Analyse the problem of underpricing of Initial Public Offerings of Stocks

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EC831: Project Economics

29/04/2022

Word Count: 7108

Abstract

This study runs 4 cross sectional analyses in order to explain previous trends in existing literature as to why Initial Public Offering underpricing occurs, and the extent to which Initial Public Offerings underperform against existing publicly trading stocks in the long run. The study finds causal relationship between the reputation or prestige of the underwriter of an Initial Public Offering and underpricing. Furthermore, the study finds younger firms, or firms with less time between their foundation and going public are also more likely to be underpriced. The study also outlines that firms within certain industries of the economy are more likely to be underpriced and gives explanation as to why in such industries underpricing is more prevalent. Finally, the study shows an overperformance of newly listed firms when adjusted against the S&P 500 Index as a general market performance benchmark.

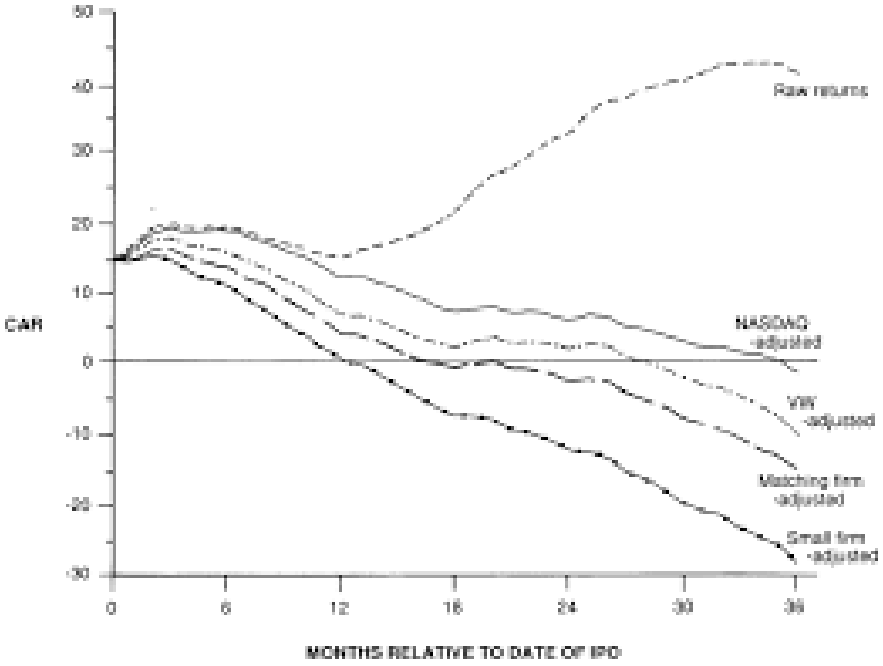
CONTENTS

1.Introduction

An initial public offering (IPO) refers to the process of a firm diversifying its ownership, transitioning from a small privately-owned company to a publicly trading stock; thereby selling shares to retail and institutional investors. Underpricing at initial public offering refers to the extent to which a stock's initial trading price is below its fundamental value, measured by the percentage change in price following public listing, over a specified period. Most commonly, underpricing is referred to as the difference in value between a stock's initial offer price, and the close price it reaches when it ceases trading upon the 1st day.

Rollinson (1969) [1] gives a foundational insight into the reasoning behind the public listing, arguing private shareholders can borrow against their assets and invest elsewhere. This makes public listing a viable strategy for accruing capital, thereby increasing the potential for long run growth. However, it is widely accepted this initial movement is short lived, as high initial investor demand drives IPO prices upwards towards its fundamental value.

Each IPO is underwritten by a reputable financial institution, who tend to under-price when there is higher uncertainty about the reception a firm's IPO will receive. Underwriters and the issuing firm themselves have contradicting incentives, with the underwriters aiming to uphold or improve their reputation, and the issuing firm looking for a large positive initial price movement, to justify the process. Ritter (1984) [2] finds of 5000 US IPOs that were listed between 1960-1982, their stock prices rose on average by 18.8% within the first month of trading. Therefore, we can see the prevalence of the underpricing phenomena, with this study looking to verify the continuation of such underpricing in the 21st century.



Source: Ritter (1991) [3]

The above graph shows the adjusted 3-year performance of IPOs against industry competitors across multiple industries and stock exchanges. We therefore see that although on average IPOs experience positive short run returns, they underperform significantly against common

trading public stocks. This study finds an existence of underpricing in the 21st century, and the significance for many existing IPO underpricing explanations. Furthermore, the study analyses the long run relative performance of IPOs to build upon existing literature within the respective field.

2. Literature Review

Many proposals have been made across various literature as to why IPO underpricing occurs. Popular explanations include "ex-ante uncertainty", examined in Ritter (1984) which attributes IPO underpricing to the uncertainty of a stock's intrinsic value at offering, due to insufficient prior performance data for specific firms. Other articles suggest IPO returns may be correlated with offer timing, proposing initial IPO returns will be at their highest during the periods with the highest general market returns. This is examined by Ibbotson and Jaffe (1975) [4] who introduce the phenomena of "Hot issue markets". Furthermore, underpricing is said to be used strategically by certain firms to prohibit predatory takeovers. The findings of Smart and Zutter (2003) [5] suggest greater underpricing can act as a strategy to maintain control during corporate control markets. The paper suggests a lower initial offering price diversifies the company's ownership to a larger pool of shareholders. This maximizes capital inflows to the company, which can act as a protection mechanism against any potential takeover. In addition, it is theorised that certain firms look to go public as a mechanism to create public shares for acquiring others by Brau and Fawcett (2006) [6]. Finally, IPO underpricing is deemed to be negatively correlated with the reputation of the listing's underwriter. Carter *et al.* (1998) [7] propose that underpricing of IPOs is far greater for firms with less reputable underwriters.

2.1. Ex-Ante Uncertainty:

"Ex-ante uncertainty" is defined as an inability of retail investors to determine the value per share of an IPO once it has begun trading. Beaty and Ritter (1986) [8]. The relationship is examined through a weighted least squares regression to find homoscedastic disturbance terms. The model's explanatory variables are log [1+Number of uses of proceeds] and the reciprocal of gross proceeds. Both sides of the equation are multiplied by log[1000+sales] as a weighting factor, this means that larger firms have higher importance within the model. The model reported a coefficient of 83,578 on the reciprocal of gross proceeds with the authors, therefore, predicting that smaller firms encounter higher returns once they have been listed publicly, meaning they are more likely to be under-priced.

