Does Financial Market Structure Impact the Cost of Capital?

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Agenda

1. What is known about cost of capital & market structure & liquidity
   - Frictions in raising capital (SEO underpricing)
   - Level of asset prices

2. Our approach/event, Nasdaq reforms (OHR):
   - Most significant market structure change?
     - Reduced spreads by 30%, reduced institutional costs 10-25%
     - Well identified, only Nasdaq and staggered phase-in
     - But, Nasdaq in 1997 ...

3. Empirical approach:
   - Staggered introduction of OHR within Nasdaq:
     - OHR treatment effect and OHR introduction as IV for liquidity
     - Controls for possible Nasdaq effect due to tech runup
   - NYSE stocks as controls for OHR treatment effect:
     - Nasdaq v. NYSE SEO underpricing (pre/post) & returns (during OHR)
     - Controls for possible non-random OHR rollout on Nasdaq

4. Summary & conclusion

Cost of Capital & Market Structure & Liquidity

- Finance allocates resources and impacts economic growth
- Markets link investors & firms for trade & price discovery
  - Impacts firms' cost of capital & investment decisions
- Limited evidence on how market structure impacts cost of capital through financing frictions and asset prices
  - Secondary market frictions (illiquidity) can affect asset returns
  - Market structure of trading affects secondary market liquidity
  - Linkage of primary and secondary markets
  - Direct link between market structure & cost of raising capital (fees, underpricing, & asset prices)?
- We provide direct, causal evidence on the relationship among the underpricing of SEOs, asset prices, & market structure & liquidity
  - Endogeneity among underpricing, liquidity, & asset prices?

Nasdaq Order-Handling Rules (OHR) Reforms

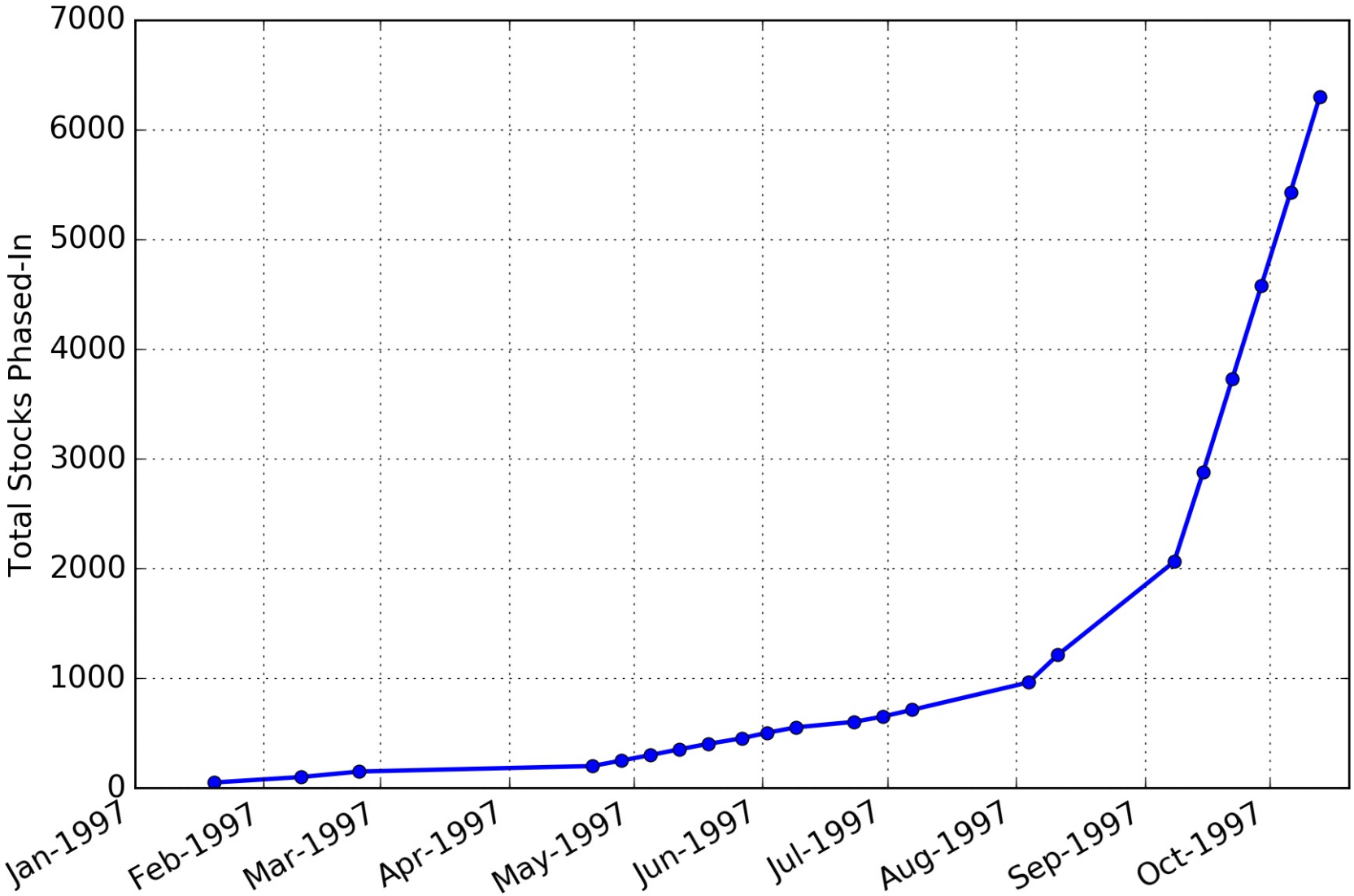
Following odd 1/8ths SEC/DOJ investigations

- OHR comprise two major changes (reduces OTC nature):
- Limit Order Display Rule: market makers display investor limit orders
- Quote Rule: market makers display best quotes & ECNs quotes
  - Less important: Minimum Quote Size, Excess Spread Rule, SOES

