The relation between IPO underpricing and asymmetric information

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Abstract

This thesis delves into the world of underpricing of Initial Public Offerings and its relationship with information asymmetry. To do so, this paper presents a model that is designed by combining firm-, industry- and market-specific variables that influence information asymmetry. The paper equalizes underpricing to initial return and regresses the latter with the five following variables; high-tech industry, firm age, underwriter reputation, market situation, and geography. Using a sample of 348 IPOs that took place in Europe between 2017 and 2019, the regression does not provide any significant results. Nonetheless, this paper presents an adequately-thought regression model that, taking into consideration its limitations, can form a baseline for future research.

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INTRODUCTION

In the financial world, Initial Public Offerings (IPOs) have been the core topics of many studies and literature publications in the past decades. Initial Public Offering is the process of offering shares of a private firm to the public by issuing new stock on a listed stock market. This in fact constitutes the transition from private to public ownership for a corporation that can be either an old, mature firm that decides to be listed and become public, or a newer young firm. This economic event has only been a part of our economy since the Dutch East India Company went public in 1602 (De Castro Ferreira, 2014).

An important example of an IPO occurred on May 18, 2012, for Facebook. This IPO raised a total of 16 billion American dollars and is considered to be the largest IPO in history. Noteworthy is that there was no perceived underpricing for this IPO, resulting in negative consequences on the market thereafter: after the disappointing offering, the IPO market closed for 41 days straight. This also resulted in an average increase of IPO underpricing levels from 11% to 20%. (Krigman and Jeffus, 2016) The common blame at the time was that investors became more risk-averse following the aforementioned event. Krigman and Jeffus (2016) however offer another perspective in their paper; they show that the increase in underpricing in the IPO market is located within the IPOs of the lead underwriters of Facebook. They do this by showing that there is no statistical difference in underpricing before and after the Facebook IPO for non-Facebook underwriters. They argue that investment bank loyalty to investor clients moved the Facebook underwriters to lower the price of future IPOs, and thus increase underpricing, to compensate for the losses of the disappointing Facebook IPO. (Krigman and Jeffus, 2016)

The phenomena related to IPOs were not established before the research of J.R. Ritter, who is now considered a person of knowledge regarding the subject of IPOs. A numerous amount of anomalies have been documented concerning the pricing of IPOs, of which short-run underpricing, the hot issue market, and the long-run underperformance being preeminent. The first inconsistency indicates that IPOs are generally priced below their market value. Ritter and Welch also observe that the short-run underpricing results in a high first-day return due to the low price (Ritter, Welch, 2002). The second inconsistency is explained by the difference in average initial returns which is found to be insufficient. The hot issue market - when the mean return is higher than the average mean return on an IPO during a certain period - is found to

fluctuate throughout the various periods of the economic cycle, mainly due to an increase in the riskiness of an IPO in the different periods. This issue is found to be associated almost exclusively with natural resource issues. For firms in other industries, a hot issue market is barely perceptible (Ritter, 1984). The last inconsistency regarding IPO is the long-run underperformance; it means the IPO can be seen as a short-run phenomenon. In the long-run IPOs are often mispriced, generally overpriced, and therefore have a lower return than comparable firms. There is also a substantial variation in the underperformance year-to-year and across industries, with companies that went public in high-volume years faring the worst (Ritter, 1991).

The underpricing phenomena can be explained within the case of a share issue; on average, there is a significant price increase on the first trading day of the relevant share. There is indeed a substantially large variation on the trading day of share. This IPO underpricing is estimated by the difference between the initial price at which the stock was offered and the closing price on the first day of trading.

IPOs were discounted in the '90s with an average of 20 percent in the United States according to Alexander Ljungqvist (2007). With the estimate explained previously, it is thus to be assumed that the share price rose with an average of 20 percent on the first day of trading. This would cause the firm (the issuer) to leave a considerable amount of money on the table.
According to a large extent of theoretical and empirical research, IPO underpricing phenomena have four different possible drivers: asymmetric information, institution, control, and behavior. There are three parties to be considered when talking about an Initial Public Offering; the issuing firm, the bank underwriting and marketing the deal, and the new investors.

Once again Ljungqvist (2007) explains these drivers. Firstly, it is understood by the asymmetric information model that the three aforementioned parties know more or less than others, which results in an information shortage or friction, causing underpricing. The institutional theory considers three different features on the marketplace: litigation, the banks' stabilizing activities on price once trading starts, and taxes. Control theories assume that underpricing of IPO's reduces the intervention of outside shareholders (once the company is public), by helping shape the shareholders base. Lastly, the presence of irrational investors who bid up the price of an IPO share can be explained by behavioral theories.

This bachelor thesis will try to delve into the relationship between the underpricing phenomena of an IPO and one of its possible drivers: asymmetric information. The current literature presents various sorts of models implementing asymmetric information. The winner's curse by Rock (1986), an adaptation of Akerlof's (1970) lemons problem, is the most acknowledged one. Information revelation theories are considered to form the second model on information asymmetry. A third asymmetry model this paper will acknowledge would be underpricing as a signal of the firm quality. This would be contradictory to Rock's assumption; the true "higher" value of the firm can be shown by using the underpricing principle. The last model is the weel-known principal-agent model that highlights the agency problems between the investment bank and the issuing firm.