One strongpoint of the model which likely verifies its findings is the fact it splits the observations into two similar-sized datasets. The presence of an industry effect on natural resources during 1980 and 1981 is therefore considered and compared to the prior period between 1977 and the start of 1980. This means that as the results compare for both periods, the study's results suggest "ex-ante uncertainty" can be seen as a relevant explanation of IPO underpricing.

Rock (1986) [9] analyses “ex-ante uncertainty” from the investor’s standpoint. Rock explores the idea that uninformed investors are likely to generally only receive overpriced IPOs, due to excess demand for under-priced IPOs from informed investors who can accurately predict their fundamental values. Where there is excess demand, shares are rationed at the offer date. This excessive demand for potentially under-priced IPOs is highlighted by Ibbotson and Jaffe (1975), who indicate some IPO underwriters receive an initial expression of interest for specific stocks for 5 times the number of shares that are to be listed. Rock’s model suggests that uninformed investors need a significant price discount on IPOs, or in other words, significant underpricing for motivation to invest. The findings in Ritter (1984) theorize that increased ex-ante uncertainty increases the advantage for the informed investor, indicating the need for increased underpricing to entice the uninformed investor. Therefore, corroborating Rock’s hypothesis. Lee et al. (1999) [10] shows on average informed investors crowd out uniformed investors in the most significantly under-priced issues. By splitting the 91 IPOs sampled above and below the median value the study finds vast overallocation in IPOs exhibiting the highest levels of underpricing. The study provides further evidence for an informational advantage for informed investors, suggested by their IPO application methods.

2.2. Seasonality:

Ibbotson and Jaffe (1975) explain IPO seasonality in terms of “hot issue markets”. The study defines “hot issue markets” to be sustained periods where a high volume of IPOs experience a significant upward movement in their prices post offering. The study subtracts the monthly return of the S&P 500 Index from each calendar month’s average offering return between January 1960 and October 1970. Any month above the median monthly return of 12.64% is defined as a “hot issue”, with the results indicating a significantly higher proportion of offerings taking place within these months.

Also analysing the long-run aftermarket performance of the sampled IPOs, Ibbotson and Jaffe found a positive slope coefficient in their fitted regression model. This suggests a long-run positive performance of IPOs that experience disproportionately large upward price movement post offering. Dallocchio *et al.* (2020) [11] explain IPO seasonality in terms of yearly variation in daylight hours. The study defines months of seasonal darkness as those being any with fewer than 12 hours of daily sunlight. Overall, the proportion of offerings under-priced in months of seasonal darkness was found to be 29.2% in comparison to 26.5% in the other months. The study attributes this difference to increased risk aversion from retail investors due to a decreased mood during these specific months. Investors, therefore, require a risk premium in order to incentivise retail investment and this comes in the form of underpricing. However, although the results show some support for this hypothesis the difference is minimal. The behavioural variables within the study’s model rely upon many assumptions which are not backed up statistically, weakening the strength of the argument.

Conversely, Pagano and Veronesi (2005) [12] accredit “IPO waves” to fluctuations in market conditions. The study proposes two main market conditions which vary to cause changes in IPO underpricing. The first is a company’s market-to-book ratio (M/B). They suggest a higher market to book ratio does not necessarily increase IPO volume, instead, they argue that increases in M/B are subsequently followed by increases in firms going public. Additionally,

they measure market volatility by the standard deviation in market returns, calculated monthly. The findings are that increased volatility decreases IPO volume, which can be linked again to the idea of "ex-ante uncertainty".

2.3. Pre and Post M&A activity:

Multiple studies suggest a relationship between IPO underpricing and the volume of M&A transactions both pre-and post-listing. Pagano *et al.* (1998) [13] concludes a firm is doubly likely to be taken over within the first three years post publicly listing. Boulton *et al.* (2010) [14] look at the link between IPO underpricing and pre-M&A activity specifically. The study hypothesises firms taken public within corporate control markets, are less likely to remain independent 3-years post offering. The study assesses 6,156 IPOs between the years 1980 and 2001 from Thompson Financials' SDC new issue database. By running an OLS regression model with initial returns as the dependent variable. Pre-IPO M&A activity is an explanatory variable, with the number of M&A transactions divided by the total number of listed firms within the industry. This is calculated for 3-, 6- and 12-month periods pre-IPO. Therefore, the model predicts a 0.439, 0.230, and 0.100 increase in initial IPO returns predicted value with a 1 unit increase in the M&A coefficient for each period respectively, assuming all other variables remain constant. The coefficients on both the 3- and 6-month periods are statistically significant at the 1% level, meaning the study's results are highly accurate regarding the causal relationship between M&A activity and underpricing.

Contrarily, Brau *et al.* (2010) [15] propose firms look to acquire within their first year as a public entity, due to the comparably higher market-adjusted return for new acquirers. Kohers and Kohers (2001) [16] propose that this is due to over-optimism by uninformed investors towards new investors. Brau *et al.* do find that the adjusted market return to comparable firms in the same industry with similar gross proceeds is still negative. New acquirers have a -5.5% adjusted return with non-acquirers having an adjusted return of -15.6%. These results are comparable with those of Ritter and Welch (2002) [17] who similarly conclude that new acquirers perform superiorly to non-acquirers over an initial three-year period. I believe this comparison to be useful as it is evident better initial performance will increase the capital available to a firm post offering. This facilitates potential takeover and means more successful firms are more likely to be able to acquire.

2.4. Underwriter reputation:

Additionally, IPO underwriters face a significant trade-off when setting an initial offer price. Logue (1973) [18] suggests underwriters who have gained a positive reputation are highly selective in which firms to take to offer. Logue also indicated that non-prestigious underwriters set their offer prices without fully reflecting market conditions. Loughran and Ritter (2004) [19] introduce the idea that underwriters intentionally underprice to reduce IPO failure. Multiple empirical models exist that have ranked underwriters, to examine the relationship between underwriter reputation and underpricing. Megginson and Weiss (1991) [20] provide the most basic metric of underwriter rank. Comparing the underpricing of both venture capitalist and non-venture capitalist backed offerings to the percentage market share

of their underwriters. The study finds increased initial returns for non-venture capitalist-backed offerings, which are likely to be held by lesser-known underwriters.