- Implemented using a staggered phase-in with 22 waves
  - 1st wave on 1/20/97, last wave 10/13/97, not completely random
  - First 13 waves: "Top 1000" Nasdaq stocks by median dollar volume, each wave including 10 largest volume stocks and a random draw of eight stocks from the top five deciles.
  - Wave 14 (Aug 4): first wave of stocks from entire Nasdaq universe
  - Initial waves comprised only 50 stocks
  - Majority of stocks phased-in in groups of $\sim$ 850 stocks in Sept-Oct

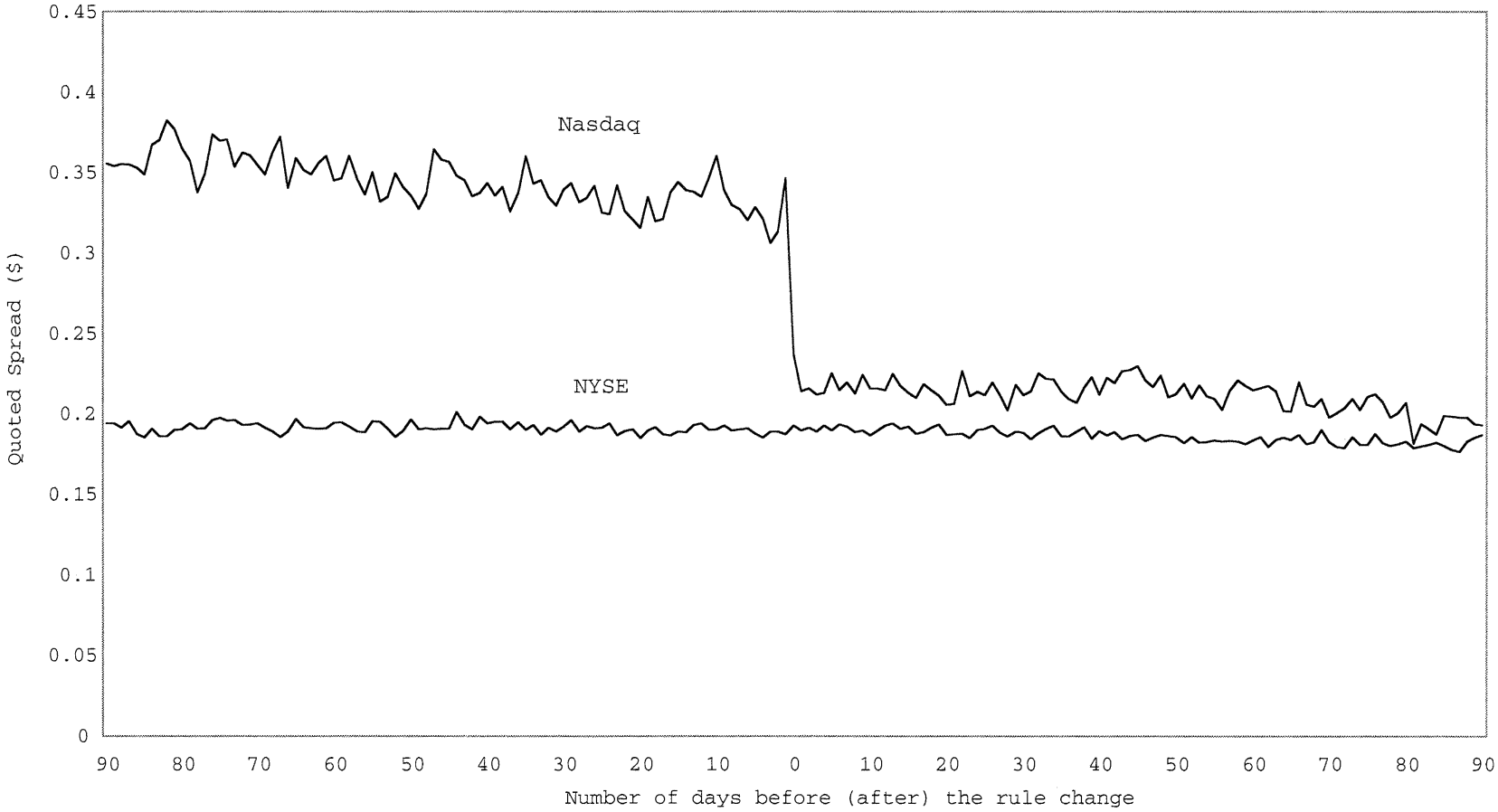
OHR Staggered Rollout

Cumulative number of stocks covered by OHR over time



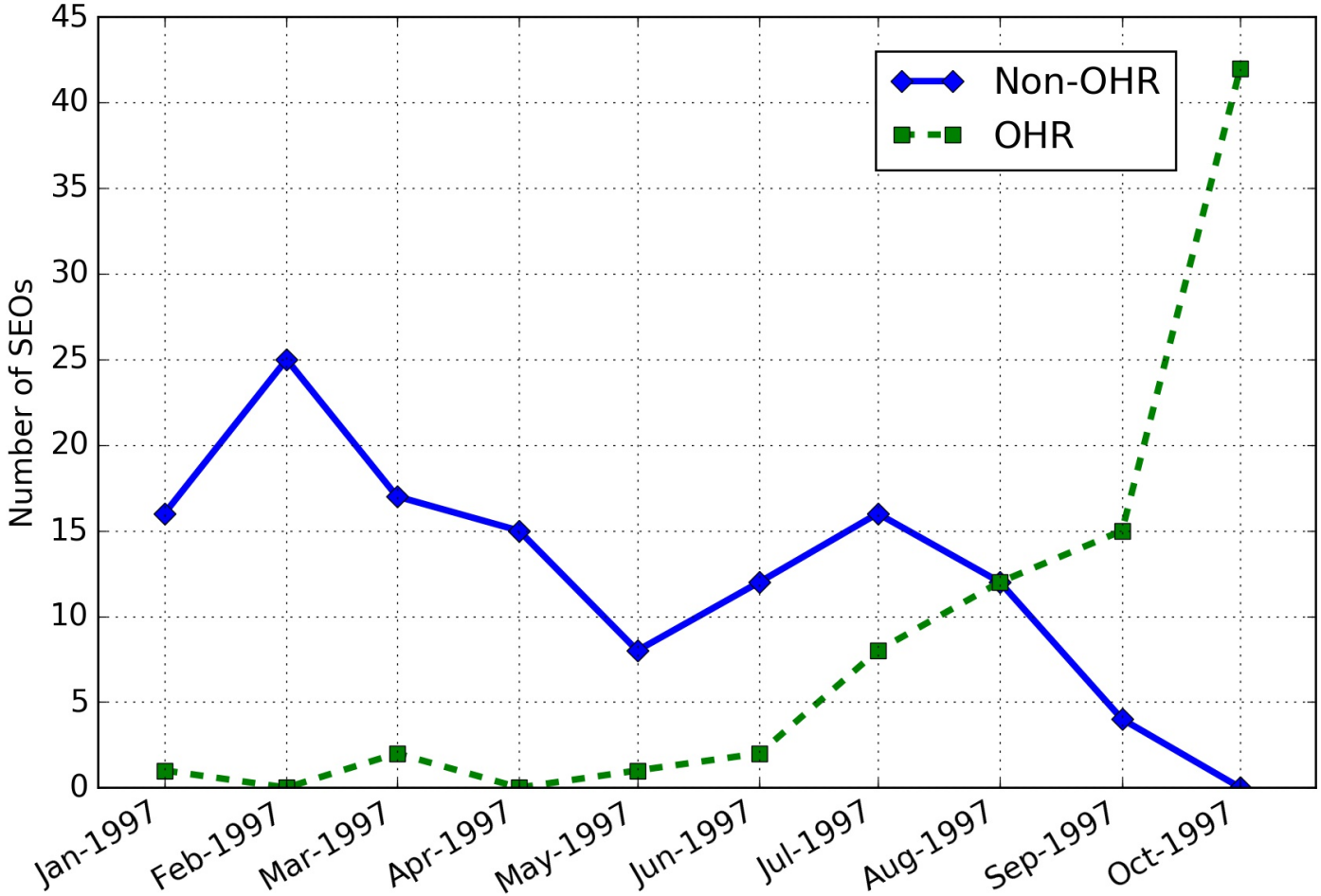
Did the Nasdaq OHR Reforms Matter?

Numerous papers show spreads decline (Weston, 2001):



- But, inside depth declined; Plexus data: institutional costs (implementation shortfall) fell 5-15bp (pre-OHR avg 40-50bp)

