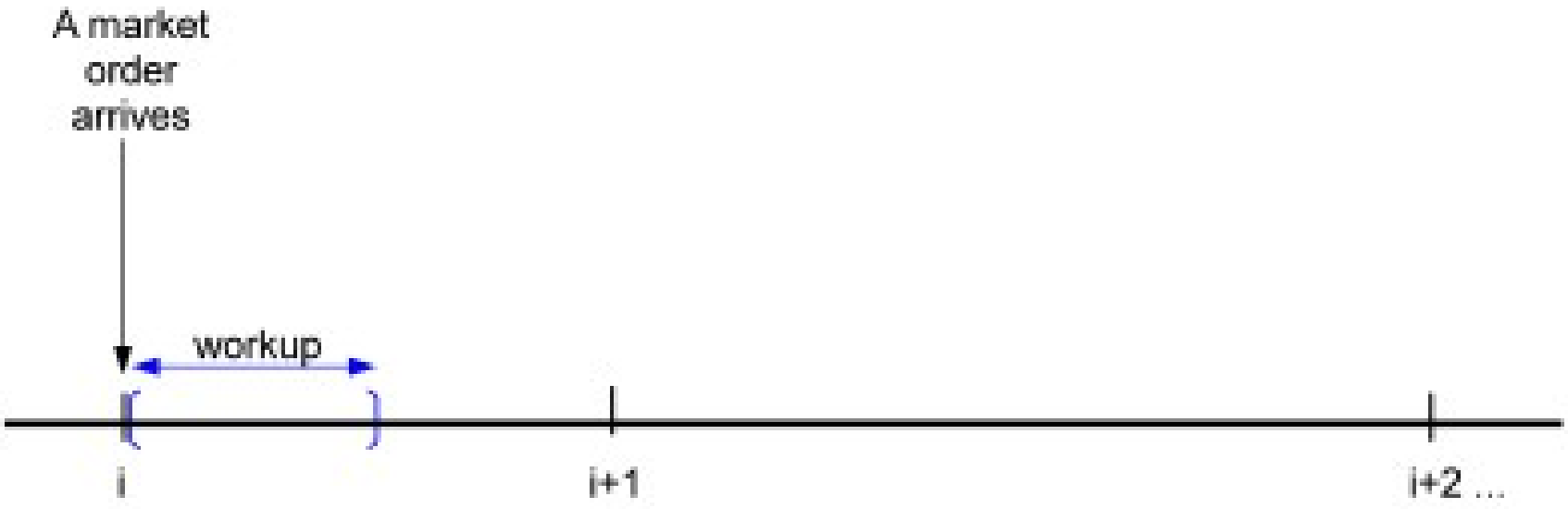
Paper Overview

1. Explore workup - unique trading feature of U.S. Treasury securities market
2. Do trades during workups contain value-relevant information? If so, to what extent?
3. How does information structure change when market is volatile? on days with important economic announcements?
4. What determine workup decision? workup volume?

Outline

Workup: How It Works



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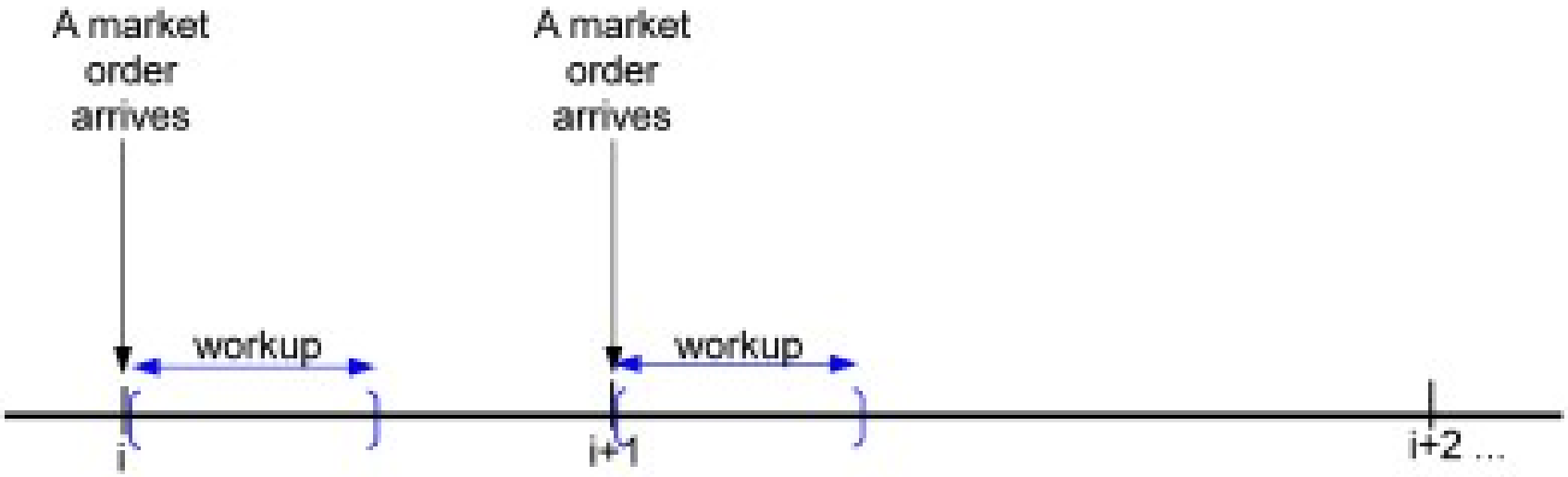