There has been, as mentioned previously, a lot of empirical and theoretical literature about IPO's, underpricing, and asymmetric information, but these subjects are challenging concepts to grasp and to put into numbers. This thesis therefore has the aim to compound all existing literature, and calculate with the help of proxies a statistical regression on the relationship between IPO underpricing and asymmetric information, eventually answering the following research question:

What is the impact of information asymmetry on underpricing when a company issues an IPO?

This paper will firstly discuss the theoretical framework in three distinct sections; the theory of IPO's, of information asymmetry and underpricing, and of information asymmetry within industries. Following that, a description of the data will be presented, including dependent and independent variables of the statistical mode. Next, the methodology used to verify the different hypotheses that help answer the research question, will be described. Subsequently, the results of this analytical research and its limitations will be explained. Lastly, this paper will conclude on main insights from its research questions and present its usability for future research.

THEORETICAL FRAMEWORK

In order to properly answer the hypothesis of this research paper, a description of important vocabulary and theories should be provided. Firstly, the chapter will thus discuss the theory of IPO's, of why companies go public and of the aftermath, as well as the concepts of information asymmetry and underpricing.

IPO Theoretical Background

There are two straightforward categories distinguishing companies in our business environment; the firsts ones are privately held companies and the second ones are public companies. Both these types of firms can find themselves in all different stages of the firm's life cycle; launch, growth, shakeout, maturity, and decline. (cfr. Figure 1) The Initial Public Offering is hereby considered as the transition from private to public for a corporation: the first crucial stage for a company to turn public. It is the instant a corporation sells its first shares to the public. Firms are often venture capital-backed and have already sold (privately) shares to investors. There are three parties to be considered when talking about an Initial Public Offering: the issuing firm, the bank underwriting and marketing the deal, and the new investors. The issuing firm (the one going public) looks for an underwriting firm, often an investment banker, to act as an intermediary who assesses and equalizes interests from both the selling and the buying side. To market an IPO, the intermediary often cautions the issuing firm to determine the price of the shares at the time of announcement. An underwriter conducts analysis of the issuer's prospects and estimates an offer price range. The final price-setting only happens at the time of the public offering (Lawrence M. Benveniste Paul A.Spindt, 1989).

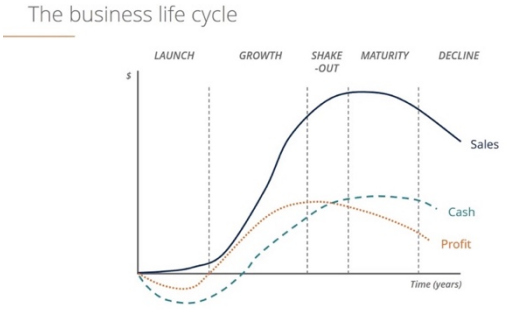

Figure 1: a firm's life cycle

Reasons for a firm to go public

Bancel and Mittoo (2007) identify that financing for growth and enhanced visibility are the most important benefits of an IPO. However, these could not be the only reasons behind an IPO, as there happen to be more conventional ways to obtain equity; bank loans or private capital. According to Ritter and Welch (2002), there is, aside from a desire to raise equity

capital for the corporation, also an opportunity for the founders, investors, and shareholders to convert, later on, wealth into cash on the public market, by selling shares of the firm to the public. Future investments or acquiring new companies could be one of the benefits of the newly created liquidity due to entering cash (Ritter & Welch, 2002). We can associate the possibility of conversion with the idea of Jenkinson and Ljungqvist (2001) that an exit route is created for the founders, investors, and shareholders. Conflictingly however, Bancel and Mittoo (2009) found moderate support for theories focusing on an exit strategy. They indeed also found strong support for the IPO theories that emphasize financial and strategic considerations, such as enhanced reputation and credibility, and financial flexibility as a major advantage of an IPO. But all other reasons for IPOs differ significantly across firms; e.g. size and age, countries, and legal systems. Others like Ritter and Welch (2002) show that non-financial rationales are considered insignificant in the process of a firm going public.

After the IPO

The decision to go public for a firm has great consequences since it is from then on exposed to fit within the regulatory requirements of stock exchanges and to undergo an intense investigation by analysts, investors, and the media (Bancel and Mittoo, 2009). Bancel and Mittoo (2009) summarize in their research all the positives and negatives for a private firm to go public, establishing the 'firm outweighing positive above negatives'.

An IPO is usually followed by four possible outcomes for the newly public firm. The firm could survive as an independent firm, be acquired, lose its current identity, or simply fail (Jain and Kini, 1999).

Underpricing Theory

IPO underpricing can be identified on stock exchanges by estimating the difference between the initial price at which the stock was issues and the closing price on the first day of trading. Early writers, notably Logue (1973) and Ibbotson (1975) found that when a company goes public, the first shares they sell are inclined to be underpriced leading to the share price, later on during the first trading day, to jump substantially. The "underpricing discount" averages 19%[1] since the 1960s in the United States, implying that companies leave a considerable

[1] Underpricing averages are based on data available on Jay Ritter's website. (http://bear.cba.ufl.edu/ritter/ipodata.htm).

amount of money on the table. Looking at the average values per decade, considerable fluctuation is observable; 21% in the 1960s, 12% in the 1970s, 16% in the 1980s, 21% in the 1990s, and 40% from 2000 to 2004 (reflecting the internet boom). When looking at the share prices in dollars, firms happen to walk by past billions of dollars (Alexander Ljungqvist, 2007).

