Internet Appendix to "The Variability of IPO Initial Returns"[*]

Section A of this supplement provides tables and figures that replicate important results using one-day instead of 21-day initial returns after the IPO. Section B provides detailed results not tabulated in the main text adding an auction variable to the GARCH models for initial returns in Table VII of the published paper.

A. Replication of Selected Results Using One-day Initial Returns

[*]Citation format: Lowry, Michelle, Micah S. Officer, and G. William Schwert, 2009, Internet Appendix to "The variability of IPO initial returns," *Journal of Finance* 65, 425 - 465, http://www.afajof.org/IA/2010.asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

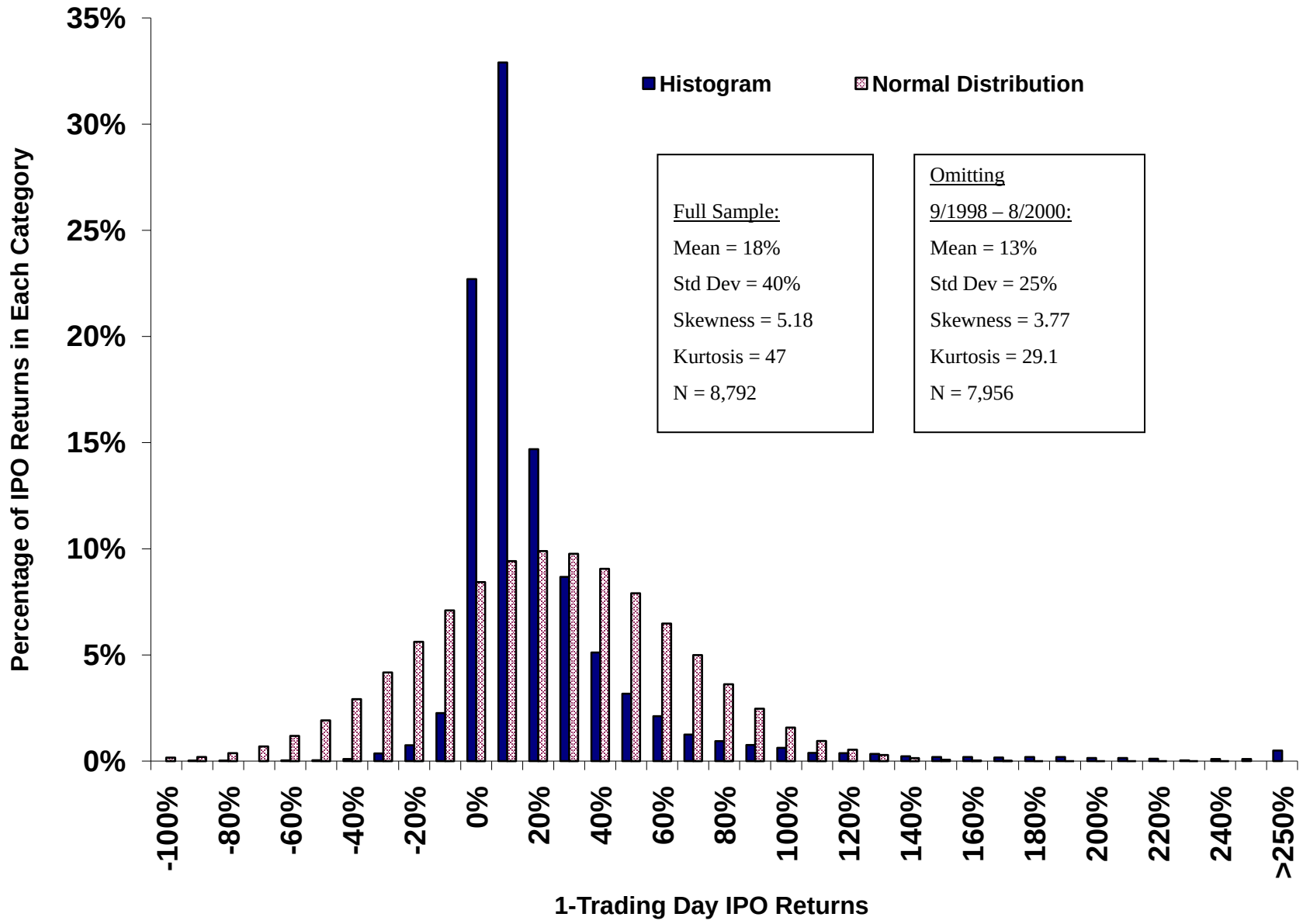

Figure IA.1. Frequency distribution of first-day IPO returns, 1965-2005.
Distribution of initial returns to IPO investments, defined as the percent difference between the aftermarket price on the 1st day of trading and the offer price.

