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A principal component approach to measure investor sentiment and its impact on IPO's underpricing

Ana Filipa Prozil Pinto

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Carlos Alves, PhD

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Abstract

In classical finance, there is no room for the presence of investor sentiment, although several authors started to shed light on the fact that investors are affected by the market sentiment which impacts the asset pricing, contributing to the emergence of behavioral finance.

Based on the increased importance of behavioral finance in the financial markets, in the present research, we study the investor sentiment relation with the initial public offering (IPO) market, specifically, with the underpricing. To do so, we constructed an investor sentiment composite index which has been deeply debated, as well. Several authors have been trying to discover how to measure investors' sentiment in the market, but there is not a universally accepted measure yet. A few composed indexes have been constructed for the United Kingdom, reason why this is the market we focus our research on.

To construct our investor sentiment index, using the principal component analysis method (PCA), we included several sentiment measures: market share turnover, volatility premium, number of IPOs and consumer confidence index, using monthly data from January 2004 to December 2016.

Lastly, using a OLS regression model, with a sample of 665 IPOs, we found evidence of a negative relation between the investor sentiment and the underpricing.

Key-Words: Behavioral Finance, Investor Sentiment; Principal Component Analysis; Initial Public Offering; Underpricing

JEL Codes: C38, G10, G12, G41

Sumário

Numa vertente clássica das finanças, a componente do sentimento do investidor não é considerada, contudo alguns autores começaram a focar-se no facto dos investidores serem afetados pelo sentimento existente no mercado financeiro, o que, por seu turno, influencia a avaliação de ativos, contribuindo para o surgimento das finanças comportamentais.

Com base na crescente importância das finanças comportamentais nos mercados financeiros, na presente investigação estudamos a relação entre o sentimento do investidor e o mercado de ofertas públicas iniciais (IPO) e, especificamente, o fenómeno de *underpricing*. Para desenvolver esta investigação, construímos um indicador de sentimento compósito, que também tem vindo a ser debatido na literatura. Diversos autores têm tentado descobrir como medir o sentimento no mercado, porém ainda não foi encontrada nenhuma medida que seja universalmente aceite. Uma vez que poucos indicadores compósitos foram construídos no Reino Unido, esta foi a alternativa seguida por nós e a razão pela qual escolhemos este mercado.

Para construir o indicador de sentimento, usamos o método de análise de componentes principais (PCA), reunindo várias medidas de sentimento: o turnover da quota de mercado, o prémio de volatilidade, o número de ofertas públicas iniciais e o índice de confiança dos consumidores, usando informação mensal para estas variáveis, de janeiro de 2004 a dezembro de 2016.

Por fim, recorrendo a uma regressão linear OLS com uma amostra de 665 ofertas públicas iniciais, descobrimos evidência de uma relação negativa entre o sentimento de investidor e o fenómeno de *underpricing*.

Palavras-chave: Finanças Comportamentais, Sentimento do Investidor; Análise de Componentes Principais, Ofertas Públicas Iniciais, Underpricing

JEL Códigos: C38, G10, G12, G41

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1. Introduction

There are several studies, in classical finance, that fail to explain some stock market anomalies regarding the prices' behavior and transactions volume, which cannot be justified by underlying fundamentals. Keynes (1936) pointed the investors' "*animal spirits*" to justify those wild movements and, since then, several financial economists have tried to understand the role of the behavioral biases in the agents' financial decisions as well as the component of the sentiment in the stock market movements (Barberis et al., 1998; Black, 1986; De Long et al., 1990). Baker and Wurgler (2007) evidenced that the assumption of market's efficiency, characteristic of classical finance, was not in agreement with the historical stock market activity. An alternative approach to classical finance was given by behavioral finance, that has gained greater prominence in the literature, which Statman (2014) tried to distinguish.

"Behavioural finance is finance with normal people in it, people like you and me. Standard finance, in contrast, is finance with rational people in it."

Although there is no room to investor sentiment in classical finance, it is one of the pillars of behavioral finance. However, there is not a universally accepted measure of investor sentiment, representing a gap in the literature that we intend to explore.

The objective of this research is to provide a new measure of investor sentiment based on a principal component analysis. Our research is focused in the United Kingdom (UK), an important market where only few composed sentiment indexes have been yet constructed. The sentiment studies involving the UK market used it as a part of the European or global market.

Therefore, we can say that our sentiment index may contribute to the literature for two reasons. First, our sentiment index is concentrated only in the UK market, instead of being aggregated with other indexes in an international context as many other studies. Hudson and Green (2015) conducted a sentiment index focusing solely on the UK market, however our sentiment index is based on entirely new set of variables, following the Baker et al. (2012) approach used in an international context but using monthly data instead of yearly like these authors did, being an improvement from their study in terms of data frequency and market. Second, our sentiment index includes the IPO volume in the domestic stock market, following

other relevant studies (Baker and Wurgler, 2006, 2007; Baker et al., 2012; Brown and Cliff, 2004), which is also used later to try to understand the IPO underpricing.