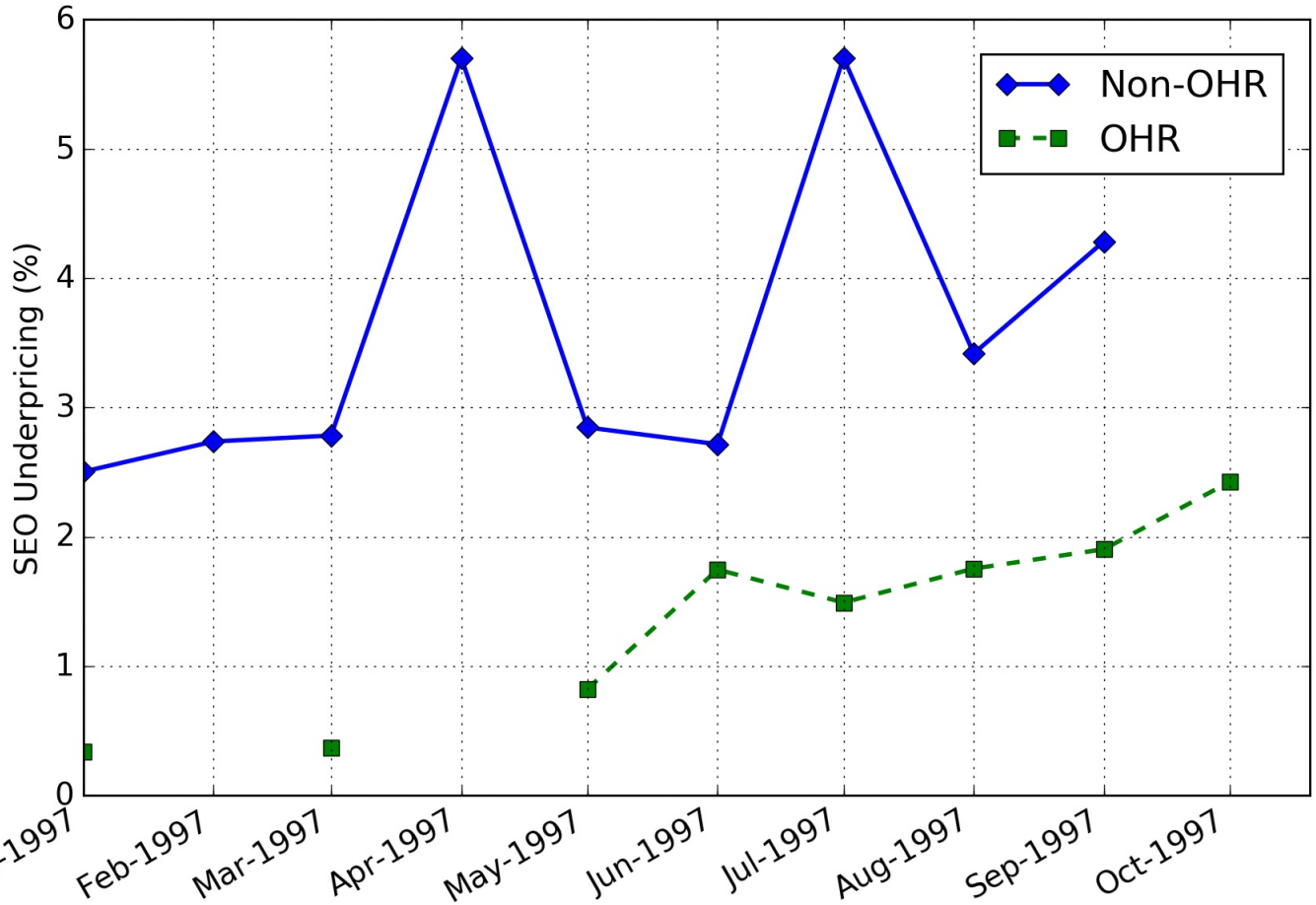
Number of Nasdaq SEOs by OHR status



- No repeat SEOs, so use observable firm characteristics as controls
- Reg M in March, 16ths in June, so also examine July-October

Nasdaq SEO Underpricing by OHR status

Underpricing is prior close minus offer price



- Pre-OHR 3.60%, post-OHR 1.97%
- Use observables to control for possible non-randomness in rollout

OHR Treatment Effect

DiD regressions (Underpricing on time effects, controls, OHR, and OHR cohort effects):

$$y_{it} = \gamma_c + \mu_t + \beta OHR_{it} + \rho' x_{it} + \varepsilon_{it}$$

	Model A		Model B		Model C		Model D	
Ln(Market Cap)			-0.64	(-1.44)	-0.62	(-1.27)	-1.04	(-2.04)
Relative Size			1.52	(0.99)	2.02	(1.28)	1.57	(1.00)