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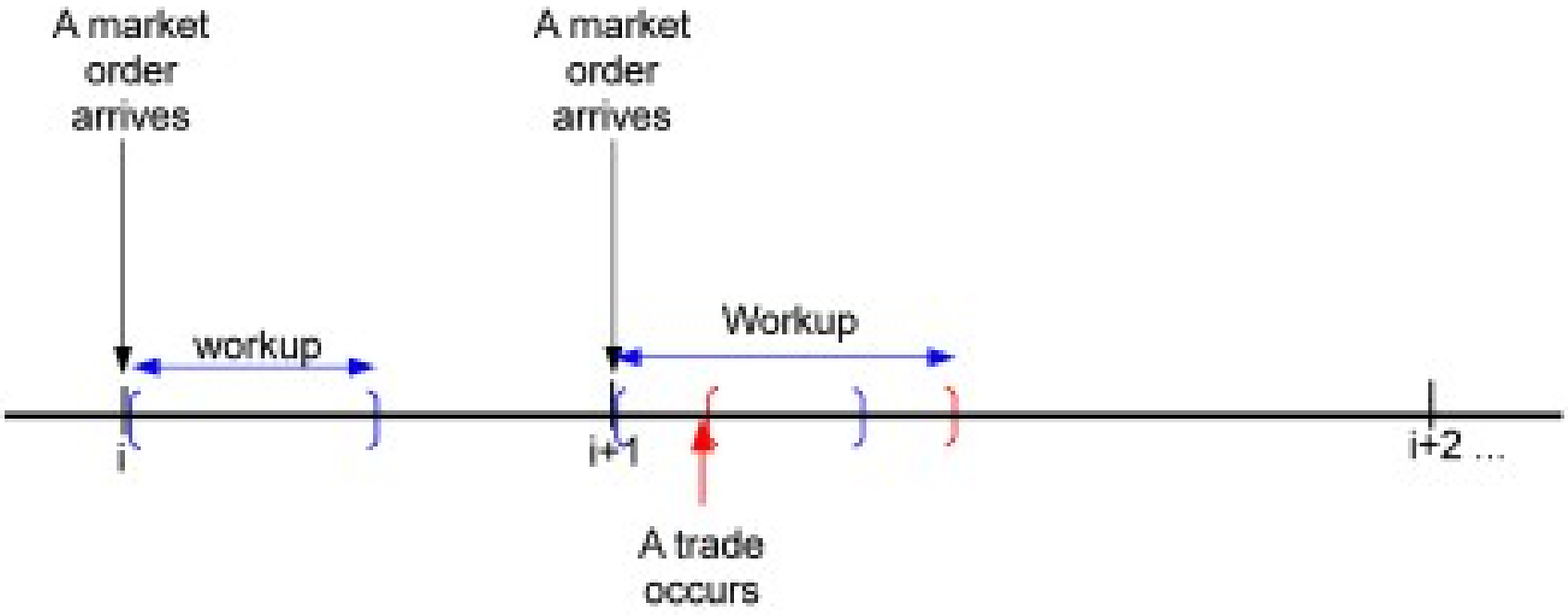

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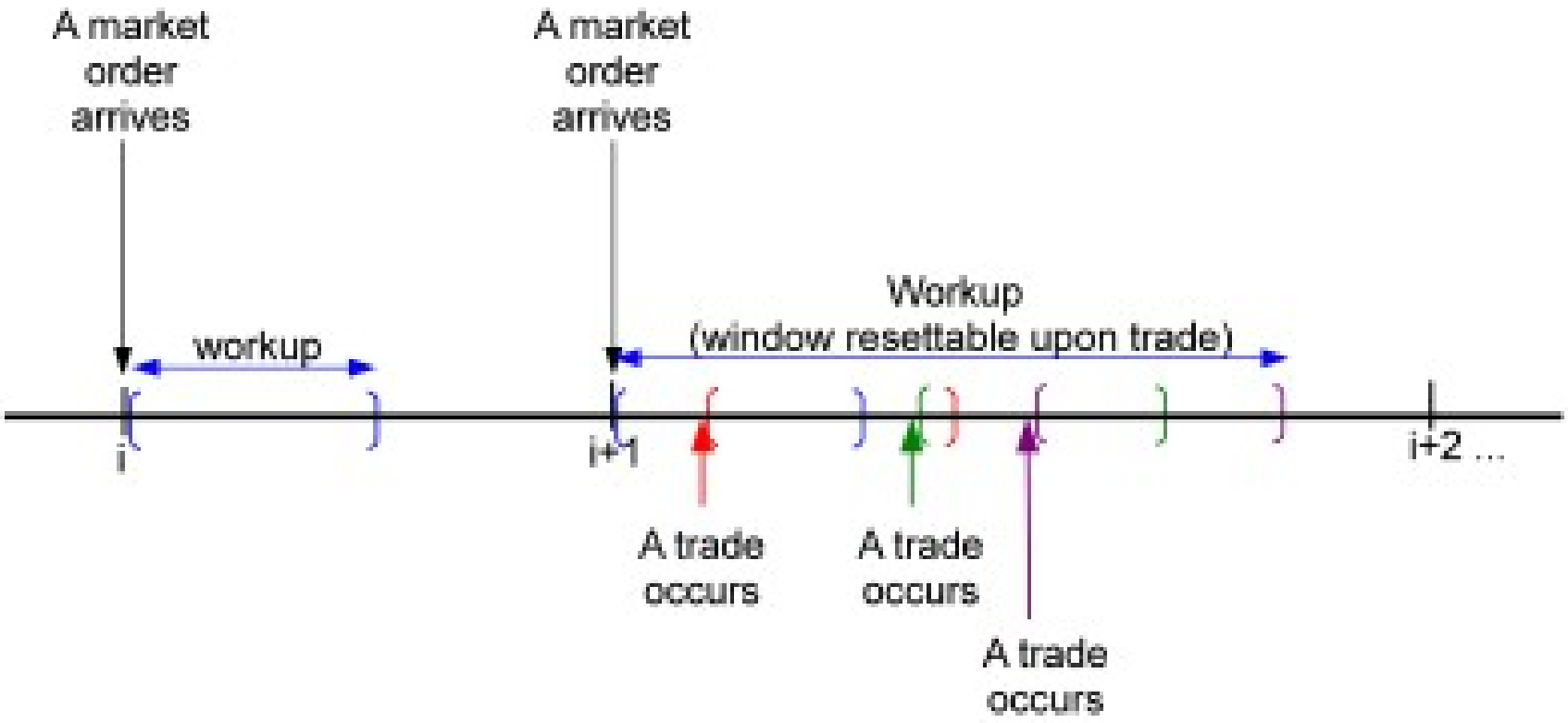

