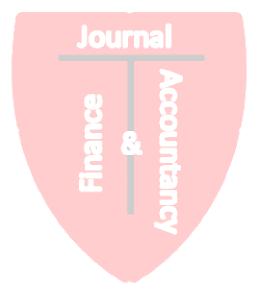# Is IPO underpricing a necessary cost or a reflection of irrational investor behavior?

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ABSTRACT

This study documents that underpricing of IPOs has significant explanatory power of systematic risk in after-market. Specifically, initial return is positively correlated with systematic risk but is not significantly correlated with idiosyncratic risk. This result could be interpreted as evidence that initial return of IPOs is a cost necessary to resolve inherent problems in the IPO process, rather than a reflection of irrational investor behaviors.

Keywords: underpricing, irrational behaviors, initial public offerings

INTRODUCTION

The question of whether risk or irrational investor behavior, such as under- or over-reaction, determines asset returns continues to be a topic of significant interest in finance and accounting literature. One of the remarkable empirical findings related to asset returns is the massive documentation of very high returns on the first trading day of an initial public offering (IPO) of equity securities. These returns, on average, often range from fifteen percent (15%) to eighteen percent (18%) in U.S. equity markets.[1] With these high first day average returns, irrational behavior by market participants would be suspected.[2] In early studies, underpricing was thought to be a necessary cost needed to resolve inherent problems, such as the existence of asymmetric information, in the IPO process. [3] However, more recent literature suggested that irrational behavior by market participants caused underpricing [Loughran and Ritter (2002); Aggarwal, Krigman, and Womack (2002); Ljungqvist, Nanda and Singh (2003); Purnanandam and Swaminathan (2004); Cook, Jarrell and Kieschnick (2003)]. Until the advent of this new line of more recent literature, majority of research works on why underpricing happens posited that underpricing is a cost needed to resolve inherent problems in the IPO process such as asymmetric information between issuers and underwriters. Many empirical studies have tested a specific theory, rather than simultaneously testing several theories, due to data availability, thus, the question remains whether underpricing at the IPO stage is caused by irrational behavior by market participants or whether it is a necessary cost needed to resolve inherent problems in the IPO process. A major purpose of this study is to answer this question. Up until now, not a single research has tested whether cost view of initial underpricing is more prevalent or irrational behavior based view of underpricing is probable.

Arguably underpricing may occur because costs are needed to resolve inherent problems in the IPO process or because of some irrational behaviors of participants, but most likely because of both reasons. Then a more realistic question is which reason is the main driver of underpricing.

This study conjectures that if the main driver of the underpricing is really the cost needed to resolve inherent problems in the IPO process, underpricing should be significantly related to systematic risk in the after-market because higher costs needed to resolve an inherent problem like asymmetric information can be an indication of high systematic risk. In contrast, if underpricing is the result of investors' irrational behaviors, then underpricing should be significantly related to idiosyncratic risk in the after-market because irrational behaviors cause primarily noise and will affect non-market related return volatility in the after-market. This study provides evidence about this issue by testing the relationship between initial return (i.e., underpricing) and systematic and idiosyncratic risks in the after-market.

The results of this study show (1) that initial return is significantly and positively related to systematic risk in the after-market, but (2) that initial return is not significantly related to idiosyncratic risk in the after-market. Therefore, the results in this study indicate that initial

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[1] This high initial return is called underpricing because the issuer could have received a significantly higher offer price, resulting in higher proceeds from the issue.

[2] Irrational behavior here is considered a choice rational decision makers will not make. For example, rational decision makers will weigh between costs and benefits of a choice and choose the choice if and only if benefits of the choice are bigger than costs.

[3] Asymmetric information problem in IPO process can exist between underwriters who know more information about the IPO market and IPO issues and issuers who go public just once and hence do not know much about IPO market or IPO issues.

return of IPOs is primarily the cost to resolve inherent problems in the IPO process, rather than the reflection of irrational investor behaviors.

To the extent that the valuation of IPOs is a special case of asset pricing, this study has implications on the debate over asset pricing in general.