According to a large extent of theoretical and empirical research, IPO underpricing phenomena have four different possible drivers: asymmetric information, institution, control, and behavior. As is explained by Ljungqvist (2007), institutional theory considers three different features on the marketplace: litigation, the banks' stabilizing activities on price once trading starts, and taxes. The evidence regarding this driver is more dual, with some countries where litigation, price stabilization, and taxes play no role in the IPO market experiencing no less underpricing. Control theories assume that underpricing of IPO's reduces the intervention by outside shareholders (once the company is public) by helping shape the shareholders base. This theory is considered fairly new and its plausibility is still doubtful. The presence of irrational investors who bid up the price of an IPO share can be explained by behavioral theories. The behavioral approach is also considered a young idea, but it has acquired evidence both with the presence of overoptimistic investors and with behavioral biases among the decision-makers at IPO firms.

Information Asymmetry Theory

Information asymmetry occurs when one party within a financial transaction has more information on the underlying deal than the other party. In the case of an IPO, management of the private firm can have an information advantage that allows it to profit from the potential investors by leaving them to (over)estimate the future cash flow due to their lack of information (Myers & Majluf, 1984).

One of the first research papers that reflected on information asymmetry and its impact, which also laid the groundwork for future papers, was published by Rock (1986). His winner's curse which is an adaptation of Akerlof's (1970) lemons problem, is the most acknowledged model on asymmetric information. Rock supposes that some investors are better informed than others (other investors, the issuing firm, or the underwriting bank) regarding the true value of the shares based on future cash flow levels. Succinctly explained; the informed investors will only buy attractive shares and others will buy randomly. This results in a curse for the uninformed

because they receive the "lesser" shares they bid on and divide the "good" ones with the informed investors. Due to the weak situation investors are in, they only want shares with a low offer price compared to its value which eventually leads to underpricing (Rock, 1986).

Information revelation theories are considered to form the second model on information asymmetry. As mentioned previously, book building helps underwriters by indicating hints of the interest from other investors to set the price. If it is true that some investors are better informed than others, then obtaining their information before setting the price becomes a key component for the ones taking a company public. However, revealing positive information without motive would supposedly conclude in a higher offer price and thus a lower profit for the informed investor. Furthermore, there is an incentive to convince the underwriter to set a lower offer price by misstating positive information (Ljungqvist, 2007). The challenge of this model is thus for the underwriter to arrange for a system that ensures information is told truthfully.

A third asymmetry model this paper will acknowledge would be underpricing as a signal of the firm quality. This would be contradictory to Rock's assumption; the true "higher" value of the firm can be shown by using the underpricing principle for firms who have a better knowledge about their future cash flow, risk, and value over investors. This method is the costliest, however if successful, equity could be sold later on with better agreements using signaling. As Ibbotson explained in 1975, the original instinct for issuers to use the signaling model was to "leave a good taste in investors' mouth" by underpricing the IPO.

The last asymmetry model is the well-known principal-agent model that highlights the agency problems that can exist between an investment bank and an issuing firm. Theoretical literature that links agency conflicts and IPO underpricing has been around for twenty years. Theories about book building show the crucial role of investment banks in extracting knowledge for price determination. Consequentially to the "dot-com bubble" in the 1990s, investigations have reestablished interest in the research regarding IPO underpricing. There are two possibilities for issuers to ease agency conflicts. The first one consists in an audit of the banks selling and arranging the price. The second one consists in creating a positive relationship by establishing a contract designed to readjust the banks' incentive by offering compensation on the price. Because underpricing is a reflection of a company transferring its wealth to an investor,

competition could occur between investors to obtain an underpriced stock by giving out a side-payment (Ljungqvist, 2007).

Information Asymmetry within Industries

An industry can be defined as "a categorization of groups of companies that have similar primary activities." Every company within every industry that enters the public market has to divulge financial information. This varies between industries because some are more regulated than others or more pressured to divulge that information. Thus, each industry has its own level of information asymmetry and the value of financial exposure depends on it. (Brown & Hillegeist, 2007) Industries that have high information asymmetry are more inclined to divulge information to have more credibility. An example is the "Pharmaceutical Lemons" from Katz (2007), which explains that firms running in the pharmaceutical industry are "lemons" because the seller knows more than the buyer (the investor) in terms of value.