Johnson and Miller (1998) [21] alternatively separate underwriters into 4 separate categories from Rank 3 to Rank 0. Through an OLS regression model, the study finds an average initial return of 3.22% for 86 firms publicly listed through prestigious underwriters. Comparatively, for 876 firms taken public by non-prestigious underwriters, the average initial return is 11.20%. The ranking system used within the study is potentially weak due to the fact it is solely measured on the volume of tombstones within reputable financial newspapers. This is sourced from Hayes (1971) [22]. However, this has no consideration of how each underwriter is incentivised.

However, Carter *et al.* (1998) use both metrics as explanatory variables in a multivariate regression model to assess the underpricing of IPOs 1 day post offering. Both are found to be statistically significant at the 1% level, with negative coefficients corroborating the idea that less underpricing occurs for reputable underwriters. This, therefore, suggests the viability of the methods used in Johnson and Miller (1988).

2.5. Long-Run Performance of IPOs:

Although a clear pattern indicates an initial positive performance of listed firms post offering, a long-run pattern remains inconclusive. Ritter (1991) finds IPOs do have a positive 3-year buy and hold return, with a sample of 1526 firms averaging a 34.47% return after 3-years post offering. However, the study also compares the return of 1526 firms already publicly trading matched by industry and market value. Comparatively, these firms had a 3-year buy and hold return of 61.86% indicating a long-run underperformance of IPOs. Stoll and Curtley (1970) [23] also report underpricing in the short run followed by an overall negative long-run performance.

Across around 200 firms analyzed the study finds a 42.4% superior return in new issues over the initial 6 months. However, in line with Ritter's finding the market adjusted long-run rate of return is still negative. Stoll and Curtley only focus on small firms. However, their failure to outline the characteristics required for a firm to be classified as small limits the ability of the study as a viable explanation as to why new issues underperform in the long run.

The overperformance of IPOs in the short run in Teoh *et al.* (1998) [24] is attributed to perverse issuer incentives. The study theorises that issuing firms can report greater earnings through accounting adjustments. As the issue progresses post IPO if earnings do not follow a priorly anticipated pattern investor confidence falls. This leads to increased sales, and therefore an excess stock market supply causes price falls, and hence negative long-run performance. The study finds the average raw 3-year buy and hold returns to be negative at -21.67% for the 1649 firms sampled. Due to this variation in existing trends in long-run IPO price movement, this study will provide its own analysis of long-run underperformance.

3. Data

3.1. Study Sample

This study analyses the 3-year price movement of 272 firms across an initial 3-year period post offering. *IPOscoop.com* provides an extensive spreadsheet displaying all 3713 offerings that have taken place to date in the 21st century. This contains an initial offer price for each of the 272 firms sampled. This study then subtracts this offer price for each IPO from its respective close price at the 1-month, 1-year, and 3-year intervals. All close price data is gathered from *Marketwatch.com*. This provides a calculated percentage return for each of the 4 periods for every company sampled. The firms' initial first-day returns are also derived from the *IPOscoop.com* extensive spreadsheet. The method used to calculate first day returns is the same as used in Dallocchio *et al.* (2020).

The sample includes approximately 14 firms for each year between 2000 and 2019. Only 12 and 8 firms are sampled from the years 2002 and 2008 respectively, due to the low volume of offerings in both. The lower volume in 2002 is likely due to the slowdown in technological firms going to market post dot-com bubble. For 2008 it's self-explanatory with the state of the financial sector post financial crisis. The sample is taken pre-Covid-19 pandemic, due to a potential bias this would present in results, due to a large fall and boom in the stock market. Every firm sampled is required to still be publicly trading 3 years post-offer date in order to undergo the appropriate analysis. Therefore, the companies have been selected on the premise of still being public as of April 2022. All 272 must have been publicly listed on either the Nasdaq or NYSE and therefore the study comprises solely of companies listed in the US.

3.2. Variable Description

The outcome variable within the study is the percentage change in each IPOs price after the 1st day, 1st month, 1st year, and 3rd year of publicly trading. Both the 1-year and 3-year coefficients for long-run returns are adjusted against the equivalent performance of the S&P 500 Index across the equivalent period, as modelled in Ritter (1991). As our study is undergoing 4 separate cross-sectional analyses for the 272 firms, our study takes a panel data form including 1088 observations. Underpricing will be defined by an upward movement in the issues price over both the 1st day and 1st month of trading publicly.

We aim to build upon the exploration undergone in Ritter (1991), investigating if the relative long-run underperformance of IPOs is still applicable within the 21st-century post-technological and financial reform. The study derives its independent variables in order to test the significance of the four primary explanations for underpricing outlined within the existing literature. The Explanatory variables include *Age, Gross Proceeds, M&A Acquisitions, Underwriter Rank, Industry, and General Market Return.*

Age and *Gross proceeds* are hypothesised to provide a metric to examine "ex-ante uncertainty" brought forward in Beaty and Ritter (1986). We propose that underwriters deliberately underprice firms in their infancy or ones that generate low gross proceeds from their offering. This is in order to incentivise uninformed investors into purchasing IPOs that are deemed in general less reputable. The age of the firms included in the data is found by calculating the difference in years between the offer date and the date the firms were founded. The firm's age is either rounded up or down dependent upon if the offer date is closer to the previous or next date of the firm's founding. Gross Proceeds are simply

calculated by using the corresponding figure for each firm on the IPOscoop.com database. Gross Proceeds are measured in millions. As Gross Proceeds are only provided for firms that went public post-2005 only 760 observations include this relevant data.

The number of *Merger & Acquisition transactions* globally for each year is included to test the hypothesis identified in Boulton *et al.* (2010). This is because more pre-offering M&A transactions increase the number of firms going public in order to protect themselves against a predatory takeover. The global transactions for the years 2000-2009 are sourced from the *Wilmer Hale M&A report* (2009). The remaining years 2010-2019 are found on *statista.com*. This explanatory variable is solely hypothesised to affect the 1-day and 1-month returns. There is no existing literature linking M&A volume to long-run IPO performance and therefore we do not expect to find any significant relationship

The *Underwriter Rank* variable used within the study is derived directly from Johnson and Miller (1988). Each firm is assigned a ranking of 0-3 determined by the perceived prestige of its lead underwriter listed by the original study. The Lead Underwriter is again sourced from the *IPOscoop.com* extensive database. Rank 3 is the most prestigious bracket, being assigned to the most reputable underwriters, i.e., Merrill Lynch and Morgan Stanley. Subsequent ranks are proposed to demonstrate a drop-off in underwriter quality. We hypothesise underwriter reputation not only affects short-term underpricing as put forward in Johnson and Miller (1988) but also that more reputably underwritten IPOs perform better long term.