Volatility			0.14	(0.86)	0.17	(1.01)	0.21	(1.21)
Ln(Price)			-1.22	(-1.98)	-1.20	(-1.91)	-0.69	(-1.14)
Ln(Volume)			0.10	(0.39)	0.12	(0.46)	0.02	(0.07)
OHR	-1.57	(-3.69)	-1.55	(-3.65)	-1.43	(-2.25)	-2.16	(-3.06)
Fixed Effects	None		None		Month		PI-Date & OHR	
Large and Small Stocks								
OHR - Small	-1.62	(-2.23)	-2.17	(-2.94)	-3.10	(-2.99)	-3.51	(-2.40)
OHR - Large	-1.06	(-3.28)	-1.07	(-2.92)	-0.94	(-2.25)	-1.42	(-2.27)
Post Tick / Reg-M Sample: July-October								
OHR - Post	-2.20	(-3.55)	-1.76	(-2.58)	-1.95	(-2.66)	-2.94	(-3.28)

Bigger effect in smaller stocks and post 16th and Reg-M

IV Results Bid-Ask

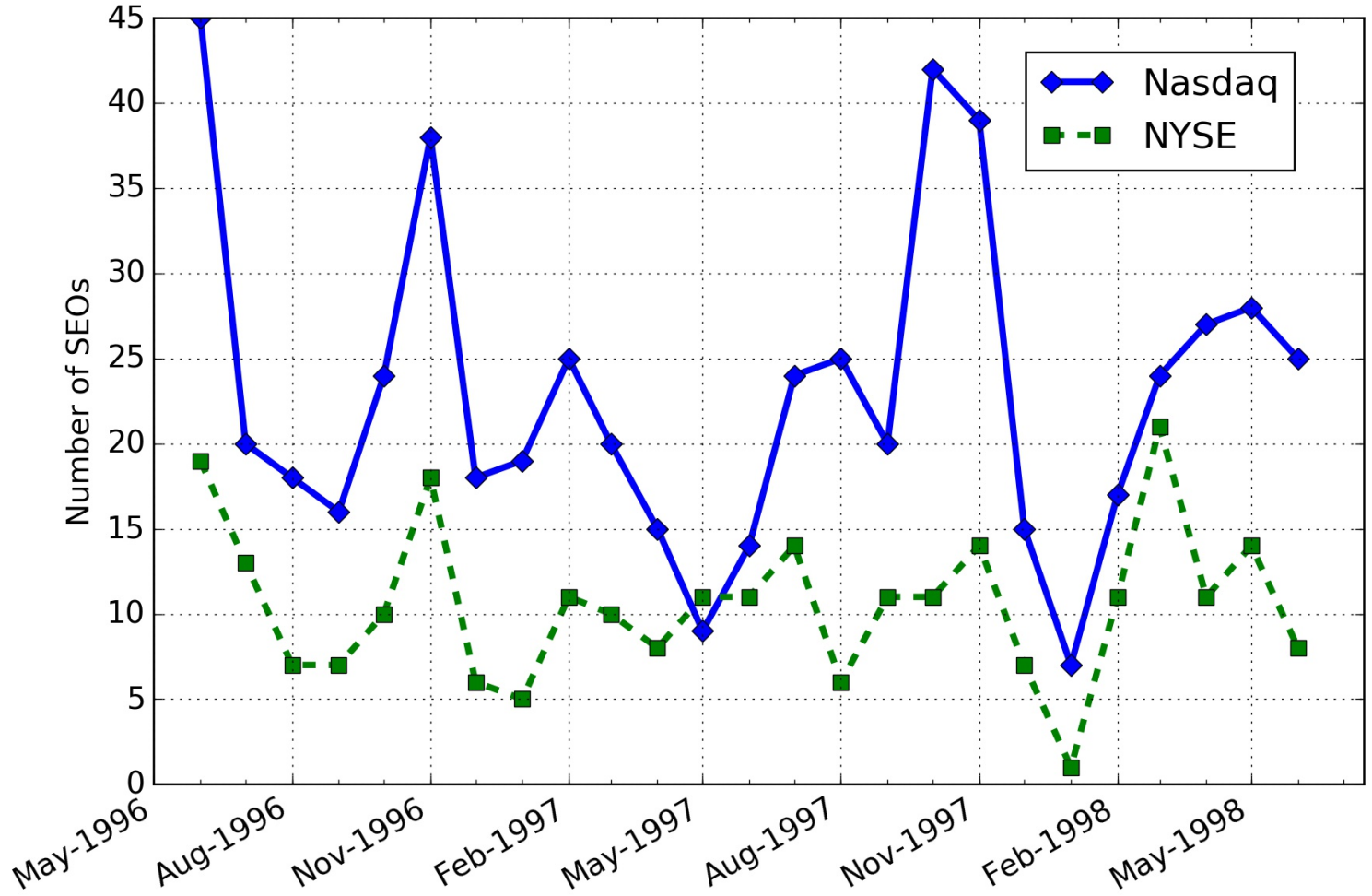
1st stage is *Liq* regressed on *OHR* dummy & controls, 2nd stage:

$$y_{it} = \mu_t + \beta Liq_{it} + \rho' x_{it} + \varepsilon_{it}$$

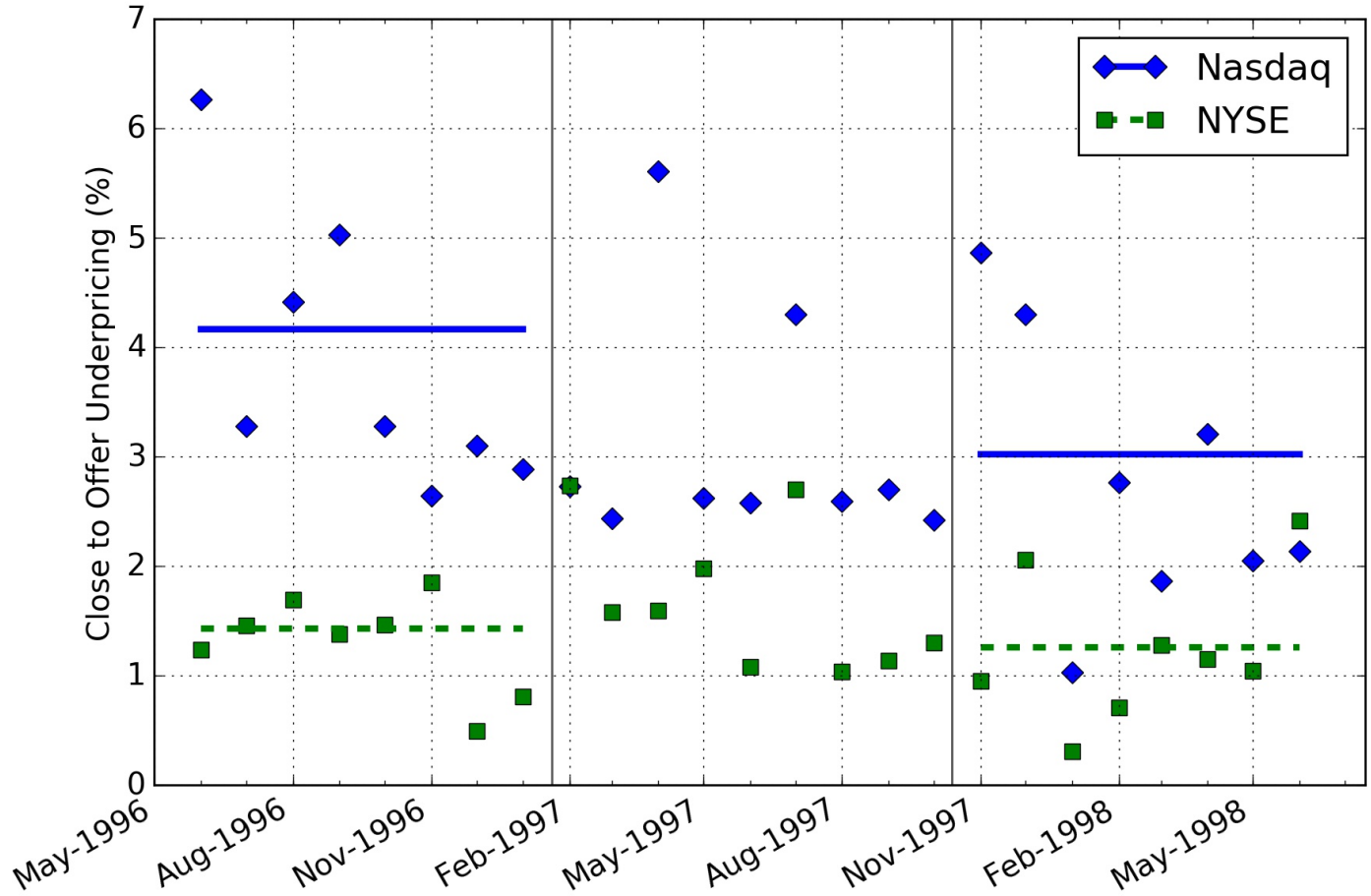
	Model A		Model B		Model C	
Ln(Cap)			-0.51	(-1.01)	-0.52	(-0.90)
Rel. Size			0.99	(0.69)	1.27	(0.82)
Volatility			0.19	(1.17)	0.21	(1.23)
Ln(Price)			-1.45	(-2.19)	-1.40	(-1.95)
Ln(Vlm)			0.67	(1.91)	0.73	(1.62)
BidAsk (%)	1.13	(3.76)	1.30	(3.44)	1.37	(2.19)
1st Stage Coef.	-1.36	(-8.40)	-1.20	(-9.32)	-1.04	(-4.26)
Effects	None		None		Time	