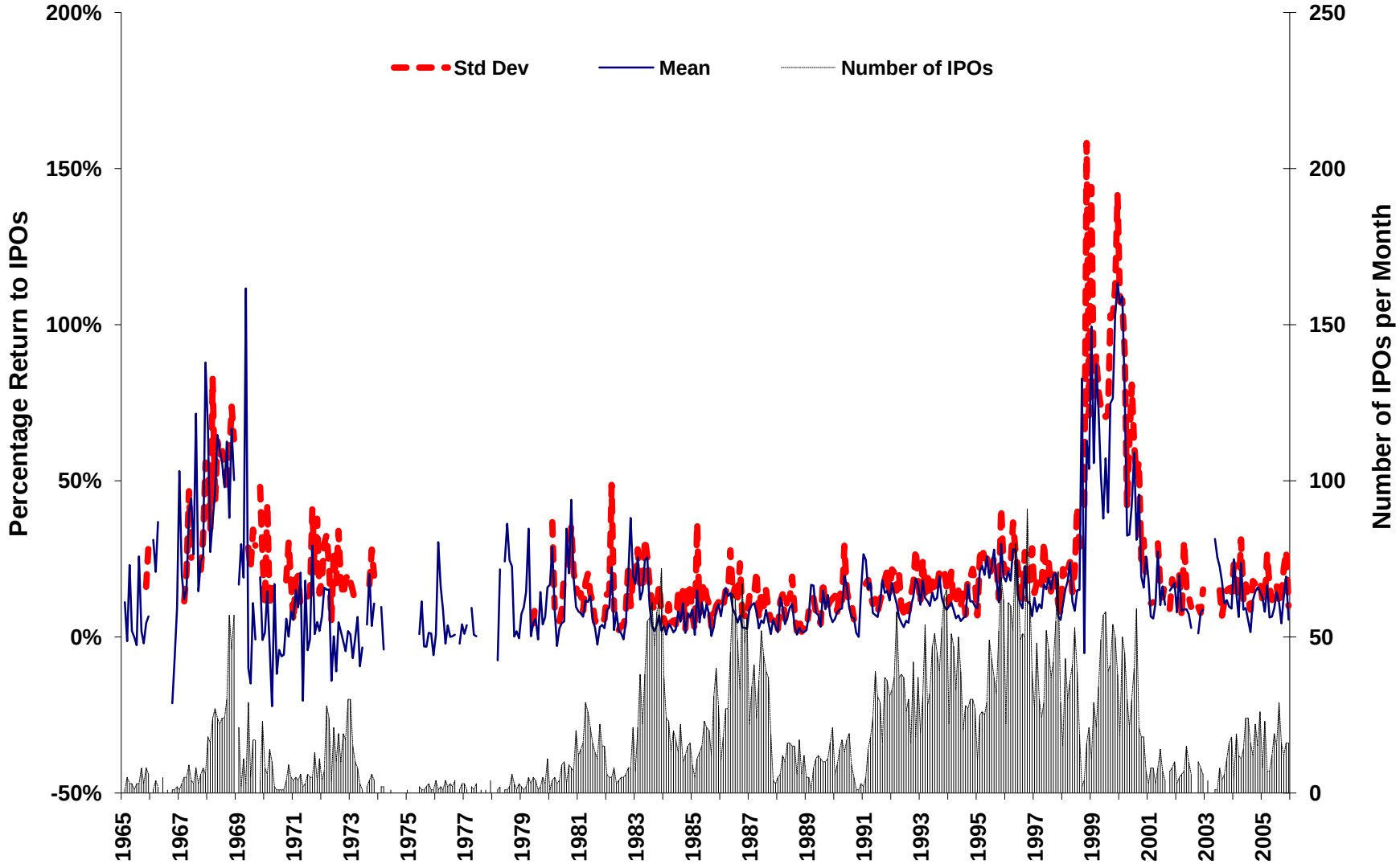

Figure IA.2. Mean and standard deviation of initial returns to IPOs and the number of IPOs by month, 1965-2005.
Initial returns are defined as the percent difference between the aftermarket price on the 1st day of trading and the offer price. Each month, the initial returns of each IPO during that month are calculated. The solid line represents average initial returns during the month, and the dotted line represents the standard deviation of these initial returns. The bars represent the number of IPOs per month (shown on the right Y-axis).

Table IA.I
Descriptive Statistics on the Monthly Mean and Volatility of IPO Initial Returns

Each month, the average and standard deviation of initial returns is measured across all firms that went public during that month. Initial returns are measured as the percent difference between the aftermarket price on the first day of trading and the offer price. The summary statistics in this table reflect the monthly time series of these cross-sectional averages and standard deviations, σ. Corr represents the correlation between the averages and standard deviations over time. Months for which there is only one IPO yield an estimate of the average IPO initial return, but not an estimate of the standard deviation. Months with four or more IPOs yield an estimate of the cross-sectional standard deviation.