Finally, this study attempts to create a link between a potential seasonality of IPO underpricing in accordance with the findings of Pastor and Veronesi (2005). By providing the explanatory variable *General Market Return* we look to provide a causal explanation between the two factors. The *General Market Return* simply refers to the annual performance of the S&P 500 Index. The historical S&P 500 Index returns are gathered from macrotrends.net.

Each firm is assigned to one of 9 primary industries under the variable name *industry*, with the aim of identifying underpricing across various sectors. Most of the aforementioned models in existing literature were undertaken pre-technological and financial reform. This study assesses the presence of trends in relation to underpricing in specific industries. All industry variables within the regression represent dummy variables, taking value 1 if the firm is within the applicable sector.

3.3 Descriptive Statistics

Table 1- IPO Mispricing by Industry

Industry	Number of Observations	Mispricing
Consumer Goods	40	24.08%
Education	3	-10.67%
Energy	25	6.52%
Financial	57	11.52%
Medicine and Pharmaceuticals	41	10.57%
Oil and Natural Resources	23	8.13%
Sport	2	-18.00%
Technology	66	21.55%
Transport	15	13.13%
Total	272	14.54%

Table 1 above shows a summary of the extent of underpricing across all 9 of the included industries. We can see more prominent underpricing within the Technology and Consumer Goods Sectors with both experiencing first-day returns greater than 20%. Overall, when excluding the two sectors with insufficient observation we can see underpricing present in each sampled industry. We can see from the total observation of the 272 firms sampled the average day-1 underpricing was 14.54%. This is slightly lower than existing pre-2000 data, with Ritter (1984) stating an 18.8% average day-1 return for 5000 firms going public between 1960 and 1980.

Table 2: The Average Age of firms in each industry

Industry	Number of Observations	Average Age
Consumer Goods	40	41.88
Education	3	6
Energy	25	24
Financial	57	28.65
Medicine and Pharmaceuticals	41	15.46
Oil and Natural Resources	23	20
Sport	2	67.5
Technology	66	14.44
Transport	15	32.8
Total	272	24.08

Table 2 displays the average age of firms at IPO for the 9 observed industries. We can see the Consumer Goods, Financial and Transport sector firms are notably older than the average firm sampled. With technological sector firms on average the youngest of the sampled firms with sufficient observations. This average may have been even lower with an extension of the years sampled to include the dot-com bubble of the late 1990s. Ljungqvist and Wilhelm (2003) [25] find an average underpricing of Internet IPOs to be 89% for 1999-

2000. A high proportion of the technology firms sampled in the early 2000s fall below the median sample age in table 3. The 90s trend stated in Ljungqvist and Wilhelm (2003) supposedly increases confidence in newer technology issuers in the early 2000s explaining the lower average age.

Table 3: Summary statistics for the regression models variables

Variable	Observations	Mean	Median	Standard Deviation
Age	272	24.080	10.500	34.210
General Market Return	272	0.067	0.100	0.100
Gross Proceeds	190	595.500	177.240	177.240
M&A Acquisitions	272	37257	39894	9948.047
Day 1 Return	272	0.145	0.070	0.240
1-Month Return	272	0.143	0.080	0.351
1-Year Adjusted Return	272	0.183	0.042	0.807
3-Year Adjusted Return	272	0.262	-0.072	2.061
Underwriter Reputation	272	1.850	3	1.292

Table 3 provides a summary of all non-dummy variables included in the 4 regression models.

4. Analysis and Results

4.1. Empirical Specification:

The preface of this investigation is to assess the relationship between both IPO underpricing and also the long-run performance of IPOs relative to existing firms. The model follows methods used in Ritter (1991) comparing the 1-year and 3-year returns to existing counterparts through an adjusted return. Ritter (1991) compares each firm based on both the time difference between foundation and offering and additionally the gross proceeds generated from the offering. This study instead compares the raw return of each firm to the 3-year S&P 500 Index return over the comparative period. Overall, although the study aims to highlight the significance of the causes of underpricing, the overall aim is to establish a pattern of negative adjusted returns in the long run.

The following model for all 4 time periods has been generated including both the dummy and non-dummy variables for the sample of 272 firms: (1)

period return (Day1Return, 1MonthReturn, 1YearReturn and 3YearReturn) = β0+β1*age*+ β2IndustryConsumerGoods+β3*IndustryEducation*+β4*IndustryEnergy*+β5*IndustryFinancial*+β6*IndustryMedicineandPharmaceuticals*+β7*IndustryOilandNaturalResources*+β8*IndustrySport*+β9*IndustryTechnology*+β10*IndustryTransport*+β11*GeneralMarketReturn*+β12*Year*+β13*UnderwriterRank+ε*

The multivariate linear regression model includes 13 regressors composing of a mixture of both dummy and non-dummy variables, and contains a random error term denoted by *ε.* The study adds additional independent variables in the empirical results section for further analysis. The error term is assumed to have a zero mean in all regression analysis and is also assumed to be serially uncorrelated across the 4 cross-sectional analyses. Ordinary Least Squares (OLS) is used within the model as minimises the sum of the squared residuals, and hence to reduce the variance and bias within the model.

The method for calculating the returns for each firm in each period is as per Dallocchio(2020): (2)

$$ROR\ i,t = \frac{\mathrm{Pi,t} - \mathrm{Pi,0}}{\mathrm{Pi,0}}$$

Where:

RORi,t = The rate of return for firm i over period of time t.

Pi,t = The price of firm i at close on date marking time t from offering.

Pi,0 = The Initial Offer Price of firm i when time t is equal to zero.