EMPIRICAL FRAMEWORK, VARIABLES, AND DATA

Gleason, Johnston and Madura (2008) studied the empirical relation between underpricing and after-market risk but their focus was whether underpricing can be used as an indication of after-market risk measured by beta and return volatility from the long term investor view. In contrast, this study uses systematic and idiosyncratic risks as dependent variables in regression to investigate whether initial return is related to a rational cost to fix inherent problems in the IPO process or simply the result of irrational investor behaviors.

As indicated above, this study's key independent variable is initial return and its dependent variables are systematic and idiosyncratic risks. However, issue characteristics including ex ante uncertainty measures, certifications by underwriters and venture capital firms, market and interest rate conditions, and industry membership are important control variables in predicting after-market risk of IPO stocks. Below explains why each identified set of variables may predict after-market risk of IPO stocks.

Independent Variables

Underpricing (i.e., initial return): Asymmetric information explanation of underpricing says that the underpricing is the cost necessary to resolve any problem related to asymmetric information or IPO mechanism. This means underpricing in general may not be driven by irrational behaviors of investors in the market. In a study on why IPO market cycle exists, Lowry and Schwert (2002) found that average initial return at the time of an IPO does not predict the eventual underpricing of the issues but rather information revealed during the overlapping registration periods among similar IPOs determines the underpricing of IPOs. This means that underpricing does not represent an avoidable bubble but rather reflects the information collected about similar IPOs during the overlapping registration periods. This study argues that one alternative way to see whether underpricing is mostly driven by irrational behaviors of investors or it is a type of cost required by information structure in the IPO market is testing whether underpricing is related to after-market systematic and idiosyncratic risks. Since systematic risk measures are supposedly capture pervasive factors affecting asset values, testing whether underpricing is associated with after-market systematic risk tells us if underpricing is mostly the cost necessary to resolve asymmetric information or inherent problem in IPO mechanism or a result of irrational investor behavior.

Issue Characteristics: Some of the issue characteristics can be related to risk in the after-market. In finance literature, size affect lots of things for businesses. To control size effect, this study includes log of market capitalization at the offer price, log of proceeds, and offer price. These are considered proxies of size of IPO firm or size of offering. Percent of primary shares in the offering is the percentage of shares newly issued divided by the total shares offered. This was included to control the liquidity effect on risk.

Ex Ante Uncertainty: Uncertainty measures on IPOs such as number of lockup days (i.e., the number of days from IPO date insiders agree not to sell the shares they have), firm age

(Carter and Manaster (1990), Carter et al. (1998), Habib and Ljungqvist(2001)), sales a year prior to IPO (Arugaslan et al. (2004)), EBIT a year prior to IPO (Purnanandam and Swaminathan (2004)) can serve as crude measures of risks for IPOs. To save observations without sales and EBIT, this study created plus sales dummy and plus EBIT dummy. Plus sales dummy has value of one if positive sales number was reported and has value of zero otherwise. Likewise, Plus EBIT has value of one if positive EBIT number was reported and has value of zero otherwise. These measures can signal potential risk to investors and therefore can predict after-market risk.

Certifications: IPOs using high reputation underwriters or having venture capital firm backing are considered lower risk since high reputation underwriters (Carter and Manaster (1990), Gompers (1996), Carter et al. (1998),) and venture capital firms (R.K. Aggarwal et al. (2002), Bradley and Jordan (2002), Loughran and Ritter (2004)) are repeated players in the IPO market and most likely will endorse only the high quality IPO firms. On the contrary, high risk IPOs may seek high reputation underwriters and/or venture capital backing. This study used underwriter rank data available in the Jay Ritter's web site. Venture backed dummy has value of one if the issue was backed by venture capital firms and has value of zero otherwise.