						Autocorrelations: Lags				
	N	Avg	Median	Std Dev	Corr	1	2	3	4	5	6
1965 – 2005											
Average IPO Initial Return	456	0.144	0.096	0.192		0.65	0.62	0.53	0.53	0.50	0.49
Cross-sectional σ of IPO IRs	370	0.224	0.160	0.222	0.877	0.73	0.73	0.68	0.64	0.59	0.56
1965 – 1980											
Average IPO Initial Return	162	0.127	0.064	0.206		0.46	0.40	0.37	0.37	0.46	0.43
Cross-sectional σ of IPO IRs	89	0.268	0.208	0.186	0.799	0.39	0.36	0.44	0.42	0.36	0.33
1981 – 1990											
Average IPO Initial Return	120	0.079	0.069	0.063		0.51	0.28	0.10	0.06	-0.06	0.00
Cross-sectional σ of IPO IRs	114	0.117	0.108	0.075	0.712	0.18	0.20	0.00	0.05	-0.09	-0.11
1991 – 2005											
Average IPO Initial Return	174	0.206	0.141	0.218		0.76	0.77	0.63	0.62	0.51	0.50
Cross-sectional σ of IPO IRs	167	0.274	0.179	0.275	0.924	0.79	0.80	0.71	0.67	0.61	0.57
1991 – 2005 (omitting September 1998 – August 2000)											
Average IPO Initial Return	150	0.136	0.118	0.070		0.37	0.21	0.18	0.10	0.04	0.01
Cross-sectional σ of IPO IRs	144	0.178	0.164	0.076	0.740	0.20	0.14	0.13	0.06	0.12	0.02

Table IA.II
Correlations between the Moments of IPO Initial Returns and IPO Market Characteristics

This table shows correlations between the monthly average and standard deviation of IPO initial returns and monthly average IPO market characteristics. The sample consists of IPOs with an offer price of at least $5 that went public between 1981 and 2005 with data available for inclusion in the subsequent regression tests. Initial returns are defined as the percent difference between the closing price on the first day of trading and the offer price. Underwriter Rank is the average Carter and Manaster (1990) underwriter ranking score, as updated by Carter, Dark, and Singh (1998) and Loughran and Ritter (2004). Log(Shares) is the logarithm of the number of shares (in millions) offered in the IPO. Percent Tech is the average of a Technology Dummy that equals one if the firm is in a high-tech industry (biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)), and zero otherwise. percent Venture Capital is the average of a Venture Capital Dummy that equals one if the firm received financing from venture capitalists prior to the IPO (as defined by SDC), and zero otherwise. percent NYSE is the average of a NYSE Dummy that equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. percent NASDAQ is the average of a NASDAQ Dummy that equals one if the IPO firm will be listed on NASDAQ, and zero otherwise. Log(Firm Age+1) is the logarithm of the number of years since the firm was founded at the time of the IPO plus one. |Price Update| is the absolute value of the percentage change between the middle of the range of prices in the initial registration statement and the offer price. The "bubble" period is defined to be between September 1998 and August 2000. The *p*-values, in parentheses, use White's (1980) heteroskedasticity-consistent standard errors.

	1981-2005		1981-2005 (omitting bubble)	
	Average IPO Initial Return	Std Dev of IPO Initial Returns	Average IPO Initial Return	Std Dev of IPO Initial Returns
Average Underwriter Rank	0.17 (0.008)	0.19 (0.011)	-0.04 (0.089)	-0.08 (0.237)
Average Log(Shares)	0.25 (0.000)	0.26 (0.000)	0.15 (0.000)	0.16 (0.000)
Percent Technology	0.52 (0.000)	0.52 (0.000)	0.26 (0.000)	0.27 (0.000)
Percent Venture Capital	0.32 (0.000)	0.32 (0.000)	0.15 (0.001)	0.11 (0.120)
Percent NYSE	-0.11 (0.022)	-0.07 (0.473)	-0.04 (0.912)	0.01 (0.037)
Percent NASDAQ	0.16 (0.001)	0.13 (0.115)	0.08 (0.370)	0.04 (0.192)
Average Log(Firm Age + 1)	-0.31 (0.000)	-0.34 (0.000)	-0.12 (0.017)	-0.29 (0.000)
Average |Price Update|	0.59 (0.000)	0.61 (0.000)	0.08 (0.097)	0.19 (0.030)