Multiplying 1st-stage & 2nd-stage coefficients yields decline in underpricing of $\sim$1.5%, similar to treatment effect regression estimate
So change in liquidity can explain all of change in underpricing

Number of NYSE & Nasdaq SEOs (96-98)

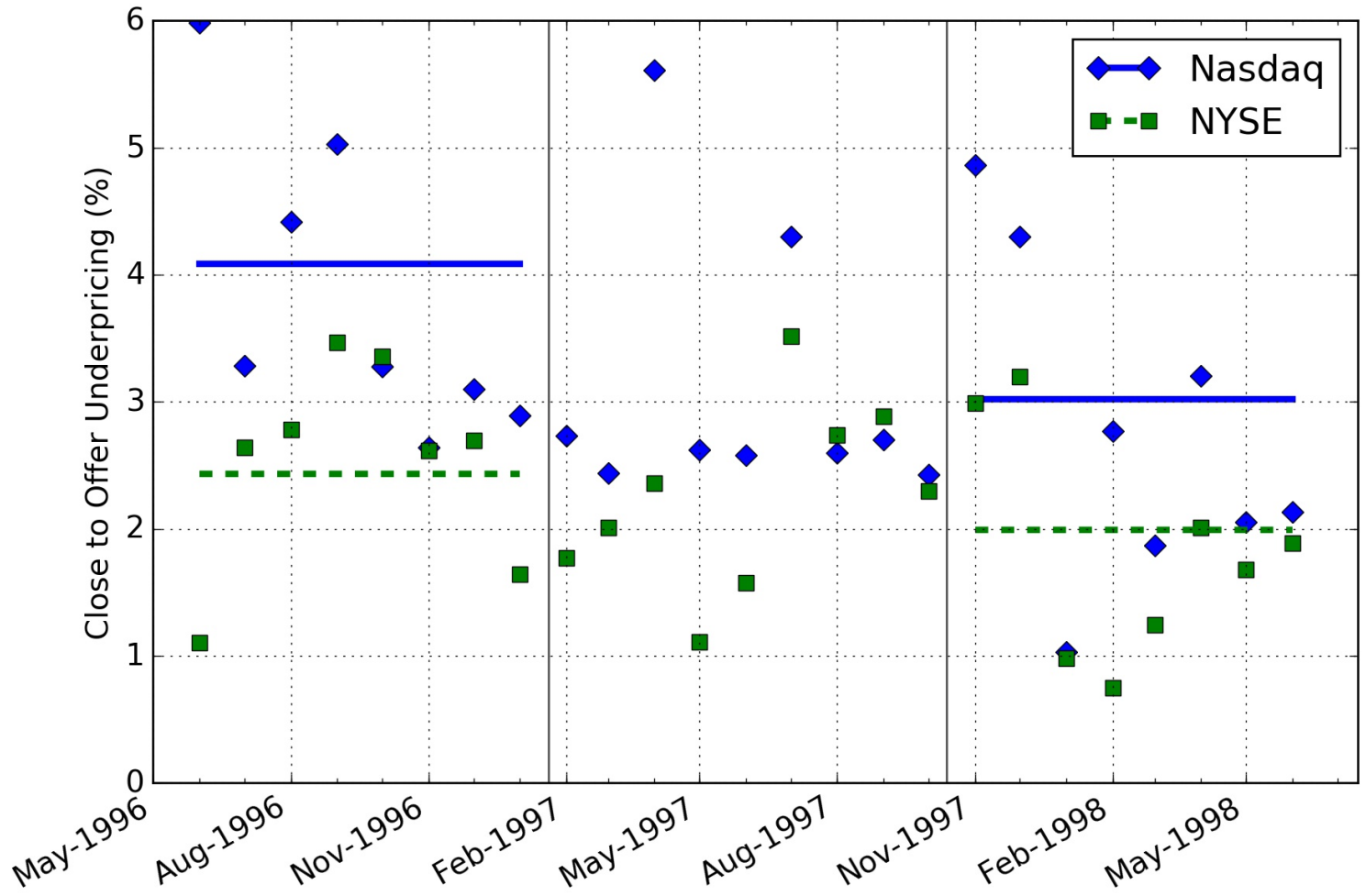


NYSE v. Nasdaq SEO underpricing (All)



- Nasdaq declines $\sim$1%; do we need to ensure NYSE and Nasdsaq stocks are as similar as possible?

NYSE v. Nasdaq SEO underpricing (Matched Sample)



- Nasdaq declines $\sim$1%

NYSE-Nasdaq Difference-in-Differences - Raw Means

Two DiD: (Nasdaq-NYSE pre) - (Nasdaq-NYSE post)
or (Nasdaq pre/post) - (NYSE pre/post)

	Underpricing (%)		Bid-Ask (%)		High-Low Spread	
$\hat{\mathbb{E}}\left[Y_i^{Nas,96} - Y_i^{NYSE,96}\right]$	2.79	(6.71)	1.00	(5.97)	1.16	(13.6)
$\hat{\mathbb{E}}\left[Y_i^{Nas,98} - Y_i^{NYSE,98}\right]$	1.04	(3.83)	-0.09	(-0.57)	0.58	(8.88)
$\hat{\mathbb{E}}\left[Y_i^{NYSE,98} - Y_i^{NYSE,96}\right]$	-0.17	(-0.59)	-0.22	(-1.22)	0.00	(0.08)
$\hat{\mathbb{E}}\left[Y_i^{Nas,98} - Y_i^{Nas,96}\right]$	-1.93	(-4.79)	-1.31	(-8.03)	-0.57	(-6.39)
τ (No Controls)	-1.75	(-3.49)	-1.09	(-4.62)	-0.58	(-5.39)
τ (Controls)	-1.39	(-3.03)	-1.11	(-6.14)	-0.55	(-5.08)

$$y_i = \delta_0 + \delta_1 t_i + \delta_2 Nas_i + \tau\, t_i Nas_i + \varepsilon_i$$