Market and Interest Rate Condition: General stock market condition, IPO market condition (Cliff and Denis (2004)), and interest rate environment can mitigate or amplify the perceived risk of IPOs and therefore can affect after-market risks. For IPO market condition variables, we include log of IPO intensity, which is log of number of IPOs in the previous quarter, and hot issue market dummy, which has value of one if the IPO was issued during the hot IPO issue market and has value of zero otherwise. An IPO issue market is judged by each issue month and it is considered hot if the average initial return of the issue month is higher than that of all IPOs in the total sample. For general market condition variable, the annual market risk premium at the time of IPO, calculated as CRSP value weighted index return minus yield on 3 month T-bill, was included. For interest rate condition variables, two interest rate composite variables were used that were generated by running principal component analysis using yield difference between 10 year Treasury bond and 3 month Treasury bill, yield difference between 10 year treasury bond and Baa rated corporate bond, relative yield of treasury 3 month against the long term average. These variables appear in asset pricing literature as macroeconomic risk factors and thus may affect the risk levels of IPOs in the after-market. Hence these variables were included as control variables in the analysis.

Industry Membership: The industry a company belongs to significantly affects its business risk and therefore can affect the after-market risks.[4] This study focuses on the effect of membership to tech industry and internet industry. Both tech and internet industry dummies are based on the data available in Jay Ritter's web site.

Dependent Variables

This study uses systematic and idiosyncratic risks as dependent variables. Despite the research findings that show the uselessness of beta in explaining stock returns, still almost every single asset pricing model contains a certain form of market or systematic risk. Researchers found that fundamental risks such as business risk, financial risk, and liquidity risk, measured by accounting variables are significantly correlated with systematic risk.[5] This encourages researchers to believe that market or systematic risk as defined in Capital Asset Pricing Model

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[4] Brigham, E. F., & Daves, P. R. (2014). *Intermediate financial management*. Cengage Learning.
[5] Reilly, F. K., & Brown, K. C. (2011). *Investment analysis and portfolio management*. Cengage Learning.

(CAPM) is a reasonable measure of risk. Thus this study used a popular market model to estimate systematic and idiosyncratic risks of IPOs as follows.

The market model of security returns describes the return generating process as follows.

$$\tilde{R}_{it} = \alpha_{it} + \beta_i \tilde{R}_{mt} + \tilde{\xi}_{it} \qquad (1)$$

where $\tilde{R}_{it}$ represents security i's return at time point t, α_{it} represents the intercept, β_i represents the beta, $\tilde{R}_{mt}$ represents the market return at time point t, and $\tilde{\xi}_{it}$ represents the white noise error term.

From equation (1), the expected return for security i is

$$E(\tilde{R}_{it}) = \alpha_i + \beta_i \overline{R}_m \qquad (2)$$

where $\overline{R}_m$ is the expected return of the market.

And the variance of the security i's return is

$$Var(\tilde{R}_{it}) = \sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_\xi^2 \qquad (3)$$

where σ_m^2 is the return variance of the market and σ_ξ^2 is the variance of the error term in equation (1).

From equations (1) and (3), risk measures were defined as they were used in the regression analysis. First measure of risk defined is square root of σ_i^2, i.e., the return standard deviation of stock i, and it was labeled as total risk. Second measure of risk is square root of $\beta_i^2 \sigma_m^2$, representing the systematic risk portion of the total risk and it was defined as systematic risk. Third measure of risk is square root of σ_ξ^2, the standard deviation of the error term and it was defined as idiosyncratic risk (or unsystematic risk).

Data

Analysis is conducted using data from Thomson Financial's SDC Global New Issues database for the period 1998-2010. The initial data set contains the firm commitment offerings for the given data period. Attention was restricted to the firm commitment type offerings. Only offerings for stock are included. Unit offerings, offerings of closed end mutual funds, and real estate investment trust offerings are excluded. Also, excluded were firms with non-positive book values, since such firms have suffered prior losses and might have different incentives for raising public equity capital. This procedure resulted in 3,093 firm commitment offerings with complete data from the SDC data set. The primary variables constraining sample size in the SDC sample are sales and EBIT. Therefore, to save more observations in the sample, Plus Sales dummy and Plus EBIT dummy were created and used.