Table IA.III
Relation between the Mean and Variance of Initial Returns and Firm-Specific Proxies for Information Asymmetry

The columns labeled OLS show cross-sectional regressions of IPO initial returns on firm- and offer-specific characteristics. The sample consists of IPOs between 1981 and 2005. Initial returns are measured as the percent difference between the aftermarket price on the first day of trading and the offer price. Underwriter Rank is the average Carter-Manaster (1990) underwriter ranking score, as updated by Carter, Dark, and Singh (1998) and Loughran and Ritter (2004). Log(Shares) is the logarithm of the number of shares (in millions) offered in the IPO. The Technology Dummy equals one if the firm is in a high-tech industry (biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)), and zero otherwise. The Venture Capital Dummy equals one if the firm received financing from venture capitalists prior to the IPO (as defined by SDC), and zero otherwise. The NYSE Dummy equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. The NASDAQ Dummy equals one if the IPO firm will be listed on NASDAQ, and zero otherwise. Log(Firm Age +1) is the logarithm of the number of years since the firm was founded at the time of the IPO plus one. |Price Update| is the absolute value of the percentage change between middle of the range of prices in the initial registration statement and the offer price. Bubble equals one if the IPO occurs between September 1998 and August 2000, and zero otherwise. The *t*-statistics, in parentheses, use White's (1980) heteroskedasticity-consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom.

The columns labeled MLE show maximum likelihood estimates of these cross-sectional regressions where the log of the variance of the IPO initial return is assumed to be linearly related to the same characteristics that are included in the mean equation (for example, Greene (1993), pp. 405-407). The large sample standard errors are used to calculate the *t*-statistics in parentheses under the coefficient estimates. The log-likelihoods show the improvement achieved by accounting for heteroskedasticity compared with OLS.

	(a) 1981-2005			(b) 1981-2005			(c) 1981-2005, Omitting Bubble		
		MLE			MLE			MLE	
	OLS	Mean	Variance	OLS	Mean	Variance	OLS	Mean	Variance
Intercept	-0.440	-0.016	-6.732	0.139	0.019	-3.615	-0.085	0.006	-4.331
	(-5.80)	(-0.35)	(-30.99)	(1.93)	(0.39)	(-14.08)	(-2.00)	(0.13)	(-16.01)
Underwriter Rank	0.001	-0.005	-0.070	0.002	-0.006	-0.111	-0.004	-0.006	-0.135
	(0.54)	(-3.04)	(-16.46)	(0.92)	(-3.69)	(-22.04)	(-2.57)	(-3.99)	(-24.71)
Log(Shares)	0.027	0.008	0.246	-0.013	0.006	0.050	0.011	0.007	0.110
	(4.79)	(2.53)	(15.22)	(-2.45)	(1.76)	(2.64)	(3.57)	(2.13)	(5.56)
Technology Dummy	0.084	0.058	1.025	0.041	0.031	0.455	0.038	0.029	0.433
	(9.65)	(5.84)	(49.16)	(5.19)	(4.70)	(16.95)	(6.83)	(4.39)	(15.24)
Venture Capital Dummy	0.008	0.014	0.143	0.011	0.007	-0.025	-0.001	0.006	-0.046
	(0.75)	(1.99)	(8.14)	(1.08)	(1.22)	(-1.05)	(-0.09)	(0.97)	(-1.73)

	(a) 1981-2005			(b) 1981-2005			(c) 1981-2005, Omitting Bubble		
		MLE			MLE			MLE	
	OLS	Mean	Variance	OLS	Mean	Variance	OLS	Mean	Variance
NYSE Dummy	0.043	0.039	-0.467	0.070	0.041	-0.388	0.043	0.041	-0.464
	(2.15)	(2.55)	(-8.78)	(3.60)	(2.14)	(-6.17)	(3.03)	(2.08)	(-7.15)
NASDAQ Dummy	0.106	0.052	0.380	0.079	0.045	-0.012	0.060	0.044	-0.051
	(6.17)	(3.52)	(9.10)	(4.78)	(2.47)	(-0.28)	(4.53)	(2.34)	(-1.12)
Log(Firm Age + 1)	-0.025	-0.012	-0.331	-0.016	-0.010	-0.210	-0.012	-0.010	-0.196
	(-7.50)	(-4.77)	(-32.45)	(-5.34)	(-4.29)	(-19.29)	(-6.04)	(-4.02)	(-17.45)
|Price Update|	0.954	0.162	4.363	0.795	0.146	3.405	0.209	0.123	3.623
	(8.76)	(4.73)	(60.56)	(7.72)	(5.04)	(35.52)	(6.63)	(4.01)	(32.10)
Bubble Dummy (9/1998-8/2000)				0.430	0.259	2.330			
				(15.52)	(8.92)	(64.77)			
R^2	0.207			0.301			0.047		
Log-likelihood	-2570.262	430.053		-2138.932	1514.808		1699.009	2352.084	
Sample Size	6,840			6,840			6,103		