Diff-in-Diff comes from a decline in Nasdaq SEO underpricing

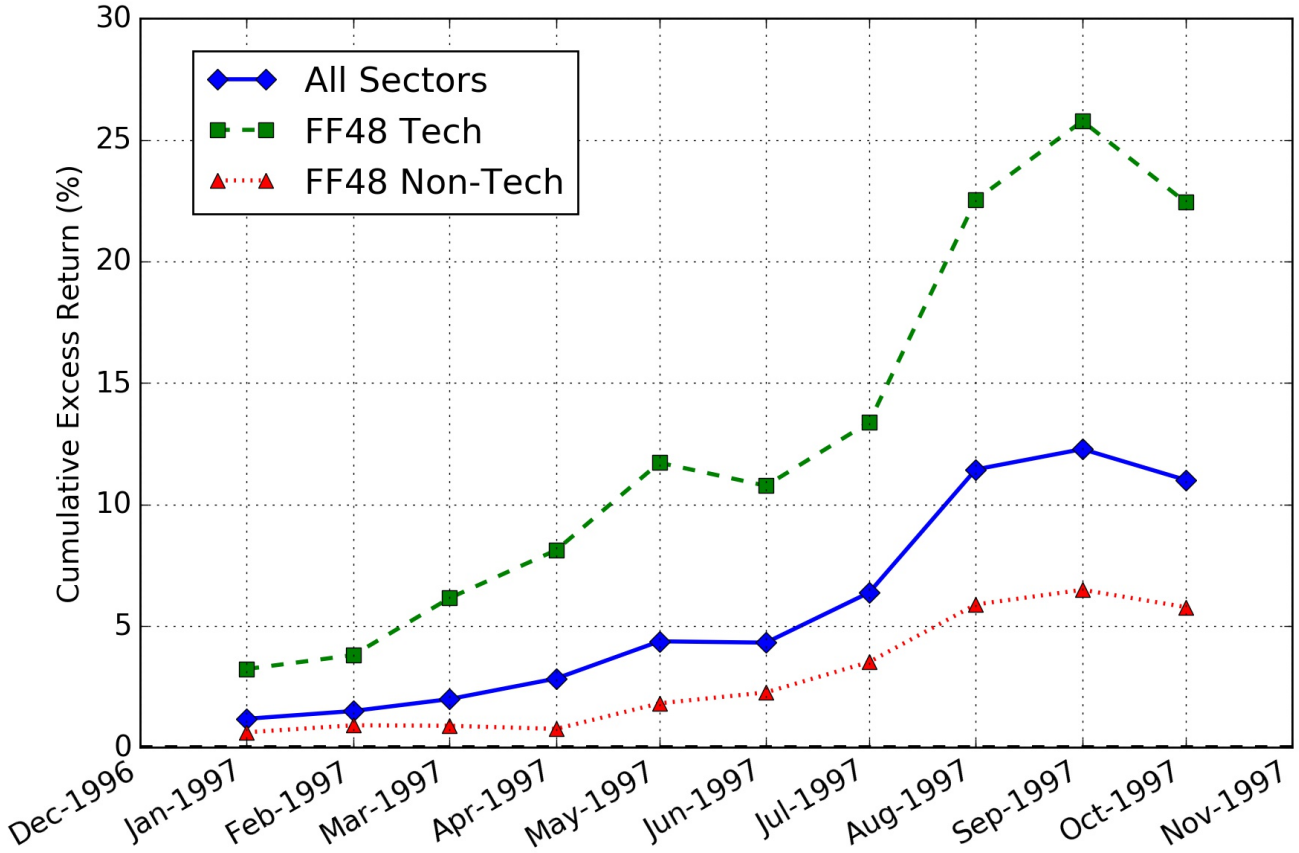
NYSE-Nasdaq Difference-in-Differences - Matched Means

	Underpricing (%)		Bid-Ask (%)		High-Low Spread	
$\hat{\mathbb{E}}\left[Y_i^{Nas,96} - Y_{i*}^{NYSE,96}\right]$	1.64	(3.29)	0.46	(2.94)	0.98	(12.5)
$\hat{\mathbb{E}}\left[Y_i^{Nas,98} - Y_{i*}^{NYSE,98}\right]$	0.49	(1.81)	-0.55	(-3.33)	0.39	(5.35)
D-in-D	-1.16	(-2.05)	-1.00	(-4.46)	-0.59	(-5.37)
$\hat{\mathbb{E}}\left[Y_i^{NYSE,98} - Y_{i*}^{NYSE,96}\right]$	0.09	(0.33)	-0.07	(-0.54)	0.06	(1.11)
$\hat{\mathbb{E}}\left[Y_i^{Nas,98} - Y_{i*}^{Nas,96}\right]$	-1.09	(-3.04)	-1.10	(-11.3)	-0.46	(-5.79)
D-in-D	-1.17	(-2.70)	-1.02	(-5.93)	-0.52	(-5.34)
N_{NYSE}^{2H96}, N_{NYSE}^{1H98}	80	66	N_{Nas}^{2H96}, N_{Nas}^{1H98}		179	128

Diff-in-Diff comes from a decline in Nasdaq SEO underpricing

Long Nasdaq - Short NYSE returns, All, Tech, Non-Tech

When should the effect be?