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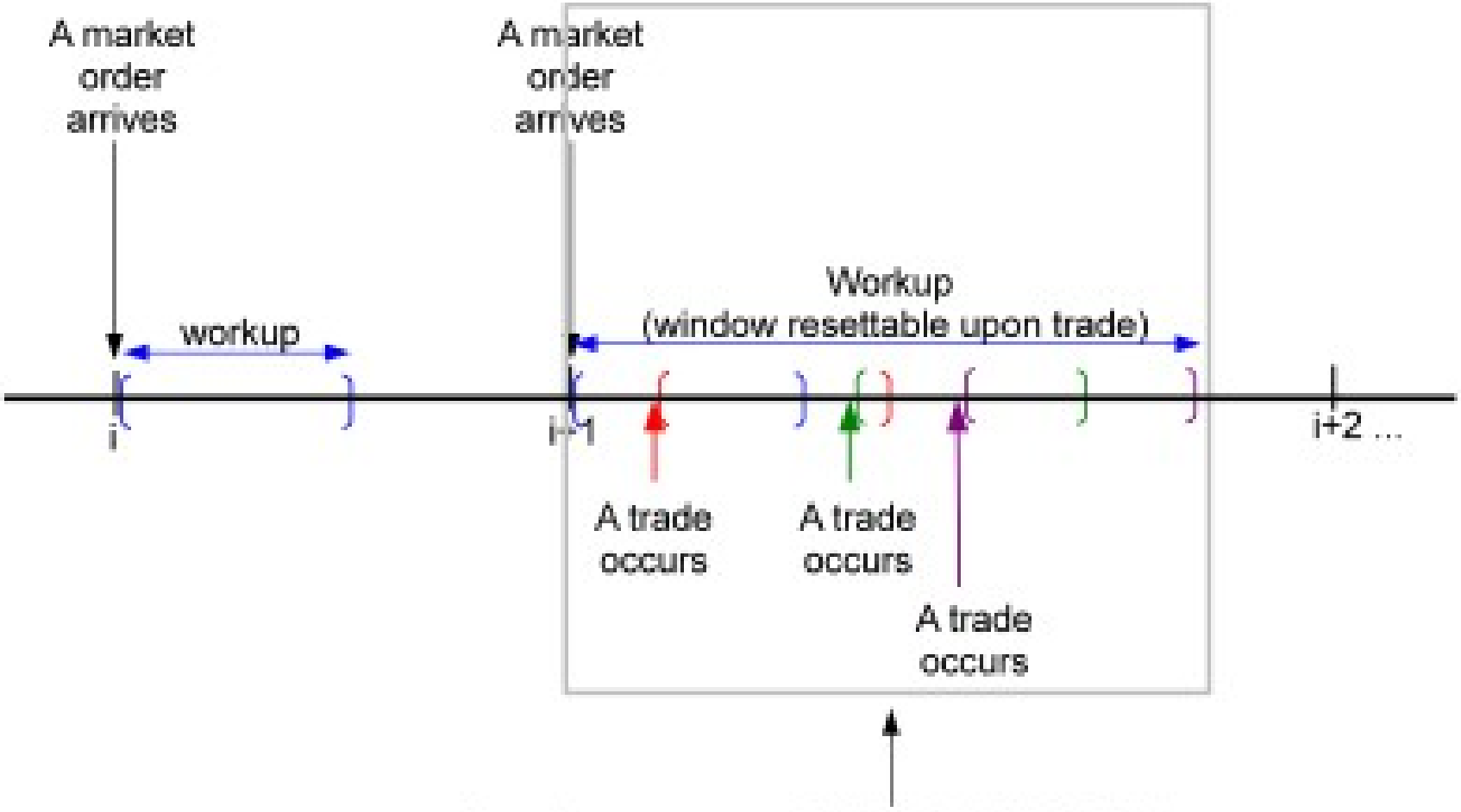