Following the construction of our sentiment index, it is used to test whether the investor sentiment is able to explain the IPO underpricing, which is a very well-known phenomenon (Beatty and Ritter, 1986; Loughran and Ritter, 2002; Loughran et al., 1994; Oehler et al., 2005). This phenomenon describes the proportion of the jump from the IPO offer price to the closing price of the first trading day. There are various theories trying to explain this phenomenon, for example, the winner's curse, the signaling theory, the market feedback hypothesis or the principal agent model within the asymmetric information field, and there are also institutional explanations or ownership and control theories, but none of them was successful enough to account for the scale of underpricing meaning that the literature still lacks to fully explain the IPO underpricing, specifically in the United Kingdom, where a significant percentage of IPOs trade above their offer price in their first trading day. Based on this literature gap, there is still space to study the theory of investor sentiment around the IPO underpricing, following a behavioral approach.

The remainder of this research is organized as follows. Section 2 summarizes the theoretical background of investor sentiment and IPOs theory. Section 3 contains the data and methodology of investor sentiment and underpricing. In section 4, the descriptive statistic can be found. Section 5 presents the results. Lastly, the section 6 represents a conclusion of the research.

2. Literature Review

This section is divided into two main subsections. The first presents the investor sentiment theory and it is divided in three subsections, the concept of investor sentiment, its measures, either direct and indirect, and the composed index method. The second focus on the initial public offerings and has five subsections, the reasons to open the capital to the public's investment, the importance of market conditions, the IPO process and the underpricing phenomenon, ending with a focus on the behavioral explanations for underpricing.

2.1. Investor Sentiment

Before formally defining investor sentiment, it is important to contextualize its emergence and to do that, we must resort to classical finance and its failures until the appearance of the behavioral finance approach and, with it, the concept of investor sentiment.

Classical finance fails to explain some stock market movements, especially regarding to asset pricing and returns. The history of stock market is full of extreme changes in stock prices and standard finance has difficulties to explain such dramatic variations, as well as the alternating between long periods of "*bubbles*" and "*crashes*". According to traditional finance, prices in the market reflect the present value of expected future cash flows. However, the assumption that market prices would always be forced to its fundamentals has not been fitting with the historical patterns of stock market. There are several criticisms either to the hypothesis of efficient markets or to the equilibrium models associated with the rational finance paradigm, and both are mutually consistent (see more details in Appendix 1).

In traditional finance there is no role for investor sentiment. However, a growing number of authors (Barberis et al., 1998; Black, 1986; De Long et al., 1990) started to consider that investors are affected by sentiment, which impacts the asset pricing, leading to the emergence of behavioral finance. This approach is based on two assumptions. First, not all the investors are fully rational arbitrageurs and their demands for risky assets might be affected by their sentiments. Irrational traders act on noise and Black (1986) entitled them as *noise traders*, since they falsely believe that they have information about future prices and select their portfolios

with basis on sentiment, rather than on an analysis of fundamentals or arbitrage opportunities. On the other hand, rational arbitrageurs hold Bayesian[1] beliefs and act on active contrarian investment strategies of the noise traders (De Long et al., 1990). However, individual investors are not the only group of investors susceptible to biases, even them are more likely to show overconfidence, herding behavior, and speculation (Barberis and Thaler, 2003). In fact, Brown and Cliff (2004) defended that sentiment is not limited to individual investors but extends it to institutional investors, confronted most of the literature (De Long et al., 1990; Kumar and Lee, 2006), who defended that individual investors are more disposed to sentiment than institutional investors. There is also some empirical evidence which suggested that institutional investors are restricted in terms of investment horizon, limits to arbitrage and psychological biases, or even in herding behavior, which result in flawed decisions. Although, due to the agency costs, there is still space for other type of investors which apparently act irrationally, while they rationally ignore their own information and follow other investors (Bikchandani et al., 1992; Scharfstein and Stein, 1990). Grinblatt et al. (1995) also provided evidence of *trend chasing*[2] among institutional investors. Second, there is the cost and risk of betting against those noise traders, resulting in limits to arbitrage (Shleifer and Vishny, 1997). Noise traders' sentiment deviates prices from fundamental values in an unpredictable way and the arbitrageurs, when trying to bet against them, have the risk of investor sentiment be more pronounced in a way that prices vary even further away from their fundamental values. Consequently, the risk aversion of arbitrageurs leads to a failure in the elimination of mispricing and, contrary to the standard models' beliefs, rational arbitrageurs could not always force prices to its fundamentals, reason why in some periods the market is dominated by irrational or sentiment investors. Therefore, the noise traders could persist in the market and influence prices as De Long et al. (1990) predicted in their behavioral theory. Investors will trade on the basis of noise, reason why Schmeling (2009) referred that noise trading as a good proxy for investor sentiment.

[1] Bayesian beliefs represent the probabilistic relationships of certain variables.

[2] *Trend chasing* or positive feedback trading is a trading strategy of the following of past price patterns.