4.2. Empirical Results:

Table 4: Regression Models for 1-day and 1-month underpricing, and long run adjusted performance rate

	Dependent Variable			
	Day 1 Return	1 Month Return	Relative 1-Year Performance	Relative 3-year Performance
Age	-0.0003	0.002	0.004	0.015
	(0.0003)	(0.005)	(0.012)	(0.030)
IndustryConsumerGoods	-0.023***	-0.103***	-0.231	-0.338
	(0.056)	(0.107)	(0.284)	(0.552)
IndustryEducation	-0.382***	-0.266	-0.542	-0.906
	(0.138)	(0.208)	(0.482)	(1.261)
IndustryEnergy	-0.190***	-0.282***	-0.010	-0.030
	(0.059)	(0.089)	(0.206)	(0.538)
IndustryFinancial	-0.124***	-0.217***	-0.263	0.096
	(0.047)	(0.071)	(0.165)	(0.433)
IndustryMedicineandPharmaceuticals	-0.144***	-0.191**	-0.470**	-0.162
	(0.052)	(0.078)	(0.182)	(0.476)
IndustryOilandNaturalResources	-0.176***	-0.202***	-0.446**	-0.720
	(0.061)	(0.091)	(0.212)	(0.555)
IndustrySport	-0.492***	-0.410	-0.708	-0.733
	(0.166)	(0.251)	(0.582)	(1.525)
IndustryTechnology	-0.036	-0.143**	-0.234	-0.417
	(0.047)	(0.071)	(0.164)	(0.430)
IndustryTransport	-0.126*	-0.191*	-0.031	-0.443
	(0.069)	(0.104)	(0.242)	(0.633)
GeneralMarketReturn	-0.014	0.138	0.943***	-1.877***
	(0.098)	(0.148)	(0.344)	(0.900)
Year	0.050	0.003	-0.064	-0.231
	(0.046)	(0.070)	(0.162)	(0.424)
M&Aacquisitions	-0.00001*	-0.00001*	-0.00000	0.00003
	(0.00000)	(0.00001)	(0.00002)	(0.00004)
UnderwriterRep	-0.036**	-0.017	-0.056	0.051
	(0.011)	(0.017)	(0.039)	(0.101)
Constant	-100.054	-6.254	129.054	461.967
	(92.451)	(139.527)	(323.610)	(847.323)
Observations	272	272	272	272
R-Squared	0.155	0.096	0.083	0.037
F-statistic (df = 14 ; 257)	3.357***	1.960**	1.659*	0.702

Standard errors in parenthesis

**p < 0.1, ** p < 0.05, *** p < 0.01*

Table 5: A table showing the 4-regression model when underwriter ranks 1, 2 and 3 are broken down into individual explanatory variables

	Dependent Variables			
	1-Day Return	1-Month Return	Relative 1-Year Performance	Relative 3-Year Performance
Age	-0.001	-0.001*	0.0001	0.002
	(0.0004)	(0.001)	(0.002)	(0.004)
IndustryConsumerGoods	-0.047**	-0.122*	-0.347	-0.549
	(0.072)	(0.105)	(0.227)	(0.428)
IndustryEducation	-0.414***	-0.293	-0.533	-0.968
	(0.136)	(0.208)	(0.485)	(1.268)
IndustryEnergy	-0.185***	-0.275***	-0.005	-0.007
	(0.058)	(0.089)	(0.207)	(0.541)
IndustryFinancial	-0.135***	-0.221***	-0.251	0.097
	(0.047)	(0.072)	(0.167)	(0.438)
IndustryMedicineandPharmaceuticals	-0.155***	-0.193**	-0.455**	-0.151
	(0.052)	(0.079)	(0.184)	(0.482)
IndustryOilandNaturalResources	-0.181***	-0.205**	-0.442**	-0.725
	(0.060)	(0.091)	(0.213)	(0.557)
IndustrySport	-0.512***	-0.425*	-0.700	-0.765
	(0.164)	(0.251)	(0.585)	(1.530)
IndustryTechnology	-0.055	-0.158**	-0.227	-0.451
	(0.047)	(0.071)	(0.166)	(0.435)
IndustryTransport	-0.136**	-0.199*	-0.029	-0.465
	(0.068)	(0.104)	(0.243)	(0.635)
GeneralMarketReturn	0.0002	0.156	0.952***	-1.820**
	(0.097)	(0.148)	(0.346)	(0.905)
Year	0.030	-0.013	-0.056	-0.266
	(0.046)	(0.070)	(0.164)	(0.430)
M&Aacquisitions	-0.00001*	-0.00001**	-0.00000	0.00003
	(0.00000)	(0.00001)	(0.00002)	(0.00004)
UnderwriterRep1	0.091**	0.076	-0.114	0.238
	(0.044)	(0.067)	(0.156)	(0.409)
UnderwriterRep2	-0.090	-0.110	-0.226	-0.211
	(0.066)	(0.100)	(0.234)	(0.613)
UnderwriterRep3	-0.075**	-0.028	-0.226	-0.211
	(0.034)	(0.052)	(0.234)	(0.613)
Constant	-58.826	25.937	113.719	531.301
	(92.085)	(140.687)	(328.172)	(858.764)
Observations	272	272	272	272
R-Squared	0.186	0.108	0.084	0.039
F-Statistic df = (16 ; 255)	3.631***	1.929**	1.464	0.651

Standard errors in parenthesis

**p<0.1, **p<0.05, ***p<0.01*

Table 6: Shows the results of the multivariate linear regression model after the addition of regressor *GrossProceeds*