Traders' Choices Given Workup Protocol

Limit order traders (liquidity suppliers):

1. submit and display 100% intended quantity
2. submit full-sized order but display only part of it (iceberg orders)
3. submit smaller sized order and wait to expand in workups

Market order traders (liquidity demanders):

1. submit full-sized order
2. submit smaller sized order and wait to expand in workups
3. do nothing and wait for a workup

Motivation

Workup is important for managing exposure/trading strategy:

1. minimize information free-riding by others (e.g., large limit order)
2. reduce price impact of trades (especially large trades)
3. allow to search for counter trading interest at the best price available

Workup resembles a crossing network (dark pool trading mechanism)
$\rightarrow$ important implications:

1. market transparency
2. price discovery
3. liquidity discovery

Related Literature

Theoretical research:

1. Harris (1997): order exposure strategies
2. Boulative and George (2013): informed liquidity providers
3. Zhu (2013): dark pool trades are uninformative
4. Ye (2013): informed traders more likely to hide information in dark venues

Empirical research:

1. Boni and Leach (2004) investigate workup protocol in earlier market setup (voice-assisted interdealer brokers)
2. Dungey, Henry and McKenzie (2013) model trading intensity on eSpeed (rival platform to BrokerTec), taking into account possible effect of workups

Our contributions

1. First paper to evaluate information content of workups and provide complete characterization of information structure (public vs. private, normal vs. workup)
2. Further our understanding of the importance of this market mechanism in shaping information mix in electronic trading
3. Extend Boni and Leach (2004)'s model to account for other important determinants of workups
4. Contribute novel Treasury market evidence to current discussion of dark pool trading - a topic of great interest to market participants, policy makers, and academia

Preview of Key Findings

1. Workup is economically important:
   - traders use workup in 50-60% of transactions
   - workup volume accounts for 45-55% of total daily volume
2. Workup order flow is somewhat informative (esp. for T-notes), but not as informative as normal order flow
3. Workups expanding volume on aggressive side are most informationally relevant
4. Workups are more likely: 1) when market is liquid (higher depth, narrower spread, upon discovery of hidden liquidity), 2) around periods of high trading intensity, volatility and workup activity
5. Workups are more prevalent on volatile days, but less informative

Data

1. Trade and limit order book data from BrokerTec
   - One of two electronic interdealer trading platforms for U.S. Treasury securities (BrokerTec and eSpeed)
   - Slightly over 60% market share
2. On-the-run 2-, 5-, 10-, 30-year U.S. Treasury securities
3. Sample period: 2006-2011

Daily Trading and Workup Activities on BrokerTec

	2-Year	5-Year	10-Year	30-Year
Volume ($B)	33.5	34.0	29.3	4.7

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Number of Transactions	1,224	2,679	2,642	1,464
% with Workup	49.0	56.2	55.2	39.1

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% with Iceberg Order Execution	4.2	4.3	4.4	3.9
% Executed at Multiple Prices	0.0	0.2	0.2	0.5

Transactions with Workup vs. without Workup

	2-Year	5-Year	10-Year	30-Year
TRANSACTIONS WITH WORKUP				
Transaction Size ($M)	41.8	18.6	16.4	5.4
Pre-workup	15.6	6.0	5.5	1.9
Workup	26.2	12.7	10.9	3.5
TRANSACTIONS WITHOUT WORKUP				
Transaction Size ($M)	11.9	4.6	4.2	1.7

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Empirical Implementation

- VAR(5) for pre-workup trade flow (LT), price revision ($\triangle$P) and workup trade flow (DT):

$$\begin{bmatrix} LT_t \\ \triangle P_t \\ DT_t \end{bmatrix} = \sum_{i=1}^{4} A_i \begin{bmatrix} LT_{t-i} \\ \triangle P_{t-i} \\ DT_{t-i} \end{bmatrix} + \epsilon_t$$

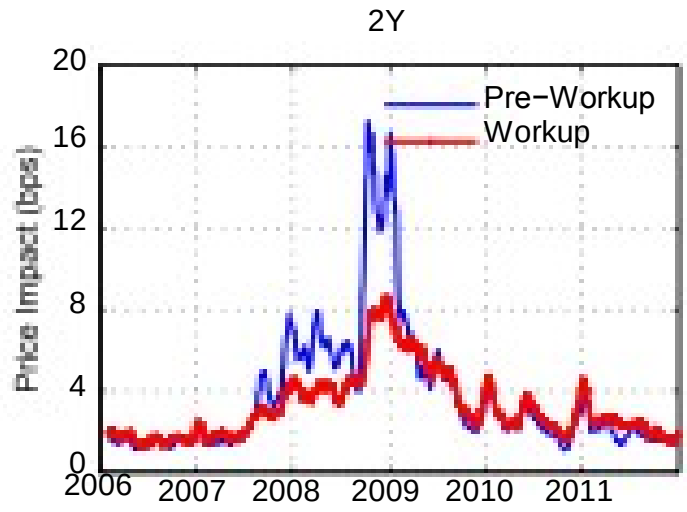
- Estimate model separately for each trading day