Table IA.IV
Relation between Initial Returns and Firm-Specific Proxies for Information Asymmetry, with ARMA(1,1) Errors and EGARCH(1,1) Conditional Volatility, 1981-2005

This table shows maximum likelihood estimates of these cross-sectional regressions where the log of the variance of the IPO initial return is assumed to be linearly related to the same characteristics that are included in the mean equation (for example, Greene (1993), pp. 405-407). The sample consists of IPOs between 1981 and 2005, ordered by the date of the offer. Initial returns are measured as the percent difference between the aftermarket price on the first day of trading and the offer price. The model in column (a) is the same as the MLE model in column (a) of Table IA.III. Underwriter Rank is the average Carter and Manaster (1990) underwriter ranking score, as updated by Carter, Dark, and Singh (1998) and Loughran and Ritter (2004). Log(Shares) is the logarithm of the number of shares (in millions) offered in the IPO. The Technology Dummy equals one if the firm is in a high-tech industry (biotech, computer equipment, electronics, communications, and general technology (as defined by SDC), and zero otherwise. The Venture Capital Dummy equals one if the firm received financing from venture capitalists prior to the IPO (as defined by SDC), and zero otherwise. The NYSE Dummy equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. The NASDAQ Dummy equals one if the IPO firm will be listed on NASDAQ, and zero otherwise. Log(Firm Age + 1) is the logarithm of the number of years since the firm was founded at the time of the IPO plus one. |Price Update| is the absolute value of the percentage change between middle of the range of prices in the initial registration statement and the offer price. The large sample standard errors are used to calculate the *t*-statistics in parentheses under the coefficient estimates. The Ljung-Box (1979) Q-statistic is based on the first 20 lags of the autocorrelation function of the standardized residuals (or the squared standardized residuals) and has an asymptotic χ^2 distribution under the hypothesis of no autocorrelation.

The data are ordered according to the offer date of the IPO, but they are not equally spaced in time. The models in columns (b) and (c) estimate ARMA(1,1) models (Box and Jenkins (1976)) to correct for the autocorrelation of the residuals in the mean equation (1). The model in column (c) includes an EGARCH(1,1) model (Nelson (1991)) in (3) that corrects for autocorrelation in the conditional variance of the residuals from the mean equation (1). The log-likelihoods show the improvement achieved by accounting for autocorrelation in the mean equation and in the conditional variance.

$$IR_i = \beta_0 + \beta_1 \text{Rank}_i + \beta_2 \text{Log}(\text{Shares}_i) + \beta_3 \text{Tech}_i + \beta_4 \text{VC}_i + \beta_5 \text{NYSE}_i + \beta_6 \text{NASDAQ}_i + \beta_7 \text{Log}(\text{Firm Age}_i + 1) + \beta_8 |\text{Price Update}_i| + [(1-\theta L)/(1-\phi L)]\varepsilon_i \quad (1)$$

$$\text{Log}(\sigma^2(\varepsilon_i)) = \gamma_0 + \gamma_1 \text{Rank}_i + \gamma_2 \text{Log}(\text{Shares}_i) + \gamma_3 \text{Tech}_i + \gamma_4 \text{VC}_i + \gamma_5 \text{NYSE}_i + \gamma_6 \text{NASDAQ}_i + \gamma_7 \text{Log}(\text{Firm Age}_i + 1) + \gamma_8 |\text{Price Update}_i| \quad (2)$$

$$\text{EGARCH model: } \log(\sigma^2_t) = \omega + \alpha \log[\varepsilon_{i-1}^2/\sigma^2(\varepsilon_{i-1})] + \delta \log(\sigma^2_{t-1}) \quad (3)$$

$$\text{Var}(\varepsilon_i) = \sigma^2_t \cdot \sigma^2(\varepsilon_i) \quad (4)$$

	(a)	(b)	(c)
Intercept	-0.016	0.244	0.248
	(-0.35)	(5.38)	(36.43)
Underwriter Rank	-0.005	-0.003	0.001
	(-3.04)	(-2.14)	(3.22)
Log(Shares)	0.008	-0.011	-0.013
	(2.53)	(-3.55)	(-23.97)
Technology Dummy	0.058	0.037	0.058
	(5.84)	(3.88)	(98.84)
Venture Capital Dummy	0.014	0.014	0.012
	(1.99)	(2.04)	(18.05)