	Dependent Variable			
	Day-1 Return	**1-Month Return**	**Relative 1-Year Performance**	**Relative 3-Year Performance**
Gross Proceeds	-0.00000	-0.00002	-0.00003	-0.00005
	(0.00001)	(0.00002)	(0.00004)	(0.0001)
Age	-0.001	-0.001	-0.001	-0.003
	(0.001)	(0.001)	(0.002)	(0.005)
IndustryConsumerGoods	-0.052***	-0.206**	-0.308	-0.565
	(0.083)	(0.116)	(0.224)	(0.416)
IndustryEducation	-0.462***	-0.433*	-0.688	-1.084
	(0.151)	(0.229)	(0.540)	(1.104)
IndustryEnergy	-0.277***	-0.390***	-0.052	0.156
	(0.072)	(0.108)	(0.256)	(0.523)
IndustryFinancial	-0.194***	-0.337***	-0.327	-0.102
	(0.060)	(0.090)	(0.213)	(0.436)
IndustryMedicineand Pharmaceuticals	-0.219***	-0.318***	-0.444*	0.164
	(0.069)	(0.104)	(0.247)	(0.504)
IndustryOilandNaturalResources	-0.232***	-0.319***	-0.543*	-1.001*
	(0.078)	(0.118)	(0.279)	(0.571)
IndustrySport	-0.525***	-0.542**	-0.722	-0.468
	(0.181)	(0.274)	(0.648)	(1.324)
IndustryTechnology	-0.067	-0.257***	-0.179	-0.094
	(0.061)	(0.092)	(0.217)	(0.444)
IndustryTransport	-0.248***	-0.324**	-0.230	-0.374
	(0.087)	(0.132)	(0.312)	(0.638)
GeneralMarketReturns	-0.096	0.100	1.108**	-1.000
	(0.137)	(0.208)	(0.490)	(1.002)
Year	0.077	0.121	-0.029	0.227
	(0.063)	(0.095)	(0.224)	(0.458)
M&A Acquisitions	-0.00001	-0.00002**	-0.00001	0.00001
	(0.00001)	(0.00001)	(0.00002)	(0.00004)
UnderwriterRep	-0.034**	-0.017	-0.089	0.144
	(0.014)	(0.021)	(0.051)	(0.104)
Constant	-153.212	-240.302	59.573	-454.563
	(125.185)	(189.555)	(447.689)	(915.129)
Observations	190	190	190	190
R-Squared	0.199	0.153	0.119	0.055
F-statistic	2.883***	2.090**	1.563*	0.675

Standard errors in parenthesis

**p<0.1, **p<0.05, ***p<0.01*

As the models states the multivariate model including the *GrossProceeds* variable only includes 760 observations, therefore with a smaller sample size we will see fewer comments upon its reported results.

Table 7: Shows the regression coefficients when both long run models take raw values in place of adjusted returns.

	Dependent Variable			
	Day-1 Return	**1-Month Return**	**Raw 1-Year Return**	**Raw 3-Year Return**
Age	-0.0003	-0.001	0.0001	-0.0003
	(0.0004)	(0.001)	(0.0003)	(0.0004)
IndustryConsumerGoods	-0.023***	-0.103***	-0.011	-0.008
	(0.056)	(0.107)	(0.028)	(0.042)
IndustryEducation	-0.382***	-0.282***	-0.016	-0.004
	(0.138)	(0.089)	(0.041)	(0.134)
IndustryEnergy	-0.190***	-0.282***	-0.016	-0.014
	(0.059)	(0.089)	(0.041)	(0.057)
IndustryFinancial	-0.124***	-0.217***	-0.002	-0.013
	(0.047)	(0.071)	(0.033)	(0.046)
IndustryMedicineandPharmaceuticals	-0.144***	-0.191**	-0.063*	-0.070
	(0.052)	(0.078)	(0.036)	(0.050)
IndustryOilandNaturalResources	-0.176***	-0.202**	-0.027	0.011
	(0.061)	(0.091)	(0.042)	(0.059)
IndustrySport	-0.492***	-0.410	0.078	-0.006
	(0.166)	(0.251)	(0.116)	(0.162)
IndustryTechnology	0.036	-0.143**	-0.019	-0.046
	(0.047)	(0.071)	(0.033)	(0.046)
IndustryTransport	-0.126*	-0.191*	-0.020	-0.201***
	(0.069)	(0.104)	(0.048)	(0.067)
GeneralMarketReutrn	-0.014	0.138	-0.136**	-0.551***
	(0.098)	(0.148)	(0.069)	(0.096)
Year	0.050	0.003	0.017	0.020
	(0.046)	(0.070)	(0.032)	(0.045)
M&Aacquisitions	-0.00001*	-0.00001*	-0.00001**	0.0000
	(0.000)	(0.00001)	(0.000)	(0.000)
UnderwriterRep	-0.036***	-0.017	0.002	0.002
	(0.011)	(0.017)	(0.008)	(0.011)
Constant	-100.054	-6.254	-33.232	-39.997
	(92.451)	(139.527)	(64.060)	(89.764)
Observations	272	272	272	272
R-Squared	0.155	0.096	0.964	0.989
F-Statistic	3.357***(df = 14;257)	1.960** (df = 14;257)	454.085*** (df = 14;257)	1,587.801*** (df = 14;257)

Standard Errors in Parenthesis

**p<0.1, **p<0.05, ***p<0.01*

4.3. Undepricing Interpretations:

Table 4 displays the regression coefficients for the 4 models within the empirical study. From table 2 we see the average age of the 272 firms sampled was 24 years, with the overall firm age ranging from 183 to 8 firms that were listed within the first 6 months post-incorporation. From Table 4, we can see the insignificance of the age variable with an initial p-value of 0.22. This would contradict the idea that younger firms increase the levels of "ex-ante uncertainty" as proposed in Beaty and Ritter (1986). In order to further analyse the causal effect of age, we split the firms sampled into two equal-size subsets of firms both younger and older than 10 years at offering. Given two subsets of 136, we perform an F-test upon the variance of both groups. This intends to show that increased variability in returns for the firms aged less than 10 would still suggest a relationship between increased "ex-ante uncertainty" for newer firms and underpricing. The F-value showing the ratio of variances between the two subsets

is equal to 2.58, which falls between the 95% confidence interval. As the test has a p-value of less than 0.001 we can conclude that there is a significant difference between the two variances. Therefore, the study shows that there is increased variability in the returns for newer issues, meaning "ex-ante uncertainty" has increased mispricing within the sample.

Of the firms sampled, the study finds a disproportionate quantity of firms given a rank of 3 using the Johnson and Miller (1988) metric for underwriter prestige. When broken down 67 of the sample received a rank of 0, 48 received a rank of 1, 15 a rank of 2, and 142 a rank of 3. From the above Table 4, we can see the underwriter's reputation exhibited a p-value of 0.011, with a negative coefficient of -0.036 on 1-day returns. This study is, therefore, able to support the hypothesis that more prestigious underwriters can more accurately price new offerings. On further analysis, in Table 5 we break down the underwriter rank into each specific numerical ranking as an individual dummy variable. With a p-value of 0.017 for the variable Underwriter Rank 3, we can again see a statistical significance at the 5% level. Interestingly, the Underwriter Rank 1 coefficient is 0.091 significant at the 5% level. This also supports that less reputable underwriters excessively underprice compared to their more reputable counterparts.