Hence, literature demonstrates that both the technology and the pharmaceutical industry have a higher level of informational asymmetry between insiders and outsiders. High-tech firms often have more volatile operating cash flows than other industries and also deal with a difficulty to meet interest and principal repayment obligations. (Chie-Tse & Gao, 2011) This is the reason why IPOs can be so attractive to high-tech firms to raise funds. High-tech firms often have consequential intangible assets such as patents and intellectual property. (Chie-Tse & Gao, 2011)

Accordingly, several other studies have linked pre-IPO R&D intensity to the first day underpricing. Firms with a high R&D cannot establish a high price for their IPO since investors frequently undervalue those IPOs. Going back to Rock's winner's curse (1986), where informed investors bid on underpriced bonds and uninformed investors bid on overpriced bonds, only underpriced IPOs attract investors because they compensate for the risk and uncertainties of high-tech IPOs. (Chie-Tse & Gao, 2011). They then prove that R&D is positively related to underpricing. Studies indicate that information asymmetry is highly correlated with a firm's R&D expenditure (Guo et al., 2006). This means that an increase in R&D will also increase the reputation of risk and thus trouble of the firm. (Guo. et al, 2006). The reason for this association comes from the uncertainty of the success of R&D investments; these investments are usually subjective to the firm and apt to financial manipulation (Guo.et al, 2006).

Some industries also give investors a higher amount of uncertainty than other industries, such as the food industry. Aboody & Lev (2000) indicate in their research that insider gains in R&D-intensive firms are bigger in comparison to firms without R&D. Furthermore, insiders often arrange their trades based on the planned changes in R&D budgets. An example would be that an increase in R&D would harm the stock price and the insider would sell, because the R&D budget has such an influence on information asymmetry and insider gains, thereby raising issues concerning management compensation, incentives, and disclosure policies (Aboody & Lev, 2000).

These different examples and shreds of evidence back the theory of this paper and demonstrate that R&D intensity and information asymmetry should be related. We can thus conclude that industries that heavily rely on R&D, like the high-tech and pharmaceutical ones, should induce a greater underpricing.

Other methodologies and results

There are numerous papers that try and dissect the correlation between underpricing and information asymmetry. One of the models (Baron's model) assumes that the underwriter is better informed than the issuing firm with regard to the demand for the firm's securities (1982). This model shows that the guidance related to setting the issue price and executing the IPO is compensated by the underpricing, thus compensating for the edge of information. As a consequence, the greater the uncertainty about the price and demand of the security, the greater the underpricing. In 1989, Muscarella and Vetsuypens studied IPOs where issuer equals underwriter. According to Baron's model, IPOs in this situation should have a significantly smaller underpricing than IPOs where the issuing bank is not the underwriter. Muscarella and Vetsuypens found, nonetheless, the contrary; the average initial return for their model was nearly 13% compared to the original 3% where the issuing firm did not serve as a lead underwriter of their own IPO. C. Sherman Cheung and Itzhak Krinsky (1994) also rejected Baron's hypothesis. The difference between Muscarella and Vetsuypens' (1989) paper is, firstly, the provision of another independent database and secondly, a different methodology using a control group of non-investment bankers as a benchmark. They also analyze if the size of the IPO has any influence on the scale of the underpricing. Similarly to their idea, the sheer presence of underpricing is not evidence for the research question of this paper because underpricing might be caused by different factors.

DATA

Data selection

This chapter displays the database of this empirical analysis and a thorough definition of its dependent and explanatory variables. This database stems from the Thomson One website[2]. Therefore, the database contains required financial data on Initial Public Offerings (IPOs) that is needed to answer the research question of this paper. The timeframe used is from 2017 until 2019 across European issuers' location. Put differently, these dates show all IPOs that occurred in the last 2 years in Europe. Furthermore, focusing on a continent location instead of a worldwide one allows for a reduction in bias. An example of factors that may bias the research are culture, politics, or development stage of a country. After erasing all IPOs from the original database that came up multiple times, the initial database of this research consists of 381 observations. However, it should be noted that a cleaning process is also applied to eliminate missing values variables. The final database hence accounts for 348 IPO observations in Europe from 2017 until 2019.

Dependent variable

To run the statistical regression theory and answer the research question, it is first needed to calculate a firms' initial returns, which are in this case equaled to underpricing. The formula used to calculate the initial return (IR), the first-day returns, is similar to the one of Gao et al. (2010) and an abundance of other papers and theses. The formula is as follows;

$$IR = \frac{(first\ day\ close\ price - first\ day\ offer\ price)}{first\ day\ offer\ price} x\ 100\%$$

where IR is the initial return of a firm, CP is the first-day close price and OP is the offering price. The first-day returns are estimated in percentages as the difference between the first day closing price and the offer price. We additionally investigate the information asymmetry that influences the IPO underpricing using proxies. This is done on both tech and non-tech firms for comparison sake. The offer price is found on the IPO's tear sheet and the close price is calculated by using the percentage of change on the first day.

[2] Thomson One has access to company financials, stock prices, revenues, M&A data, stock exchange, annual reports, news, and events, etc.

Independent variable

To evaluate whether information asymmetry is correlated with underpricing, proxies representing asymmetry are used based on the Gao et al. (2019) methodology. Unfortunately, not all proxies were found in Thomson One. The independent variable used are;

High-tech Industry (Industry-specific factor):

This variable has already been extensively explained in the theoretical framework chapter. To summarize, many studies have shown a high correlation between a firm's R&D costs and information asymmetry, with high R&D costs often found in high-tech firms. (Guo et al., 2006) We measure the variable industry factor as 1 for high-tech and 0 for non-high-tech industries. Thus, the hypothesis as said affirms:

Hypothesis 1: Information asymmetry and thus underpricing is more present in tech firms than others.