The dependent variables are total risk (i.e. daily return standard deviation), systematic risk, and idiosyncratic risk. All risk measures are based on the market model and calculated based on the daily returns from the Center for Research in Security Prices (CRSP) tapes for the first year from the IPO. The structure of interest rates was also controlled for. Interest rate data were collected from the St. Louis Federal Reserve Bank web site to construct the default risk premium (Moody's seasoned Baa corporate yield less the 10 year constant treasury rate), the term structure premium (10 year constant treasury yield less the 3 month yield), the 3 month Treasury rate, and a dummy that takes on a value of one if the Fed funds rate is higher one year after the offering than at the offering date. These interest rate variables were found highly

collinear. To reduce multicollinearity among these interest rate variables, principal component analysis was run and the first two principal components were extracted (i.e. those with the largest eigenvalues). Two other principal components have significantly smaller eigenvalues and are ignored. The first principal component (interest 1) is highly negatively correlated with the treasury three month rate and positively correlated with the term structure premium, consistent with a standard upward sloping yield curve, and the second principal component (interest 2) is highly negatively correlated with the default premium and positively correlated with the Fed dummy, consistent with a robust economy that may be overheating (i.e. the Fed has begun to tighten).

EMPIRICAL RESULTS

The means, standard deviations and ranges of the variables used in the analysis appear in Table 1. Average initial return, average total risk (daily return standard deviation), average systematic risk, average idiosyncratic risk were 27.69%, 21.79%, 4.4%, and 21.24% respectively. Not surprisingly idiosyncratic risk is most of the total risk and systematic risk is very small. Both standard deviation and minimum and maximum values of risk measures suggest a considerable variation.

Table 2 shows the correlation between risk measures and independent variables. Across three different risk measures, log of proceeds, venture backing, hot IPO market issue, internet industry dummy, tech industry dummy, and initial return are showing relatively high correlation with risk measures. It is interesting to find that initial return shows a significantly higher correlation (0.4482) with systematic risk than with total risk (0.2436) and idiosyncratic risk (0.2008). Underwriter rank seems highly correlated with systematic risk (0.2677) but not so high with total risk (-0.0498) and idiosyncratic risk (-0.081). Log of market cap is highly correlated with systematic risk only.

Table 3 shows the results of regression analysis and analyses were all tested for heteroskedasticity using the White test and for multicollinearity using variance inflation factors. Heteroskedasticity was detected and standard errors and t-statistics are consequently computed using White asymptotic standard errors. Multicollinearity was not a problem in the regressions. No variance inflation factor exceeded 3. Ten is often considered a critical value for variance inflation factors.

Regression results of total risk

The results of the regression of after-market total risk in table 3 show that the model explains about 41.40% of the variation in after-market total risk.

Initial return is marginally significant in explaining total risk and the coefficient is positive, meaning that IPOs with higher initial return exhibit higher total risk in the after-market.

All issue characteristic variables and uncertainty variables are statistically significant and among them, log of market capitalization, percent of primary shares, and plus sales dummy have positive coefficients and log of proceeds, offer price, log of lockup days, log of firm age, and plus EBIT dummy have negative coefficients.

Between two certification variables, only venture-backed dummy is statistically significant and has a positive coefficient.

All market and interest rate condition variables are statistically significant. Log of IPO

intensity, hot issue market dummy, and interest 2 are positively correlated with total risk and market risk premium and interest 1 are negatively correlated with total risk.

Both internet industry dummy and tech industry dummy are statistically significant and positively correlated with total risk.

Regression results of systematic risk

The results of the regression of systematic risk are also reported in Table 3. The model explains about 43.05% of the variation in systematic risk.

Initial return is statistically significant and its coefficient is positive, meaning that IPOs with higher initial return exhibit higher systematic risk in the after-market.

Among issue characteristic and uncertainty variables, log of market cap, percent of primary shares, and plus sales dummy are statistically significant and their coefficients are all positive.

Both certification variables, venture-backed dummy and underwriter rank, are statistically significant and their coefficients are all positive.

Among market and interest rate condition variables, hot issue market dummy, interest 1, and interest 2 are statistically significant. Hot issue market dummy and interest 2 are positively correlated with but interest 1 is negatively correlated with systematic risk.

Both internet industry dummy and tech industry dummy are statistically significant and positively correlated with systematic risk.

Regression results of idiosyncratic risk

The results of the regression of idiosyncratic risk are also reported in Table 3. The model explains about 40.53% of the variation in idiosyncratic risk.

Initial return is not statistically significant although its coefficient is positive.