- Nasdaq increase corresponds to lead up to large phase-in waves
- 11.5%, plausible in Amihud-Mendelson-Pedersen framework
- Effect is much larger in Tech (22%) v. non-Tech (5%)

Conclusions

- Direct, causal evidence on the relationship among the underpricing of SEOs, asset prices, & market structure & liquidity
  - Use Nasdaq OHR reforms
  - Underpricing falls 1-2 percentage points (from 3.6% pre-OHR)
    - Within Nasdaq DiD based on rollout, and NYSE/Nasdaq DiD pre/post
    - IV suggests improvements in liquidity are responsible
  - Nasdaq returns outperform NYSE returns by 11% during OHR rollout
    - Driven mostly, but not only, by technology stocks
- Underpricing effect is smaller than price level effect; however, timing of price level effect is more difficult to identify; harder to do purely within Nasdaq
- OTC v. centralized trading is important for cost of capital
  - What about other assets? e.g., Treasuries? FX? bonds? derivatives?

Summary Stats - Nasdaq 1997

	Mean	Median	Std. Dev
Underpricing	2.9828	2.0479	3.1740
Value ($m)	76.772	54.000	75.812
Relative Size	0.2744	0.2412	0.1693
Cap ($m)	298.97	173.13	329.31
Ln(Cap)	5.2090	5.1541	1.0149
Ln(Price)	2.8717	2.8693	0.5691
Volume ($m)	53.503	21.367	92.704
Volatility	3.0052	2.7694	1.4367
BidAsk (%)	2.3354	2.0342	1.4005
HiLo	1.4803	1.3502	0.8101
OHR	0.3770	0.0000	0.4859

Summary Stats - Nasdaq by OHR Status

	Mean	Median	Std. Dev
BidAsk (%) - Non OHR	2.8276	2.4633	1.4628
HiLo - OHR	1.1260	1.0749	0.4091
HiLo - Non OHR	1.6947	1.5125	0.9127
Underpricing - OHR	1.9668	1.3747	2.2781
Underpricing - Non-OHR	3.5976	2.6668	3.4768

Correlations - Nasdaq 1997

	UP	Rel. Size	Ln(Cap)	Ln(P)	BA(%)	OHR
Underpricing	1.0000	0.2759	-0.3846	-0.3586	0.3538	-0.2497
Relative Size	0.2759	1.0000	-0.5344	-0.3983	0.3014	-0.0694
Ln(Cap)	-0.3846	-0.5344	1.0000	0.8027	-0.4833	0.0194
Ln(Price)	-0.3586	-0.3983	0.8027	1.0000	-0.3218	-0.1066
BidAsk (%)	0.3538	0.3014	-0.4833	-0.3218	1.0000	-0.4530
OHR	-0.2497	-0.0694	0.0194	-0.1066	-0.4530	1.0000

Summary Stats - Nasdaq vs. NYSE 1996 - 1998

	Nasdaq	NYSE	t-stat	NYSE*	t-stat
Underpricing	3.452	1.463	9.09	2.495	4.37
	(3.904)	(2.138)		(3.019)	
Relative Size	0.271	0.235	2.24	0.261	0.91
	(0.174)	(0.225)		(0.163)	
Ln(Cap)	5.507	6.750	-13.6	5.817	-4.84
	(1.091)	(1.230)		(0.940)	
Ln(Price)	3.066	3.382	-7.86	3.090	-0.74
	(0.549)	(0.509)		(0.482)	
Volatility	3.228	2.126	13.9	2.818	5.57
	(1.409)	(0.768)		(0.878)	
BidAsk (%)	2.332	1.732	6.16	2.311	0.24
	(1.540)	(1.106)		(1.255)	

IV Results High-Low

	(1) Model A		(2) Model B		(3) Model C	
Ln(Cap)			-0.076	(-0.14)	-0.160	(-0.25)
Rel. Size			2.536	(1.62)	2.853	(1.72)
Volatility			0.224	(1.37)	0.233	(1.33)
Ln(Price)			-1.186	(-1.93)	-1.174	(-1.69)
Ln(Vlm)			0.208	(0.63)	0.250	(0.71)
HiLo	2.674	(3.59)	2.763	(3.30)	2.759	(2.11)
1st Stage Coef.	-0.574	(-6.01)	-0.561	(-5.64)	-0.518	(-2.80)
KP Rank LM	30.3		26.52		9.0	
CD Wald F	27.93		26.62		7.83	
1st Stage F	36.18		31.82		10.35	
N	208		196		196	
Fixed Effects	None		None		Time	

Asset Pricing

	(1) All Sectors		(2) FF48 Tech Stocks		(3) FF48 Non-Tech Sto	
Coef.	Param.	t-stat	Param.	t-stat	Param.	t-stat
$R_m - R_f$	-0.15***	(-3.41)	-0.30**	(-2.35)	-0.09**	(-2.52)
SMB	0.52***	(7.06)	0.30**	(2.08)	0.62***	(9.31)
HML	-1.04***	(-11.4)	-1.50***	(-8.04)	-0.68***	(-7.44)
UMD	0.14	(1.19)	0.78***	(3.51)	0.00	(-0.02)
First Phase-in Pre-Period	0.05	(0.57)	0.26	(1.01)	-0.02	(-0.26)
First Phase-in Post-Period	0.06	(0.74)	0.10	(0.80)	0.06	(0.67)
Early Implementation Phase	0.02	(0.58)	0.04	(0.59)	0.01	(0.40)
Major Phase-in Pre-Period	0.30***	(3.80)	0.54***	(4.81)	0.17**	(2.28)
Major Phase-in Post-Period	0.06	(1.09)	0.11	(1.58)	0.03	(0.67)
Main Implementation Phase	0.00	(0.02)	-0.03	(-0.22)	0.00	(-0.02)
Post-Implementation Phase	-0.09**	(-2.51)	-0.19	(-1.04)	-0.03	(-0.85)