Firm age (firm-specific factor):

The age of the company is calculated by subtracting the founding year of the company to the year the IPO was issued. To reduce bias, the idea of grouping the different stages of age of the firms comes to mind. Groups are formed from firms with a lesser age than 5, firms between 5 or 10 years old, and firms older than 10 years. This leads to following hypothesis:

Hypothesis 2: Firm age is negatively correlated to underpricing

Underwriter reputation (firm-specific factor):

According to "The Bond Buyer" and others there is an evident ranking between the underwriters. The article states the ten best underwriters in 2018 of the world as; BAML, Citi, JPMorgan, Morgan Stanley, RBC Capital Markets, Goldman Sachs, Wells Fargo, Raymond James, Piper Jaffray, and Jeffries. All IPOs that contain one of these enterprises as underwriters will be assigned the value of 1, otherwise 0. Esteemed underwriters are considered better in estimating the offer price and engage with established investors. Carter & Manaster (1990) suggest that a positive reputation entails less risk and thus reduced underpricing. The third hypothesis of this research states:

Hypothesis 3: The underwriter reputation is negatively related to the level of underpricing

Market situation (market-specific factor):

To evaluate if the market is in a hot or cold cycle, an average of the number of IPOs per quarter will be calculated. Every quarter with a higher amount of IPOs will be considered as hot, and every quarter with a lower amount of IPOs then the average will be considered as cold. The fourth hypothesis thus states:

Hypothesis 4: Hot market cycles are positively correlated with underpricing

Geography (market-specific factor):

One of the main grounds for the database is its location; Europe. Even though choosing Europe shrinks the bias of a worldwide database there is still bias present due to differences among countries. To narrow this bias down, two large groups are tested against each other based on cultural and economic indicators. The countries that are a part of Northern Europe are Austria, Belgium, Denmark, Finland, France, Germany, Guernsey, Ireland-Rep, Isle of Man, Jersey, Luxembourg, Netherland, Norway, Sweden, Switzerland, and the United Kingdom. The countries considered as Southern and Eastern Europe are all other European countries, in the very large term of the word that Thomson One uses.

Hypothesis 5: An IPO of a Northern European firm has less underpricing than an IPO from elsewhere in Europe.

Descriptive table

Table 1 depicts an overview of the descriptive statistics. The mean of the offer price and close price of the first day was respectively 8.37and 9.989385. In addition, they present a standard deviation of 20.61127 and 32.7807 respectively, which gives some information about the spread of the distribution. One can also observe that the offer price has a minimum and maximum of 0.01 and 281.83, and the close price 0.0012 and 534.29. This means that there are a few outliers for offer and close prices. Noticeable is that there exists a closing price that equals 0. A possible explanation for this observation is that when the market closed on the issue date, the stock of the IPO was worth nothing. However, as this is highly unlikely in reality, the IPO was removed from the analyzed database. Following these variables, the initial return has a mean of 74.70% and a minimum and maximum of -99% and 10512.9%.

Among the 348 IPOs, 20.11% of the firms are considered to be in the High-Tech industry. Notice that in this analysis, the age of the firm is split into 3 different categories. There are 26.72% of the 348 firms younger than 5 years, 18.68% between 5 and 10 years old, and 54.60% older than 10 years. As explained preivously, a computation is made to see if the IPO has been issued by one of the 10 most prestigious underwriters in the world; 18.10% of the database is considered issued by a prestigious firm. The fourth variable considers the hot and cold markets; 33.62% of the IPO's happen during a hot market situation and 66.38% during a cold market situation. The last variable in the descriptive table is the European region: 20.11% of the IPOs happened in Northern Europe, and 79.89% in Southern or Eastern Europe.

Table 1: descriptive table of variables

variable	Mean	Standard deviation	Min.	Max.
First day offer price	$ 8.373736	$ 20.61127	$ 0.01	$281.83
First day close price	$ 9,989385	$ 32,7807	$ 0,0012	$ 534.2933
Initial return	74.69782%	788.0066%	-99%	10512.9%
sector				
Hight-tech	20.11%			
Non high-tech	79.89%			
firm age				
<5 years	26.72%			
5 < > 10 years	18.68%			
>10 years	54.60%			
reputation				
10 prestigious	18.10%			
other	81.90%			
Market situation				
hot	33.62%			
cold	66.38%			
Geography				
Northern EU	20.11%			
Southern & Eastern EU	79.89%			

METHODOLOGY

In order to empirically analyze the effect of technology, age, financial reputation, market situation and geography on the initial return at the end of the IPO day, an Ordinary Least Squares (OLS) approach is applied. The baseline is as follows:

$$\gamma = \beta_0 + \beta_1 * Tech + \beta_2 * X_{REPU} + \beta_3 * X_{H\&C} + \beta_4 * X_{f_{age}} + \beta_5 * X_{eu} + \varepsilon$$

Where Y represents the initial return (IR). This designates that the dependent variable Y indicates the degree of underpricing for every IPO in Europe between 20017 and 2019. The constant is represented by β_0, the independent variables by their corresponding X values, with each a corresponding β coefficient. Lastly, the regression contains an error term.