All issue characteristic variables and uncertainty variables with the exception of log of firm age are statistically significant and among them, log of market capitalization, percent of primary shares, and plus sales dummy have positive coefficients and log of proceeds, offer price, log of lockup days, and plus EBIT dummy have negative coefficients.

Between two certification variables, only venture-backed dummy is statistically significant and has a positive coefficient.

All market and interest rate condition variables are statistically significant. Log of IPO intensity, hot issue market dummy, and interest 2 are positively correlated with total risk but market risk premium and interest 1 are negatively correlated with total risk.

Both internet industry dummy and tech industry dummy are statistically significant and positively correlated with total risk.

CONCLUSION

This study documents the evidence that while underpricing of IPOs significantly and positively correlated with systematic risk, it is not significantly correlated with idiosyncratic risk. Therefore, it seems that IPO underpricing in general is a rational cost needed to resolve inherent problems in the IPO process rather than a reflection of investor irrational behavior.
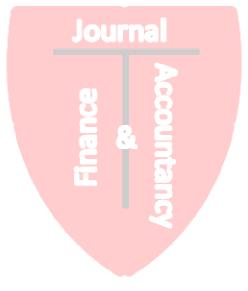
It is also shown that while ex ante uncertainty measures proven to affect initial

underpricing of IPOs such as log of lock up days, plus sales dummy and plus EBIT dummy are significantly correlated with idiosyncratic risk, plus sales dummy is the only uncertainty variable that is significantly correlated with systematic risk.

Between two certification variables, venture-backing dummy significantly affects both systematic and idiosyncratic risks, but underwriter rank significantly affects systematic risk only.

All market and interest rate condition variables affect idiosyncratic risk significantly; Log of IPO intensity, hot issue market dummy and interest 2 are positively correlated with idiosyncratic risk, while market risk premium a year before the issue and interest 1 are negatively correlated with idiosyncratic risk. In contrast, among market and interest rate condition variables, hot issue market dummy and two interest rate variables are the only significant variables in explaining systematic risk. Hot issue market dummy and interest 2 are positively correlated with systematic risk, while interest 1 is negatively correlated to systematic risk.

Both industry membership variables, internet dummy and teach dummy, are significant in explaining systematic and idiosyncratic risks and they are positively correlated with systematic and idiosyncratic risks. Industry membership variables seem to have the most explanatory power of systematic and idiosyncratic risks.

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APPENDIX

Table 1
Summary Statistics

Variable	N	Mean	STD	Min	Max
Risk Measures:					
Return Standard Deviation	3,093	0.2179	0.0527	0.0798	0.4732
Systematic Risk	3,093	0.0440	0.0258	0.0010	0.1631
Idiosyncratic Risk	3,093	0.2124	0.0507	0.0795	0.4720
Issue Characteristic:					
Log of Market Capitalization	3,093	12.2515	1.3329	7.6295	17.8092
Log of Proceeds	3,093	17.7387	1.0814	14.9141	22.7142
Offer Price	3,093	13.2927	5.8578	3.5000	97.0000
Percent of Primary Shares	3,093	0.9115	0.1685	0.0284	1.0000
Uncertainty Measures:					
Log of Lockup Days	3,093	4.0304	2.2504	0.0000	7.5099
Log of (1+ age)	3,093	1.9407	1.1488	0.0000	5.1120
Plus Sales Dummy	3,093	0.2856	0.4518	0.0000	1.0000
Plus EBIT Dummy	3,093	0.1565	0.3634	0.0000	1.0000
Certification:					
Venture Backed Dummy	3,093	0.4290	0.4950	0.0000	1.0000
Underwriter Rank	3,093	7.1935	2.4398	0.0000	9.0010
Market & Interest Rate Condition:					
Log of IPO Intensity	3,093	4.6665	0.6981	0.0000	5.5134
Hot Issue Market Dummy	3,093	0.5268	0.4994	0.0000	1.0000
Market Risk Premium	3,093	1.2358	3.7482	-16.2000	8.0000
Interest 1	3,093	26.4680	3.1841	22.7380	34.9252
Interest 2	3,093	144.6218	13.3341	128.4718	179.9050
Industry Membership:					
Internet Industry Dummy	3,093	0.1385	0.3454	0.0000	1.0000
Tech Industry Dummy	3,093	0.3275	0.4694	0.0000	1.0000
Initial Return	3,093	0.2769	0.6183	-0.9834	13.0417