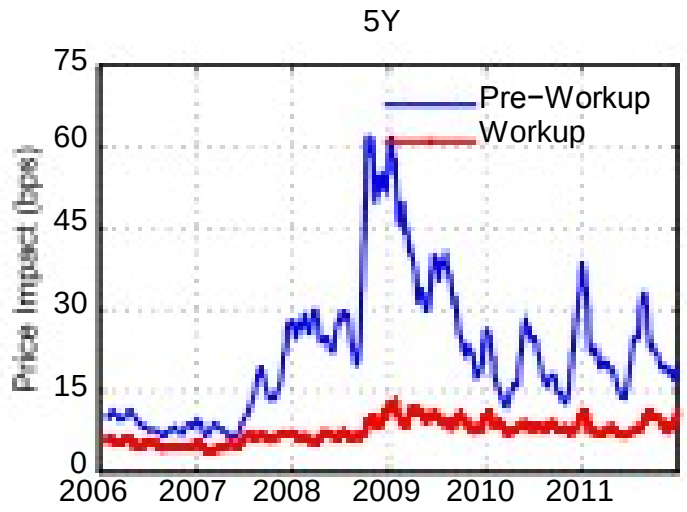
- Compute permanent price impact (long-run cumulative impulse response of price to shocks in pre-workup trades and workup trades)

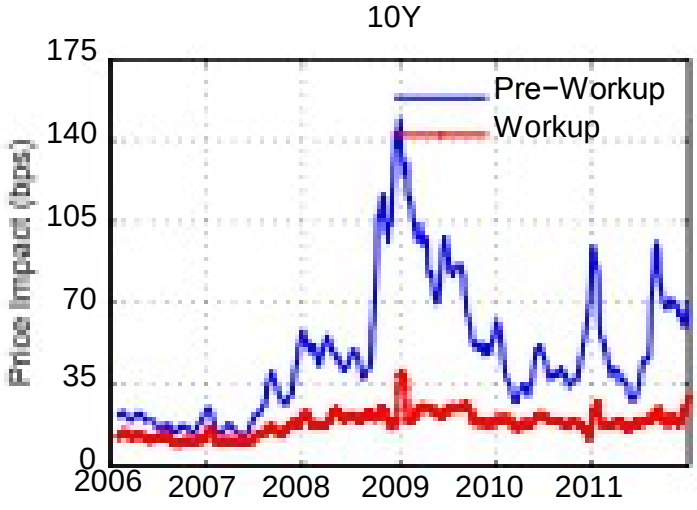
- Compute Hasbrouck information share of pre-workup trades and workup trades (contribution of respective variances to variation of permanent price impact)

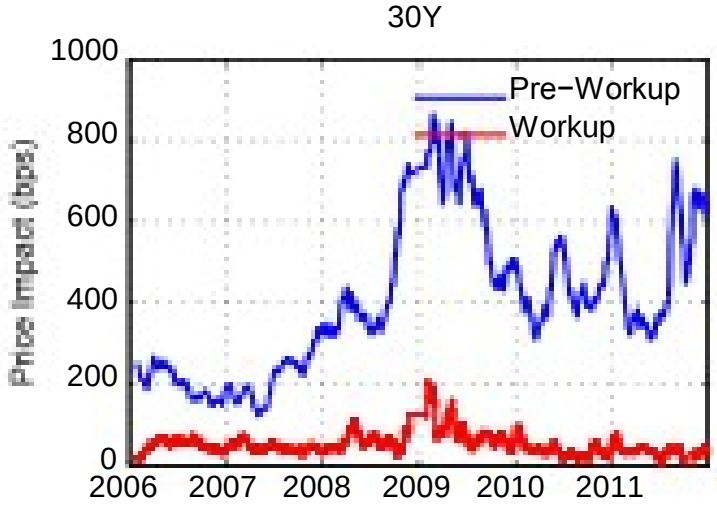
Permanent Price Impact of Trade ($1M)