From an econometrical point of view, the first thing to check in a regression is whether the variances of errors are constant (i.e. homoscedasticity). The most well-known test to achieve this purpose was created in 1979 by Breusch & Pagan. (see annex 1) This test regresses the residual of every single observation on the dependent variable in order to define if the variances of errors are homoscedastic or heteroscedastic (i.e. variances of errors not constant). Put differently; the null hypothesis of this test is homoscedasticity and can be, as a rule of thumb, rejected if the p-value is lower than 10%. (Breusch & Pagan, 1979).

The Breusch & Pagan test delivers a p-value equaling 0,000 for the baseline regression; this signifies that the regressions suffers from restricted heteroscedasticity. Therefore, the standard error of the baseline regression is robust to heteroscedasticity. Moreover, a white test (see annex 2) is implemented to assess the possibility of unrestricted heteroscedasticity. The test results in a p-value of 0,4716 (i.e. homoscedasticity). However, since one of the two tests displays heteroscedasticity, it turns out more cautious to use robust standard errors.

RESULTS

Table 2 presents the results of the OLS model described above. Across six specifications, the OLS model gradually measures the impact of independent variables on the initial return (i.e. underpricing). Unfortunately, the results are not significant for any of the variables. Several explanations can be raised to justify these results, and these are discussed in the chapter Limitations. Nonetheless, even though the results are not statistically significant, they are discussed in a more intuitive than scientific manner in the next chapter.

Table 2: regression

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ir_100	ir_100	ir_100	ir_100	ir_100	ir_100
High tech (ref. No)						
Yes	-63.770	-50.725	-44.771	-63.263	-67.699	-30.411
	(53.256)	(46.112)	(46.348)	(53.028)	(56.413)	(35.334)
Firm age (ref. average)						
Mature		-173.859				-182.020
		(159.842)				(164.647)
Young		-67.034				-45.125
		(196.743)				(170.692)
Reputation (ref. others)						
Ten prestigious			109.840			120.802
			(170.220)			(169.766)
Market situation (ref. cold market)						
Hot market				-52.982		-40.589
				(100.296)		(90.042)
Geography (ref. Southern and Eastern Europe)						
Northern Europe					-114.473	-133.602
					(154.946)	(144.010)
Constant	87.528*	197.741	63.821	122.595	179.765	304.057
	(52.878)	(168.776)	(46.869)	(97.505)	(159.198)	(292.101)
Observations	348	348	348	348	348	348
R-squared	0.001	0.009	0.004	0.002	0.004	0.018

Robust standard errors in parentheses
*** p<0.1, ** p<0.5, * p<0.1

Discussion

As explained, firm age is split into three different categories; firms considered as young existed on the day of the IPO for less than 5 years, average firms were between 5 and 10 years old on the issue date, and mature firms have been there longer than 10 years. The reference for this

variable is the average category. The hypothesis states a negative relationship between the age of a firm and underpricing. Put differently, the initial return decreases by 173.86% when IPO is launched by a mature firm and 67.03% for a younger firm. These estimates imply, without asseverating statistically, that there is a greater underpricing in younger firms than in mature ones.

The second regression contemplates a reputation variable. All IPOs issued by at least one of the 10 most prestigious underwriters form a group, with the baseline formed by all IPOs not underwritten by those firms. Based on the database, statistically speaking, an IPO that belongs to the first category will have an initial return 109.84% higher in comparison to others. This rejects the hypothesis that "*The underwriter reputation is negatively related to the level of underpricing"*. However, once again we cannot reject nor confirm this due to statistical insignificance. There are many possible reasons why an underwriter underprices its IPOs. The first reason is that it is better for the underwriter to underprice than overprice an IPO. If the IPO is underpriced, clients buy the shares at a smaller price than its value, which is positive for them; happy customers are recurring customers. Another likely reason goes along with the first one, with biggest clients of the firms often becoming or already being acquainted. The underwriter would probably prefer not to induce a loss of money to their clients/friends, rather than make them win a certain amount. The last feasible reason is that the underwriter itself doesn't want to be left or stuck with overpriced shares that he cannot sell. There are thus several reasons why underwriters prefer to underprice an IPO.

Another hypothesis states that hot markets are positively correlated with underpricing. By looking at table 2 we see that the coefficient behind hot markets equals -52.98%. This indicates that IPOs' issued during hot markets are less underpriced than during cold markets. Once more, these results are not significant, thus we neither reject nor confirm this hypothesis even though it disaffirms the hypothesis.

The last, not principal, variable acknowledged is the geography of an IPO. The table displays a coefficient of -114.47% behind Northern Europe. This coefficient suggests that the IPO of a Northern-European firm is less underpriced than an IPO from Southern or Eastern Europe. This observation is in line with the given hypothesis but can, as well as the others, not be confirmed nor rejected. Because Northern European firms can seem more stable and reliable than others, a possible reason for overpricing is the trust the customers put into those firms. They are more

likely to pay more for a Norther European firm than a Southern or Eastern European firm. There is subconsciously a preference for IPOs' that are considered more reliable due to geography and cultural bias.