	(a)	(b)	(c)
NYSE Dummy	0.039	0.044	0.052
	(2.55)	(2.77)	(25.05)
Nasdaq Dummy	0.052	0.045	0.050
	(3.52)	(2.95)	(125.15)
Log(Firm Age + 1)	-0.012	-0.009	-0.011
	(-4.77)	(-3.95)	(-39.32)
|Price Update|	0.162	0.184	0.204
	(4.73)	(5.67)	(84.39)
AR(1), ϕ		0.975	0.969
		(348.23)	(1986.58)
MA(1), θ		0.959	0.938
		(226.53)	(1017.61)
Variance intercept, γ_0	-6.732	-7.662	1.401
	(-30.99)	(-39.99)	(3.75)
Underwriter Rank	-0.070	-0.081	-0.059
	(-16.46)	(-20.13)	(-14.01)
Log(Shares)	0.246	0.321	-0.306
	(15.22)	(22.35)	(-17.89)
Technology Dummy	1.025	0.961	0.432
	(49.16)	(47.05)	(15.27)
Venture Capital Dummy	0.143	0.093	0.006
	(8.14)	(5.55)	(0.29)
NYSE Dummy	-0.467	-0.445	-0.144
	(-8.78)	(-8.51)	(-2.57)
Nasdaq Dummy	0.380	0.328	0.216
	(9.10)	(8.00)	(6.10)
Log(Firm Age + 1)	-0.331	-0.339	-0.240
	(-32.45)	(-35.52)	(-26.24)
|Price Update|	4.363	4.036	2.756
	(60.56)	(60.26)	(31.92)
ARCH intercept, ω			0.034
			(21.07)
ARCH, α			0.024
			(21.66)
GARCH, δ			0.978
			(953.47)
Ljung-Box Q-statistic (20 lags)	2,248	237	138
(*p*-value)	(0.000)	(0.000)	(0.000)
Ljung-Box Q-statistic (20 lags, squared residuals)	335	399	113
(*p*-value)	(0.000)	(0.000)	(0.000)
Log-likelihood	430.05	632.07	1644.46
Sample Size	6,840	6,839	6,839

Table IA.V
Relation between Initial Returns and Firm-Specific Proxies for Information Asymmetry, as well as Market Volatility Measures, with ARMA(1,1) Errors and EGARCH(1,1) Conditional Volatility, 1981-2005

This table shows maximum likelihood estimates of these cross-sectional regressions where the log the variance of the IPO initial return is assumed to be linearly related to the same characteristics that are included in the mean equation (for example, Greene (1993), pp. 405-407). The sample consists of IPOs between 1981 and 2005, ordered by the date of the offer. Initial returns are measured as the percent difference between the aftermarket price on the first day of trading and the offer price. Underwriter Rank is the average Carter and Manaster (1990) underwriter ranking score, as updated by Carter, Dark, and Singh (1998) and Loughran and Ritter (2004). Log(Shares) is the logarithm of the number of shares (in millions) offered in the IPO. The Technology Dummy equals one if the firm is in a high-tech industry (biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)), and zero otherwise. The Venture Capital Dummy equals one if the firm received financing from venture capitalists prior to the IPO (as defined by SDC), and zero otherwise. The NYSE Dummy equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. The NASDAQ Dummy equals one if the IPO firm will be listed on NASDAQ, and zero otherwise. Log(Firm Age + 1) is the logarithm of the number of years since the firm was founded at the time of the IPO plus one. |Price Update| is the absolute value of the percentage change between middle of the range of prices in the initial registration statement and the offer price. The variable s^2_{t-1} is the time-series variance of the returns to the equal-weighted portfolio of NASDAQ stocks from CRSP for the 21 trading days ending at day t-1. The variable c^2_{t-1} is the cross-sectional variance of the 21-trading-day returns to stocks on NASDAQ ending at day t-1. The large sample standard errors are used to calculate the t-statistics in parentheses under the coefficient estimates. The Ljung-Box (1979) Q-statistic is based on the first 20 lags of the autocorrelation function of the standardized residuals (or the squared standardized residuals) and has an asymptotic χ^2 distribution under the hypothesis of no autocorrelation.