Order Flow Segmented by Workup









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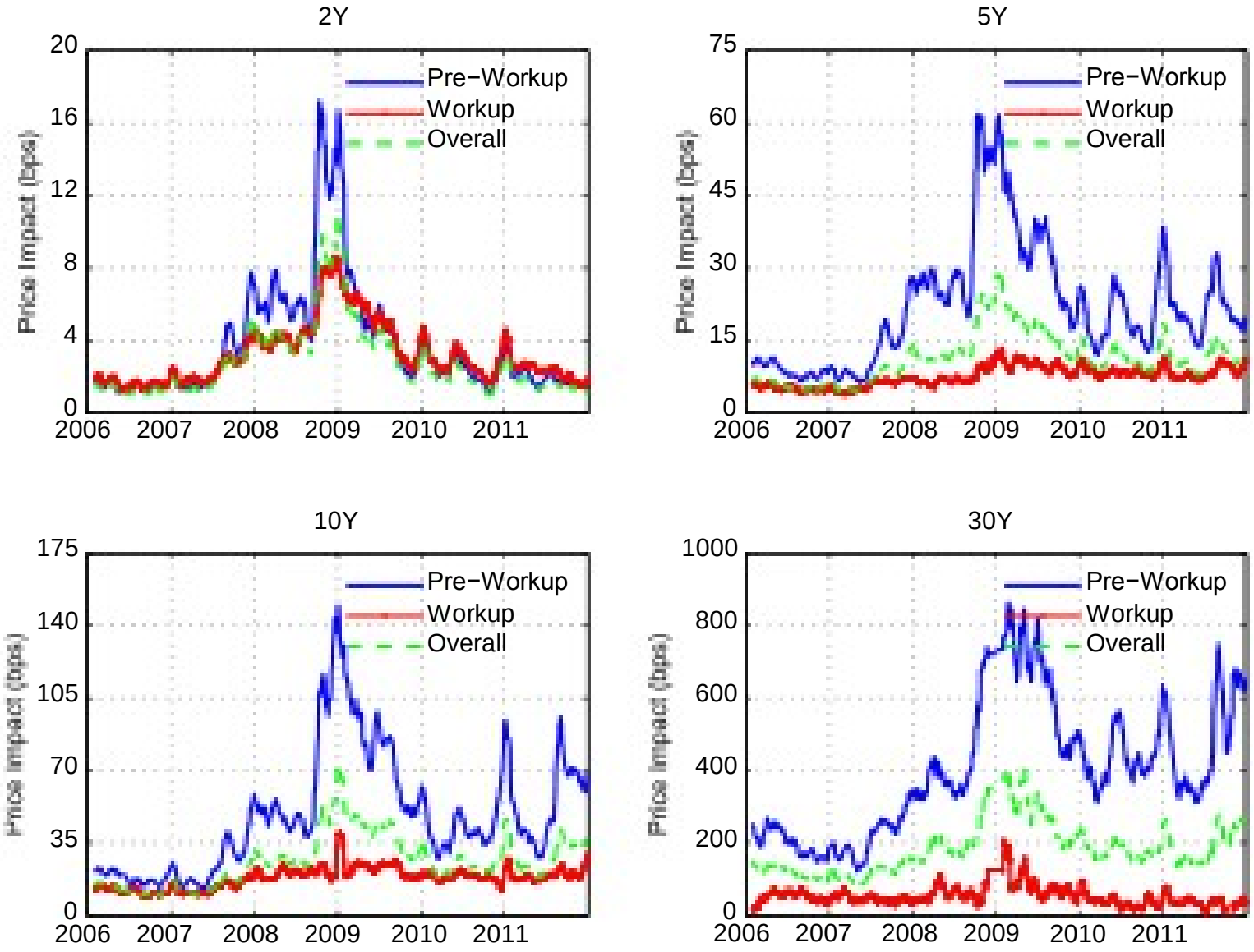
Ignoring Order Flow Segmentation (Green Line)



Information Structure

		Trade Related Information		Public
		Lit Trades	Dark Trades	Information
2-Year	Mean	15.23	17.48	67.28
	95% Range	[3.52-30.67]	[3.01-38.67]	[41.72-87.73]
5-Year	Mean	16.09	6.72	77.19
	95% Range	[6.07-26.35]	[0.54-17.82]	[63.19-91.08]
10-Year	Mean	18.52	8.21	73.28
	95% Range	[7.83-30.10]	[0.67-21.19]	[59.11-86.53]
30-Year	Mean	16.66	1.05	82.29
	95% Range	[5.66-29.95]	[0.00-5.13]	[68.69-93.73]