The main independent variable of this research is industry-based. In the theoretical framework, one can find why high-tech is considered as main variable in relation to information asymmetry and underpricing. This proxy is used on its own, and in combination with every independent variable. A positive point of this regression is the consistency; high tech, in every model has a negative coefficient. The first hypothesis focuses on a positive relationship between underpricing and high tech. It suggests that the firms operating in a high information asymmetry industry would be subject to a higher underpricing. The different examples and papers mentioned in the theoretical framework chapter demonstrate that R&D intensity and information asymmetry should be related. Thus, industries that heavily rely on R&D, like high-tech and pharmaceutical companies, should induce a greater underpricing.
Looking at the different coefficients, are observed; -63.770% in a stand-alone regression, between -44.771% and -67.699% in combination with another independent variable, and -30.411% in the complete regression. A negative coefficient, statistically speaking, means that underpricing decreases with that specific amount when a firm operates in a high-tech industry. This coefficient is rejecting the first hypothesis, as it indicates that tech-industries have less underpricing than non-tech industries.
Like the others, no coefficient is significant for this variable, but this indicates the contrary to the most important hypothesis. The regression however shows that the smallest underpricing occurs in the most complete regression. The inconsistency of negative coefficients can likely be explained by the lack of data and a possible bad proxy for high information asymmetry. This will be further discussed in the limitations section.

Limitations

Although the research question of this paper turns out to be crucial, it has not been resolved quite yet. The underpricing anomaly and information asymmetry can be explained by different factors and this paper has not represented them all in the empirical analysis. This section discusses the possible reasoning behind the insignificance of the results.

First, the final database contains 384 observations after cleaning. Although similar samples are satisfactory for a large body of empirical studies, for this particular research, it was not the

case. Using a 2 year span was not sufficient. Applying a larger timeframe, namely 2000-2019, could lead to more significant results as this timeframe contains two financial crashes, the internet-bubble in the 2000s and the financial one in 2008 and the twenty-tens. Location-wise, there is not much to condemn, as such a choice depends entirely on the scope of a research paper, but once again, the database could be expanded by integrating IPOs from all over the world. The United States for example display a huge array of IPOs. Furthermore, the amount of proxies was diminished from the earlier versions of this thesis because of missing data in Thomson One, thus variables of the original database were not used. Those missing variables could potentially increase the accuracy and explanatory power of this paper even though it would be very difficult, nearly impossible, to find them all and create the perfect regression. Due to a lack of time and resources, it was not achievable to create a larger database.

Secondly, let's focus on the industry-based variable and the insignificance of our principal variable. A possible reason related to the insignificance of this variable has already mentioned: the lack of data. Furthermore, it would be possible that the proxy for high-tech does not represent the high-information asymmetry industry well. Considering high-information asymmetry industries as industries with a high R&D cost could lead to positive results but should be researched more thoroughly. One industry representing a whole variable may not have high explanatory power but could be improved by for instance adding pharmaceutical companies, as stated in the theoretical framework.

Thirdly, looking at the firm age variable, a potential improvement would be to further split up the age clusters. When looking over the database, many outliers were to be seen. The reason for the chosen groups was that established firms from 10 years or 50 years don't show much difference once in place. The oldest firm present in the database is 259 years old. Younger firms however create important change and understand the industry and market better year after year. Thus, a firm of 1 or 10 years old has a much greater difference then a firm of 40 or 50 years old. Potentially not dividing firm age into groups, or into different groups, could have created a higher explanatory power for this variable.

Fourthly, let us focus on the reputation variable. A first point to acknowledge is the hesitation to include 10 or 25 prestigious firms in the equation. The 15 which were not used are; Stifel, Robert W. Baird, Barclays, Siebert Cisneros Shank, Ramirez, Loop, DA Davidson, Ziegler, UBS, PNC, Janney, KeyBanc, George K. Baum Co., FTN Financial Capital Markets, and

Messirow Financial, also backed by “The Bond Buyer”. This addition to the list of the most prestigious underwriters in the world is based on the year 2018. This could thus be biased in the regression since it was used over 2017 and 2019 as well. The last item that is missing in this model are the IPOs that were underwritten by the issuer, which were all categorized as not underwritten by the 10 most prestigious underwriters. A possible third category could have been created to omit this difference.

Lastly, a fifth variable that can be enriched is the hot & cold markets. It could potentially be more useful to not calculate the average of the amount of IPOs per quarter, but rather the average mean return per quarter to compare and define each as hot or cold.

In conclusion, a lack of a larger database, qua timeframe, location, and variables decreases the accuracy and significance of the regression, as well as the independent variables’ content.

CONCLUSION

In line with the four drivers that Ljungqvist (2007) describes in his paper as the source of underpricing of, this thesis has tried to delve into the puzzle of short-term underpricing of an IPO and one of its possible causes, information asymmetry. The main research question was as follows:

What is the impact of information asymmetry on underpricing when a company issues an IPO?

Although this relationship has already undergone an extensive amount of research and studies, information asymmetry is a broad and vast subject that can be analyzed in an extensive amount of ways. This is the reason why there is still a lot of ongoing discussion on this matter.