Table 2
Correlation between risk measures and explanatory variables

	Return Standard Deviation	Systematic Risk	Idiosyncratic Risk
Return Standard Deviation	1		
Systematic Risk	0.5473	1	
Idiosyncratic Risk	0.9945	0.4596	1
Log of Market Capitalization	0.0145	0.4739	-0.0403
Log of Proceeds	-0.2415	0.2402	-0.2833
Offer Price	-0.1957	0.2544	-0.239
Percent of Primary Shares	0.1993	0.0402	0.2057
Log of Lockup Days	-0.1308	-0.237	-0.1105
Log of (1+ age)	-0.1518	-0.0419	-0.1547
Plus Sales Dummy	-0.0086	0.1026	-0.0212
Plus EBIT Dummy	-0.1908	-0.0493	-0.1957
Venture Backed Dummy	0.2722	0.2219	0.265
Underwriter Rank	-0.0498	0.2677	-0.081
Log of IPO Intensity	0.1937	0.0104	0.2036
Hot Issue Market Dummy	0.3117	0.2764	0.2978
Market Risk Premium	-0.0407	-0.0071	-0.0428
Interest 1	-0.2425	-0.07	-0.2488
Interest 2	-0.1613	0.0285	-0.1744
Internet Industry Dummy	0.4144	0.3966	0.3925
Tech Industry Dummy	0.3262	0.3464	0.3054
Initial Return	0.2436	0.4482	0.2008

Table 3
After-Market Risks as a function of initial return

	Total Risk		Systematic Risk		Idiosyncratic Risk	
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Constant	0.2932***	0.0272	-0.0392***	0.0126	0.308***	0.0264
Initial Return	0.0033*	0.0018	0.008***	0.0015	0.001	0.0016
Issue Characteristic:						
Log of Market Capitalization	0.0057***	0.0014	0.0057***	0.0007	0.0046***	0.0014
Log of Proceeds	-0.0107***	0.0019	0.0003	0.0009	-0.0109***	0.0018
Offer Price	-0.0015***	0.0002	-0.0001	0.0001	-0.0016***	0.0002
Percent of Primary Shares	0.0242***	0.0044	0.0038*	0.0022	0.0237***	0.0042
Uncertainty Measures:						
Log of Lockup Days	-0.0011***	0.0004	-0.0001	0.0002	-0.001***	0.0004
Log of (1+ age)	-0.0012*	0.0007	-0.0003	0.0003	-0.0012	0.0007
Plus Sales Dummy	0.0117***	0.0026	0.0029**	0.0013	0.0112***	0.0025
Plus EBIT Dummy	-0.0113***	0.0031	-0.0021	0.0015	-0.0107***	0.003
Certification:						
Venture Backed Dummy	0.0146***	0.0016	0.0023***	0.0008	0.0146***	0.0016
Underwriter Rank	-0.0004	0.0004	0.0006***	0.0002	-0.0004	0.0004
Market & Interest Rate Condition:						
Log of IPO Intensity	0.0054***	0.0017	-0.0001	0.0008	0.0054***	0.0017
Hot Issue Market Dummy	0.0149***	0.0017	0.0034***	0.0008	0.0145***	0.0016
Market Risk Premium	-0.0009***	0.0002	-0.0001	0.0001	-0.0009***	0.0002
Interest 1	-0.0039***	0.0005	-0.0025***	0.0002	-0.0035***	0.0005
Interest 2	0.0007***	0.0001	0.0004***	0.0001	0.0006***	0.0001
Industry Membership:						
Internet Industry Dummy	0.0382***	0.0026	0.0113***	0.0014	0.0364***	0.0025
Tech Industry Dummy	0.0169***	0.0017	0.0109***	0.0009	0.0147***	0.0016
N	3,093		3,093		3,093	
Adj. R-Square	41.40%		43.05%		40.53%	

* indicates statistical significance at 10% level. ** indicates statistical significance at 5% level. *** indicates statistical
significance at 1% level.