The data are ordered according to the offer date of the IPO, but they are not equally spaced in time. The ARMA(1,1) models (Box and Jenkins (1976)) correct for the autocorrelation of the residuals in the mean equation (1). The EGARCH(1,1) model (Nelson (1991)) in (3) corrects for autocorrelation in the conditional variance of the residuals from the mean equation (1).

$$IR_i = \beta_0 + \beta_1 Rank_i + \beta_2 Log(Shares_i) + \beta_3 Tech_i + \beta_4 VC_i + \beta_5 NYSE_i + \beta_6 NASDAQ_i + \beta_7 Log(Firm\ Age_i + 1) + \beta_8 |Price\ Update_i| + \beta_9 \log(s^2_{t-1}) + \beta_{10} \log(c^2_{t-1}) + [(1-\theta L)/(1-\phi L)]\varepsilon_i \quad (1)$$

$$Log(\sigma^2(\varepsilon_i)) = \gamma_0 + \gamma_1 Rank_i + \gamma_2 Log(Shares_i) + \gamma_3 Tech_i + \gamma_4 VC_i + \gamma_5 NYSE_i + \gamma_6 NASDAQ_i + \gamma_7 Log(Firm\ Age_i + 1) + \gamma_8 |Price\ Update_i| \quad (2)$$

$$\text{EGARCH model: } \log(\sigma^2_t) = \omega + \alpha \log[\varepsilon_{i-1}^2/\sigma^2(\varepsilon_{i-1})] + \delta_1 \log(\sigma^2_{t-1}) + \delta_2 \log(s^2_{t-1}) + \delta_3 \log(c^2_{t-1}) \quad (3)$$

$$Var(\varepsilon_i) = \sigma^2_t \cdot \sigma^2(\varepsilon_i) \quad (4)$$

	(a) Mean Equation (1)	(b) Variance Equations (2) and (3)
Intercept	0.248	0.122
	(36.43)	(22.40)
Underwriter Rank	0.001	0.003
	(3.22)	(32.49)
Log(Shares)	-0.013	-0.009
	(-23.97)	(-24.37)
Technology Dummy	0.058	0.055
	(98.84)	(142.65)

	(a)	(b)
Venture Capital Dummy	0.012 (18.05)	0.026 (73.92)
NYSE Dummy	0.052 (25.05)	0.052 (13.22)
Nasdaq Dummy	0.050 (125.15)	0.044 (11.25)
Log(Firm Age + 1)	-0.011 (-39.32)	-0.003 (-18.86)
|Price Update|	0.204 (84.39)	0.167 (98.34)
Market volatility, time-series, $\text{Log}(s^2_{t-1})$		-0.070 (-2.74)
Market dispersion, cross-sectional, $\text{Log}(c^2_{t-1})$		-0.046 (-8.00)
AR(1), ϕ	0.969 (1986.58)	0.959 (2956.87)
MA(1), θ	0.938 (1017.61)	0.904 (1140.91)
Variance intercept, γ_0	1.401 (3.75)	1.131 (3.49)
Underwriter Rank	-0.059 (-14.01)	-0.066 (-15.86)
Log(Shares)	-0.306 (-17.89)	-0.268 (-16.03)
Technology Dummy	0.432 (15.27)	0.340 (13.04)
Venture Capital Dummy	0.006 (0.29)	0.073 (3.41)
NYSE Dummy	-0.144 (-2.57)	-0.290 (-4.74)
Nasdaq Dummy	0.216 (6.10)	0.043 (1.02)
Log(Firm Age + 1)	-0.240 (-26.24)	-0.239 (-26.65)
|Price Update|	2.756 (31.92)	2.463 (31.22)
ARCH intercept, ω	0.034 (21.07)	0.039 (14.44)
ARCH, α	0.024 (21.66)	0.023 (23.91)
GARCH, δ_1	0.978 (953.47)	0.976 (961.77)

	(a)	(b)
Market volatility, time-series, Log(s^2_{t-1})		0.045
		(1.70)
Market dispersion, cross-sectional, Log(c^2_{t-1})		-0.013
		(-1.44)
Ljung-Box Q-statistic (20 lags)	138	38
(*p*-value)	(0.000)	(0.010)
Ljung-Box Q-statistic (20 lags, squared residuals)	113	128
(*p*-value)	(0.000)	(0.000)
Log-likelihood	1644.46	1657.30
Sample Size	6,839	6,839

B. Results from adding an auction variable to the GARCH models for initial returns in Table VII of the published paper

Table IA.VI
Relation between Initial Returns and Firm-Specific Proxies for Information Asymmetry, as well as Market Volatility Measures, with ARMA(1,1) Errors and EGARCH(1,1) Conditional Volatility, Including a Variable for IPO Auctions, 1981-2005