In this research paper, first of all, the first day-returns for the European IPO market between 2017 and 2019 are analyzed. To explain the variations in the level of underpricing of IPOs, various variables, which are proxies of information asymmetry, are used. These proxies are mainly based on the paper of Gao et al. (2010). The regression model in this paper, unfortunately, has no statistical significance for any variable and thus no explanatory power. Discussion on the variables purely reflects upon observations on coefficients of the model, but cannot be used to confirm or reject any of the hypotheses. The first variable considers high-tech firms as high-information asymmetry industry proxy. The hypothesis states a positive relationship between the high-tech industry and underpricing. The coefficient of -30,411, however, states the contrary, which is quite deceiving knowing that this variable is considered the most important one. A reasonable positive finding within this variable is the consistency across the different regressions and improvement of the coefficient if the regression is expanded. The following variable used is firm age, for which the hypothesis suggests a negative correlation with underpricing. The initial return decreases by 173,859, statistically speaking, when issued by a mature firm and 67, 034 for a younger firm. Even though the younger firm peculiarly has a negative coefficient, comparing the young and mature firms with each other suggests a valid hypothesis. These numbers could thus imply that there is a greater underpricing in younger firms than in mature firms. Based on the coefficient of 109,840 for the variable reputation, the underwriters' reputation is positively related to underpricing, which indicates the contrary to the hypothesis. The reasons for this may be that underpriced IPOs are preferred over overpriced IPOs by underwriters. The next hypothesis states that hot markets are

positively correlated with underpricing. But the coefficient, unfortunately, states the contrary: IPOs issued during hot markets are less underpriced than in cold markets. The last variable of geography indicates the hypothesis of a positive relationship between Northern European (compared to other European) IPOs and underpricing. These numbers, once again, do not reject or confirm the hypothesis, it is a simple guideline to understand the regression.

Altogether, there are certain coefficients that are consistent with the hypothesis and others that aren't. From this research, we cannot positively state that there is a definite correlation between underpricing and information asymmetry. The regression and variables acknowledged in this paper are not significantly related but can still indicate a possible turnout. In the meantime however, the proposed model can be used as a baseline to be enhanced and expanded in order to possibly find a significant relationship.

Future research

For future research, it could be more relevant to contemplate a different proxy for information asymmetry within industries. One could potentially conduct research to analyze the different industries and their level of information asymmetry, for instance in relation to R&D or not. Consequently, one could enlarge and specify this proxy to more than the high-tech industry. Additionally, why not calculate the underwriter's prestige differently, through the ratio of the number of IPOs underwritten by a firm to the total amount of IPOs during the 3 years preceding the IPO. Even going further, one could analyze the difference between when an IPO has an underwriter or is underwritten directly by the issuer.

Although a sufficient amount of proxies is included in this research paper, it may be wise to expand the database in location, not only Europe, and in timeframe, longer than 2 years. This would create a database larger than 348 observations and possibly increase the accuracy of the regression. Furthermore, it is important to add other factors to the regression that could influence the level of information asymmetry of an IPO. It is paramount to include a various set of factors that are firm-dependent, market-dependent, timeframe-dependent, or even industry-dependent. Examples of other factors that may be used as proxies for information asymmetry are; the issue size, the firm size, market capital, venture capitals, VC backed firms, logged NASDAQ, overallotment, R&D intensity, market liquidity, IPO cycles, lot winning rate, IPO trends further than hot & cold markets, etc.

In sum, creating a larger database, with the help of more variables, a longer timeframe, and larger geographic presence could potentially have higher explanatory power than the one used in this paper. The model employed in this thesis is still relevant and can be a guideline for other researchers to expand upon.

Annex

Annex 1: Breusch-Pagan test - Test for heteroscedasticity of the entire model

Breusch-Pagan test - Test for heteroskedasticity of the entire model:

$$\widehat{u_{it}} = \alpha_0 + \alpha_1 x_{1it} + \cdots + \alpha_n x_{nit} + v_{it}$$ where

H_0: For all i and t: Var ($\widehat{u_{it}}$) of the unobserved effects model is constant [Homoskedasticity: $\alpha_0 = \alpha_n = 0$]

H_1: For all i and t: Var ($\widehat{u_{it}}$) of the unobserved effects model is non-constant [Heteroskedasticity: $at\ least\ one\ \alpha_i \neq 0$]

We reject the null hypothesis if p-value is smaller than 1%.
In this case, the p-value is zero and we thus reject the null hypothesis meaning that the Var ($\widehat{u_{it}}$) of the unobserved effects model is non-constant at the 1% level.

Annex 2: White test – Test for heteroscedasticity

White test – Test for heteroskedasticity:

This test is a special case of the Breusch-Pagan test. The White test does not require specification of a list of variables, as that list is constructed from the regressor list. In addition, it tests for heteroskedasticity of the original regressors along with their squares and cross-products.

$$\widehat{u_{it}} = \alpha_0 + \alpha_1 x_{1it} + \cdots + \alpha_n x_{nit} + \alpha_{n+1} x_{nit}^2 + \cdots + \alpha_{2n} x_{nit}^2 + \alpha_{2n+1}(x_{1it} * x_{2it}) + \cdots + v_{it}$$ where

H0: Homoskedasticity: $\alpha_0 = \alpha_n = 0$
H1: Unrestricted heteroskedasticity: $at\ least\ one\ \alpha_i \neq 0$

We reject the null hypothesis if p-value is smaller than 1%.
In this case, the p-value is zero and we thus reject the null hypothesis meaning that the Var(u) of unobserved effects model is non-constant at the 1% level.

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