The Mergers and Acquisitions variable examined shows a minimal negative relationship upon underpricing. The coefficient for the M&A variable in both cases was slightly negative being -0.00001 in both regression models. Even when adjusting M&A transactions to thousands rather than the raw number of transactions the effect is still inconclusive and opposes the hypothesis proposed. The p-value on the model for 1-day returns is only significant at the 10% level, thus we conclude increased M&A activity doesn't increase underpricing.

The fact that 52% of the sample was deemed to be underwritten by prestigious underwriters may have limited a causal relationship between M&A volume and underpricing. As these underwriters have a reputation to uphold, they must contradict the incentives of the issuing firm which seeks to underprice as a protection mechanism. Therefore, as this is our principal explanatory link between the two variables this is a potential reason for our analysis's inability to identify a significant causal relationship. The study considers the M&A volume for the year of issue, which may not fully reflect the current market situation if the transactions are unevenly distributed across the year's course.

When analysing the relationship between a firm's industry and underpricing we see a significant relationship for each dummy variable excluding *IndustryTechnology.* All firms have negative coefficients hence decreasing the 1-day return within the model, with both the technological and financial sectors having particularly small effects on reducing underpricing. Both have regression coefficients of -0.036 and -0.124 respectively, however this was to be expected as they were the two most underpriced industries in table 1.

The reason for increased underpricing in the technological sector may be due to high investor confidence in technological firms post dot-com bubble. The study is yet to put forward the idea of information asymmetry between underwriters and retail investors outlined in Zhang (2012)[26], due to difficulty quantifying the proposal within an empirical model. Zhang's study outlines a mismatch in private information held by the underwriter and the issuing firm will

increase IPO underpricing. It may be argued within the financial sector there will be a lesser discrepancy between the information held by each agent, reducing the causal effect of the *IndustryFinancial* variable.

With negative coefficients of -0.176 and -0.190 both *IndustryOilandNaturalResources and IndustryEnergy* coefficients have the biggest causal effect on reducing underpricing. Both are highly statistically significant with p-values less than 0.01. The reason for Oil and Natural Resource firms is likely due to the size and profitability of the sampled firms' pre-issue. Firms are likely natural monopolies due to the large, fixed costs required for industry entry, which facilitates large profits. Therefore, for retail investors there is far smaller speculative interest in such firms, which may have led to the smaller levels of underpricing. The energy firms in table 2 have an average age of 24, far greater than the median age of all 272 firms sampled of 10.5 given in table 3. Therefore, from the F-test on the age coefficient we know this likely means less variability in day-1 returns for energy firms, accounting for the large negative coefficient on day-1 underpricing for the *IndustryEnergy* variable.

The *GeneralMarketReturn* coefficient in the short run has a positive overall effect on underpricing, with 0.02 and 0.156 coefficient on the 1-day and 1-month models. However, in both models it is statistically insignificant, and we are therefore unable to attribute seasonality in IPO underpricing. Especially with the relative size of the coefficient in the 1-day model.

The GrossProceeds variable displayed in Table 6 shows no significance in any of the 4 cross-sectional analyses. In all 4 the coefficient is small however this is unsurprising due to the coefficient being measured in millions. We therefore ignore the effect of gross proceeds on underpricing and cannot verify the proposal in Beaty and Ritter (1986) that higher gross proceeds reduce ex-ante uncertainty and hence underpricing.

4.4. Long Run Interpretations

Overall, there is very little significance in any of the regression modelling long run adjusted. With only *GeneralMarketReturn*, *IndustryMedicineandPharmaceuticals* and *IndustryOil andNaturalResources* showing statistical significance at any level in the 1-year adjusted model. No variables show significance in the 3-year model. This is potentially to be expected as the chosen explanatory variables were majority focused on displaying causal relationship upon underpricing. We ignore the significance of the *GeneralMarketReturn* variable due to S&P500 Index acting as a confounding variable, as it is included in the calculation of both the regressor and the outcome variables. When looking at the raw long run returns the GeneralMarketReturn coefficient is positive in both regression models in Table 7, with statisitical significance at the 1% level. Therefore, we can conclude long run raw IPO returns are positively correlated with positive market returns. However, as prior literature generally focuses on adjusted returns this provides little support of our stated hypothesis.

Again, as with both short run models each industry coefficient is negative in both the 1-year and 3-year adjusted models. The coefficients on the *IndustryEnergy* and *IndustryTransport* models are the least negative in the 1-year model calculating at -0.005 and -0.029 respectively. This again is likely due to the large, fixed costs required for operation for such

firms in each industry. With both having high average ages of 24 and 32.8 as shown in table 2 there is an increased likelihood of long run profitability. Which explains the lower negative effect on 1-year adjusted returns for both variables. Within the 3-year model the *IndustryTransport* coefficient is much larger which supports the findings in Despoina and Eirini (2010)[27] stating the optimum sell point for investors of shipping IPOs is the 11^{th} month. The *IndustryFinancial* coefficient within the 3-year model is positive, suggesting the greatest overall long- run performance of IPOs in the financial sector. However, as the coefficient is of no statistical significance, we are unable to conclude the statement.

For both the 1-year and 3-year adjusted returns the *UnderwriterRep* coefficient shows no statistical significance. This analysis therefore cannot support the findings in Logue (1973), which suggests prestigious underwriters are able to identify high potential IPOs destined for greater long run returns. The relationship for long-run performance is potentially harder to assess due to the lack of consideration for firms not listed on major stock exchanges. More reputable underwriters will have a far higher volume of IPOs taken to market. Therefore, a more even distribution between the various ranks may have allowed a greater causal relationship to be identified.

As mentioned in the variable description, no existing relationship between M&A activity and long-run market performance has been discovered. Hence, as there is no link found in the regression for long-run adjusted returns it will not be included in the analysis. The *GrossProceeds* variable is excluded from all long-run models. The lacking data for gross proceeds within the sample, and its lack of causal relationship within the studied literature, leads us to rule out its effect on long run adjusted returns.