Note: Numbers are in percentage points

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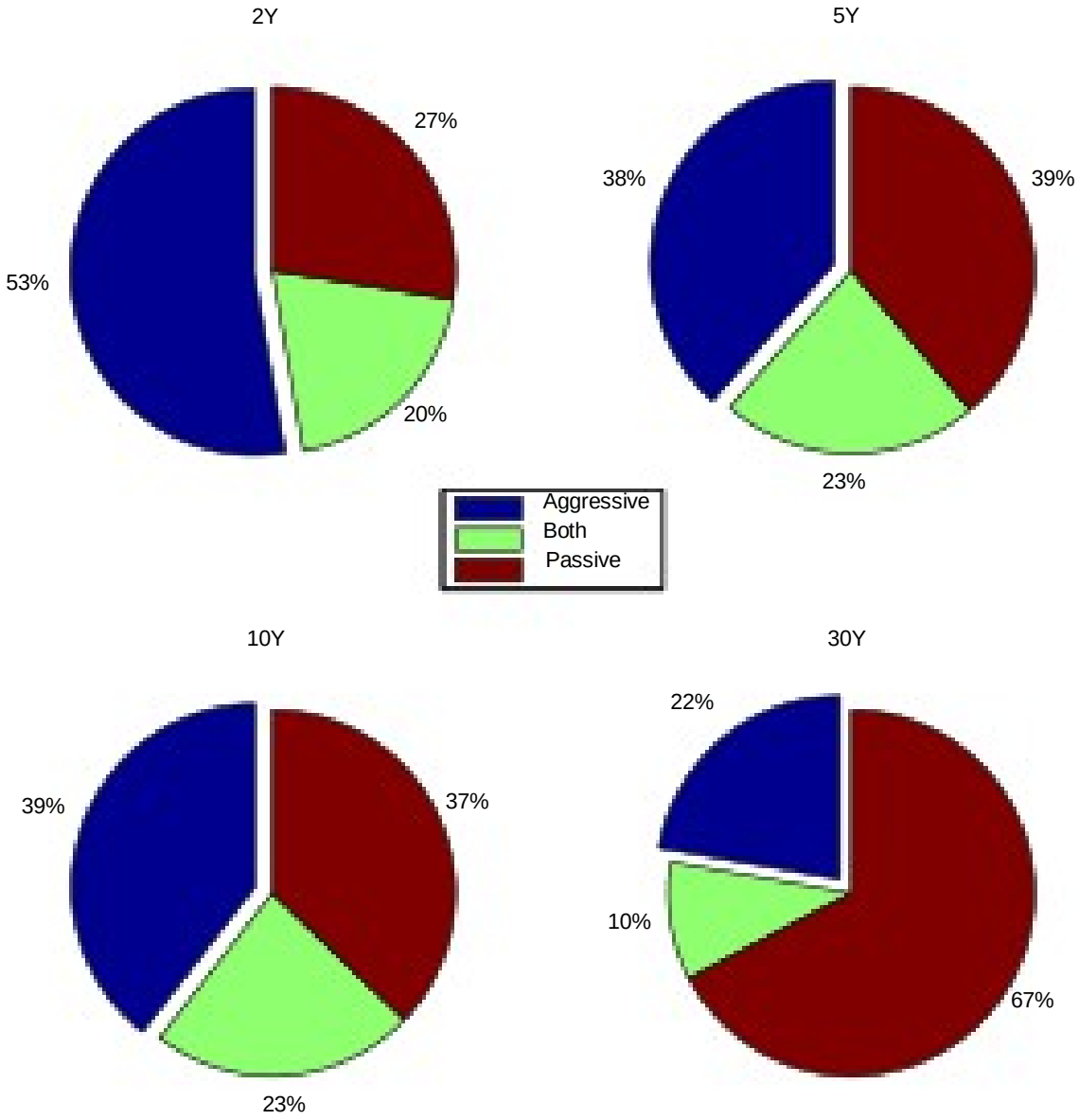
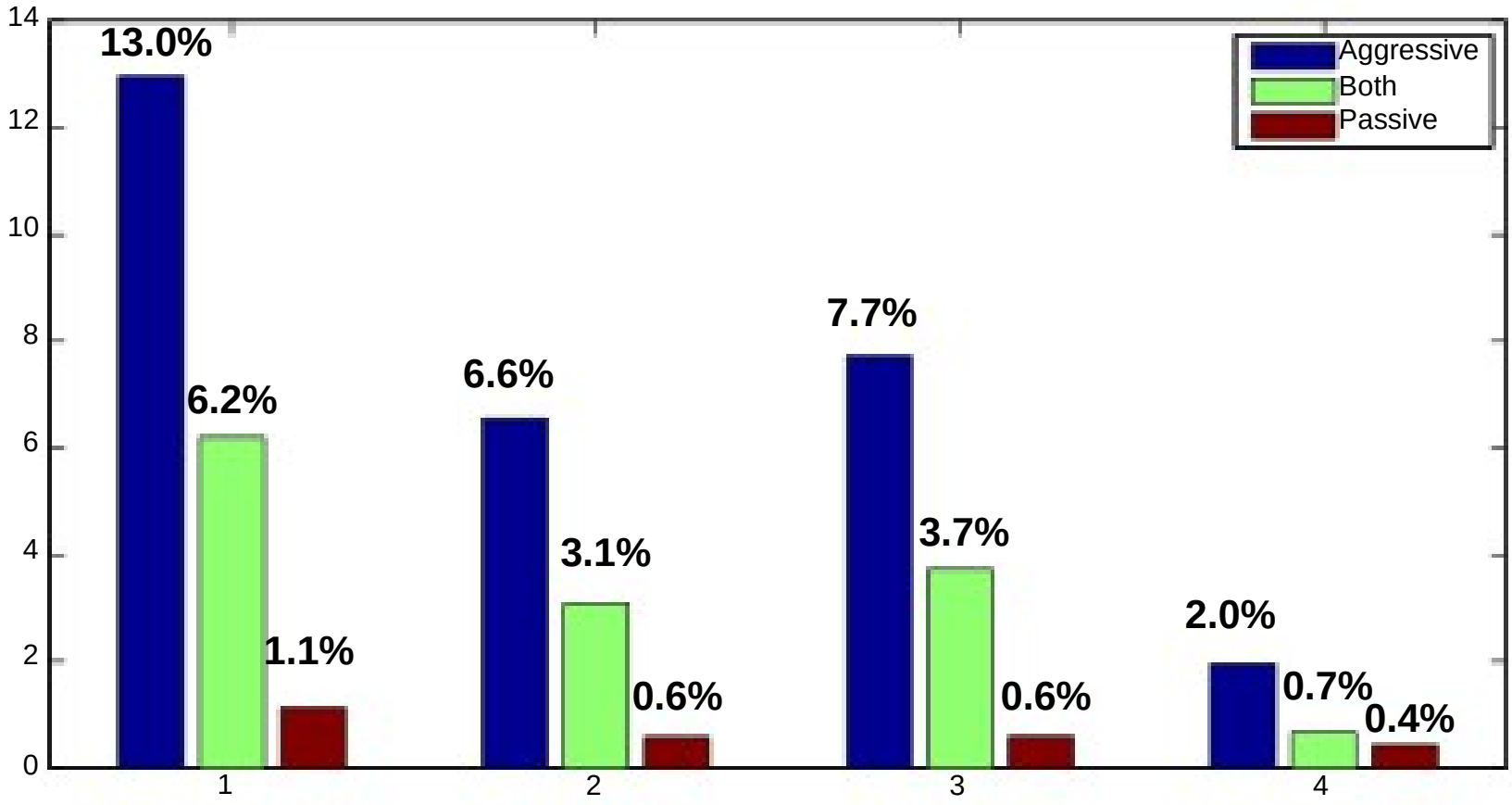
Which Sides Do Workups Expand?