This table shows maximum likelihood estimates of these cross-sectional regressions where the log the variance of the IPO initial return is assumed to be linearly related to the same characteristics that are included in the mean equation (for example, Greene (1993), pp. 405-407). The sample consists of IPOs between 1981 and 2005, ordered by the date of the offer. Initial returns are measured as the percent difference between the closing price on the 21st day of trading and the offer price. Underwriter Rank is the average Carter and Manaster (1990) underwriter ranking score, as updated by Carter, Dark, and Singh (1998) and Loughran and Ritter (2004). Log(Shares) is the logarithm of the number of shares (in millions) offered in the IPO. The Technology Dummy equals one if the firm is in a high-tech industry (biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)), and zero otherwise. The Venture Capital Dummy equals one if the firm received financing from venture capitalists prior to the IPO (as defined by SDC), and zero otherwise. The NYSE Dummy equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. The NASDAQ Dummy equals one if the IPO firm will be listed on NASDAQ, and zero otherwise. Log(Firm Age + 1) is the logarithm of the number of years since the firm was founded at the time of the IPO plus one. |Price Update| is the absolute value of the percentage change between middle of the range of prices in the initial registration statement and the offer price. The variable s^2_{t-1} is the time-series variance of the returns to the equal-weighted portfolio of NASDAQ stocks from CRSP for the 21 trading days ending at day *t*-1. The variable c^2_{t-1} is the cross-sectional variance of the 21-trading-day returns to stocks on NASDAQ ending at day *t*-1. Auction equals one for the 16 firms that used W. H. Hambrecht's OpenIPO auction process (from Table VIII of the published paper), and zero otherwise. The large sample standard errors are used to calculate the *t*-statistics in parentheses under the coefficient estimates. The Ljung-Box (1979) Q-statistic is based on the first 20 lags of the autocorrelation function of the standardized residuals (or the squared standardized residuals) and has an asymptotic χ^2 distribution under the hypothesis of no autocorrelation.

The data are ordered according to the offer date of the IPO, but they are not equally spaced in time. The ARMA(1,1) models (Box and Jenkins (1976)) correct for the autocorrelation of the residuals in the mean equation (1). The EGARCH(1,1) model (Nelson (1991)) in (3) corrects for autocorrelation in the conditional variance of the residuals from the mean equation (1).

$$IR_i = \beta_0 + \beta_1 Rank_i + \beta_2 Log(Shares_i) + \beta_3 Tech_i + \beta_4 VC_i + \beta_5 NYSE_i + \beta_6 NASDAQ_i + \beta_7 Log(Firm\ Age_i + 1) + \beta_8 |Price\ Update_i| + \beta_9 \log(s^2_{t-1}) + \beta_{10} \log(c^2_{t-1}) + \beta_{11} Auction_i + [(1-\theta L)/(1-\phi L)]\varepsilon_i \quad (1)$$

$$Log(\sigma^2(\varepsilon_i)) = \gamma_0 + \gamma_1 Rank_i + \gamma_2 Log(Shares_i) + \gamma_3 Tech_i + \gamma_4 VC_i + \gamma_5 NYSE_i + \gamma_6 NASDAQ_i + \gamma_7 Log(Firm\ Age_i + 1) + \gamma_8 |Price\ Update_i| + \gamma_9 Auction_i \quad (2)$$

$$\text{EGARCH model: } \log(\sigma^2_t) = \omega + \alpha \log[\varepsilon_{i-1}{}^2/\sigma^2(\varepsilon_{i-1})] + \delta_1 \log(\sigma^2_{t-1}) + \delta_2 \log(s^2_{t-1}) + \delta_3 \log(c^2_{t-1}) \quad (3)$$

$$Var(\varepsilon_i) = \sigma^2_t \cdot \sigma^2(\varepsilon_i) \quad (4)$$

	(a) Mean Equation (1)	(b) Variance Equations (2) and (3)
Intercept	0.163 (6.84)	0.933 (3.18)
Underwriter Rank	0.002 (5.69)	-0.034 (-8.29)
Log(Shares)	-0.008 (-5.42)	-0.121 (-7.23)
Technology Dummy	0.062 (47.16)	0.357 (14.13)
Venture Capital Dummy	0.029 (24.33)	0.276 (73.92)
NYSE Dummy	0.044 (4.46)	-0.607 (-8.69)
Nasdaq Dummy	0.061 (6.10)	-0.195 (-4.83)
Log(Firm Age + 1)	-0.006 (-7.89)	-0.174 (-16.68)
|Price Update|	0.225 (54.53)	1.453 (16.53)
Market volatility, time-series, Log(s^2_{t-1})	0.725 (5.83)	0.080 (2.80)
Market dispersion, cross-sectional, Log(c^2_{t-1})	0.176 (3.77)	-0.006 (-0.76)
Auction Dummy	-0.176 (-160.46)	-0.729 (-1.35)
AR(1), ϕ	0.959 (716.08)	
MA(1), θ	0.893 (351.34)	
ARCH intercept, ω		0.025 (9.05)
ARCH, α		0.018 (21.29)
GARCH, δ_1		0.982 (1190.26)
Log-likelihood	-1684.20	
Sample Size	6,839	

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