Most interestingly we find a positive mean adjusted long run performance in both the 1-year and 3-year models for the sample. From table 3, we see an average 1-year adjusted return of 18.3% and an average 3-year adjusted return of 26.2%. This contradicts all prior research on long run IPO performance, with Ritter (1991), Stoll and Curtley (1970) and Teoh *et al.* (1998) all stating long run underperformance. The potential validity of this study's results on long run relative performance must be questioned both due to the sampling methods and the size of the sample itself.

The exclusion of all delisted firms, means any firms who filed for bankruptcy or ceases operation, has not had its performance evaluated. Demers and Joos (2006)[28] find 16% of 3574 listed between 1980 and 2000 either liquidates or delisted within 5 years post IPO. It is fair to assume this would have had a large negative effect on both the 1-year and 3-year adjusted returns and previous models considered such firms. The change to the Index used as a benchmark for adjusted return also varies from previous models. The use of the S&P 500 Index in contrast to the methodology in Ritter (1991) likely explains the difference in results. The median 3-year adjusted return displayed in table 3 is -7.2%, showing a large proportion of the sampled 272 firms still experienced negative adjusted long run underperformance.

5. Limitations

Although the short run interpretations show significance of multiple variables used within the 2 underpricing focused regression models, both the R-squared and adjusted R-squared values

for each model are very low. With an R-squared value of 0.186 in the 1-day model, and 0.108 in the 1-month model we see a lack of explanation for the variability in returns in each period, from our chosen explanatory variables. Multiple explanations for IPO underpricing within the cited literature have been omitted from the model including the number of total IPOs in the month each IPO is offered. This was theorised in Ibbotson and Jaffe (1975) and could be a better indicator of seasonality in IPO returns, as it is more specific to each IPO than our *GeneralMarketReturn* variable. Another variable left out of the study, pointed to in multiple previous studies is the winner's curse problem in the study undertaken by Lee et al. (1999). Our study's model shows no consideration for share allocation for each studied IPO, which is another area of potential improvement in the methodology.

Furthermore, the model lacks heteroskedastic adjustments, assuming homoskedasticity. The standard errors reported non-heteroskedastic robust. Therefore, this further implies a potential requirement for additional variables. There is potential for systematic variation in the model's error terms, due to the poor specification of the model's regressors. Perhaps the empirical specification requires remodeling as previously mentioned in order to give a more complete analysis on the causes of IPO underpricing, and the use of a Breush-Pagan test would allow the verification of each of the study's variables.

Overall, the model could likely be improved by adapting the regressions for the 2 long term dependent variables. In both models the study's independent variables show very little significance, due to the selection criteria of the explanatory variables focusing on the underpricing phenomenon. Thus, the study has been able to make insignificant contribution on the long run underperformance of IPOs in the 21st century. With a second adapted model in addition to equation (1) that targets explaining long run underperformance, the study's contribution would likely be more valuable.

Additionally, the lack of logarithmic variables in the model could have also improved the accuracy of the model's results. Within both the *GrossProceeds* and *Age* variables there are large outliers within the dataset, with the Facebook offering raising approximately 30 times the mean for the sample presented in table 3. The data for both variables is heavily skewed by these outliers, and a remodeling to a log-linear model would likely increase the linearity of the model for both variables.

The time constraint whilst gathering data and the difficulty in findings the relevant statistics needed to align this study with existing models, limits the sample size to 272 firms. Several models observing the price adjustment of IPOs post offering use thousands of firms in their analysis, allowing more accuracy and reliability in their analyses. The main sampling issue is the study required all firms to still be publicly trading as of April 2022 in order to find the required data to contribute to the model's analysis. Firms which have traded publicly since the beginning of the 21st century and are still to this date publicly listed likely give a disproportionate insight into the general trend of long run IPO underperformance. The study acknowledges that in general to remain public for this extended period post IPO, the firm's IPO is far more likely successful. This may be the reason for our mean adjusted overperformance of the 272 sampled IPOs against the S&P 500 Index.

6. Conclusion

This study analyses how underpricing and long run relative performance of IPOs across 9 different industries in the 21st century varies with different characteristics in each sampled firm. Within the 272 sampled firms the study finds that the IPO underwriters' prestige, the age of the firm when listed, and the industry of the firm affected the extent to which its 1st day returns varied. All 3 variables therefore aligned with the findings of previous literature, which showed some strength of the study's empirical model. In all 3 regression Tables reported in the data summary section the models F-statistic for the cross-sectional analysis on 1-Day Returns to be highly significant at the 1% level. Therefore, this meant that the study's modeled variables improved the models fit, and thus it has given sound analysis towards the extent of underpricing in the 21st century.

The model has allowed for clear comparison across industries, with technological sector firms still experiencing relatively high underpricing, despite existing literature suggesting reduced investor speculation towards such firms post dot-com bubble. When comparing firms across the industries the study contradicts its proposed hypothesis of underpricing increasing due to ex-ante uncertainty in smaller firms. Firms in the Consumer Goods Industry were on average aged substantially above the mean age for the sampled IPOs. However, the Consumer Goods sector firms were some of the most underpriced IPOs on average. The study attributed this due to substantially lower market power for firms within this industry in comparison to the Energy or Oil and Natural Resource sector firms. This has been explained by the far higher fixed costs required for a firm in both the industries, reducing competitiveness, and therefore increasing the overall profitability of Energy and Oil firms pre-IPO. The study theorised they subsequently garner less speculative interest from investors, which is why the sampled firms in these sectors experienced less relative underpricing.

The study was unable to attribute seasonality as a factor in underpricing with the targeted General Market Return variable insignificant at every level. With only Age reporting significant out of the two variables aiming to find a casual relationship between ex-ante uncertainty and underpricing showing significance, the study is unable to conclusively identify this. A more concise model aiming to look at any of the variables individually may improve the insight given by the study toward underpricing. This is because it would allow additional control of omitted variables which influence the effects of any of the regressors within the study's model.

Moreover, the study was unable to find any significance of the chosen variables when looking at long run adjusted performance. As mentioned within the limitations, this was likely due to the emphasis towards underpricing during the selection process of the independent variables. Overall, we were therefore unable to make any contribution as to why long run underperformance varies on a firm-to-firm basis.

Most interestingly the study contradicted all existing literature stating that IPOs outperformed the market when adjusted against the S&P 500 Index. This coupled with the lacking significance of the regressors in the long run undermined the overall strength of the model.

7. Citation

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