Aggressive Side Workups Matter Most to Price Discovery

Percent Contribution to Price Discovery by Side of Volume Expansion During Workups



Aggressive workups: disproportionately more informative than the others

Workup Choice Model

Logistic regression of workup choice on:

- Depth on Same Side
- Depth on Opposite Side
- Pretrade Bid-Ask Spread
- Pre-workup volume (logged)
- Indicator for revelation of hidden order in pre-workup stage
- Average trade duration over last 5 minutes (logged)
- Volatility over last 5 minutes (hi lo range)
- % transactions with workup over last 5 minutes
- % volume expanded during workups (conditional on workup) over last 5 minutes
- Dummies for Tokyo and London trading hours

Determinants of Workup - Select Coefficients

	2-Year	5-Year	10-Year	30-Year
Depth - Same Side	0.131	0.145	0.147	0.049
Depth - Opposite Side	-0.101	0.081	0.046	0.522
Pre-trade Spread	-0.217	-0.240	-0.172	-0.009
Hidden Depth Revealed	0.156	0.419	0.338	0.992
Pre-workup Volume	0.095	0.081	0.087	-0.193
Last 5-Min Average Trade Duration	-0.174	-0.264	-0.265	-0.207
Last 5-Min Volatility	0.084	0.042	0.030	0.007
Last 5-Min Workup Probability	0.496	0.641	0.586	0.406
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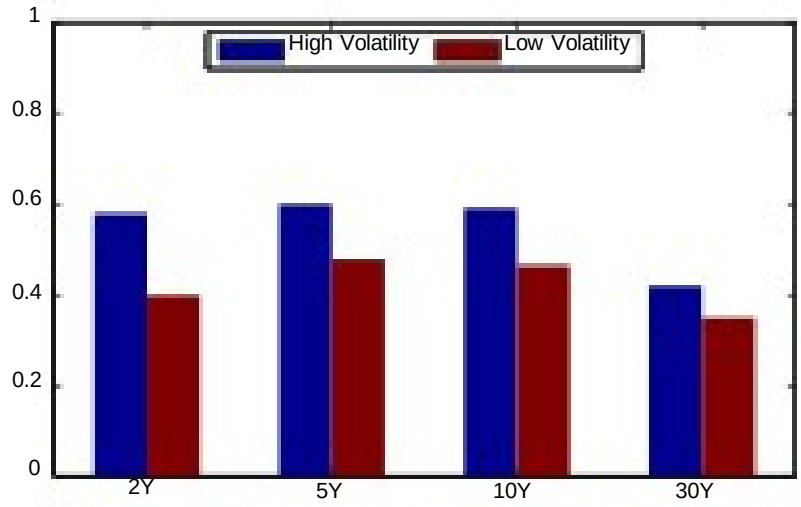
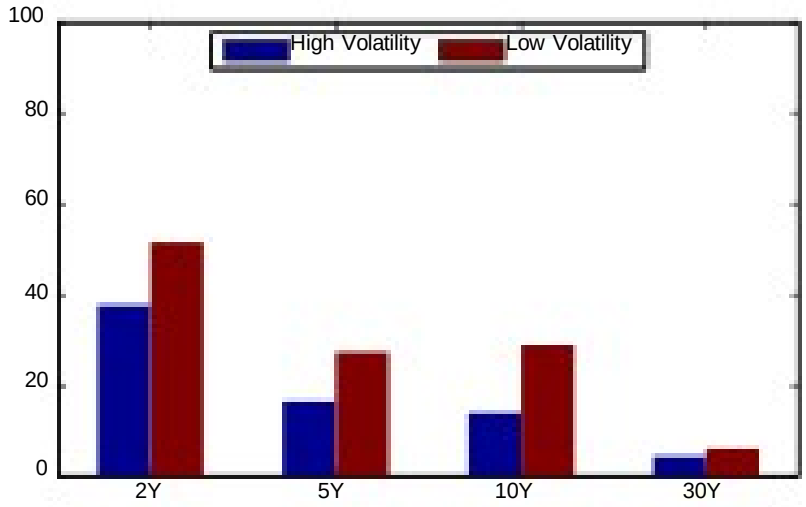
Workup Trades Are More Prevalent but Less Informative in Volatile Market



(a) Workup Probability



(b) Workup Informativeness

Notes:

- High/Low: 95th/5th percentiles of daily volatility distribution
- Workup informativeness: % of private information contribution

Conclusion

1. Workups uncover a large portion of market liquidity
2. Workup trade flow generally contains less information than its transparent counterpart.
3. Informativeness of workups varies: 1) most informative at short maturity, least informative at long maturity; 2) most informative when expanding volume on aggressive side.
4. Workups are more likely to occur when market is liquid (higher depth, narrower spread), when volatility and trading/workup activity is high, and for larger sized orders.
5. Workups are more prevalent but relatively less informative on volatile days → useful for guarding against adverse price movements; less so for hiding private info.