2.1.1. The concept of investor sentiment

The concept of investor sentiment had a long journey until it started to get attention by the researchers. Initially, it has been considered a myth by classical finance but, from the 1990s onwards, it began to gain importance aligned with the assumptions of the behavioral finance approach, in the sense that equilibrium of asset prices and market outcomes are impacted by the presence of irrational or sentiment investors.

Previously, Keynes (1936), in the General Theory of Employment, Interest and Money, introduced a characteristic of human nature, the *spontaneous optimism*, which drives most of the positive activities and contributes to the wild movements and the instability observed in the market. This is the result of the *animal spirits*[3].

The aggregate of human decisions in the society, based on a set of beliefs, is referenced as the *social humor*. It is the general level of optimism or pessimism in a society when most of the financial decision-makers' emotions are affected at the same time (Nofsinger, 2005). When applied to the financial markets' field, it is the market's feelings revealed through the securities traded over there. According to Kumar and Lee (2006), sentiment investors come and leave the market together and sentiment is considered as a market wide phenomenon (Hrnjić and Sankaraguruswamy, 2011). Therefore, it is possible to rename social humor to *investor sentiment*[4]. The role of investor sentiment in financial markets was studied by authors such as Black (1986), De Long et al. (1990) and Barberis et al. (1998).

In the literature, there are several definitions to investor sentiment which range from statements about investors' mistakes to specific errors from model to model (Shefrin, 2008). The concept is used in different ways by academic researchers (Daniel et al., 1998; Qiu and Welch, 2004; Shefrin, 2007; Welch, 1992). On the one hand, it was used in the sense of investor optimism or pessimism and according to Baker and Wurgler (2006, p.1648), it is given as "*the propensity to speculate…an optimism or pessimism about stocks in general*". Brown and Cliff (2004) also referred to investor sentiment as the speculators bias, defined as excessive optimism or

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[3] "*a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities"* (Keynes, 1936, p.161).

[4] Throughout this research, when we refer to investor sentiment, it is in the sense of the market wide phenomenon.

pessimism. On the other hand, the same term of investor sentiment could be defined as a belief about future cash flows and investment risks, that is not justified by the facts at hand (Baker and Wurgler, 2007; De Long et al., 1990). According to Zhang (2008, p.9): *"investor sentiment represents market participants' beliefs about future cash flows relative to some objective norm, namely the true fundamental of the underlying asset."*. Broadly, investor sentiment is the theory of how investors form their beliefs, however, they are based on cognitive and psychological bias, rather than on fundamental changes in the stock market (Xu and Green, 2013). This idea had already been supported by Shleifer (2000) when he said that investor sentiment is the beliefs of people based on *heuristics*[5] rather than on *Bayesian* rationality. Slovic et al. (2002) showed that basic emotions are a *heuristic* used in the evaluation of different scenarios, especially when rapid responses are required, and there is an excess of information associated with the decision and much complexity and uncertainty. Furthermore, emotions are the mental state that results from the relationship of the individual and the environment that surrounds him (Lobão, 2012; Poblet and Casanovas, 2007). There are studies in the field of neurology (Bechara et al., 2000; Elster, 1998; Grossberg and Gutowski, 1987; Lo and Repin, 2002; Loewenstein, 2000; Olson, 2006) that investigated the development of emotions over the years considered it as a first form of rationality and found evidence of a strong relationship between emotions and rationality. Even in financial decisions, it is necessary to consider emotions if we want to understand the choices of investors. Due to the connotation of sentiment with emotions, the media also refers to sentiment as *investor fear* or *risk aversion* (Zhang, 2008).

2.1.2. Measures of investor sentiment

In this subsection we present the main measures of investor sentiment pointed out by a vast literature but, before that, it is important to meet some characteristics that the measures must exhibit. First, the investor sentiment must be powerful enough to be reflected in prices. Second, the investor sentiment must impact a large proportion of a given population and lastly,

[5] Kahneman and Egan (2011) referred to the technical definition of *heuristics* as a simple procedure that helps to find adequate, although imperfect, answers to difficult questions.

the effect should be correlated in a large proportion of a country's population (Edmans et al., 2007).

The literature highlights two main ways of measuring investor sentiment: through direct measures, resulting from investor or consumer' surveys, or indirect measures, which constitute a set of indicators that are *proxies* of investor sentiment.

The first and direct way of measuring investor sentiment, is obtained through explicit sentiment proxies, concerning survey-based measures. For example, the *UBS Index of investor optimism*, a joint effort of UBS and Gallup, is a survey of investor outlook (more details about this survey are in Appendix 2). There are more two types of surveys, the *Consumer Confidence Index (ICC),* constructed by the Conference Board and the *Michigan Consumer Confidence Index (MCCI),* constructed by the University of Michigan Survey Research Centre. Generally, a consumer confidence index is an economic indicator about the current and future economic or financial expectations of responders over the next 12 months. The consumer confidence focuses on five questions, presented by Qiu and Welch (2004) (see Appendix 3). These surveys were used by Lemmon and Portniaguina (2006), and focus on the personal financial situation, the expectations regarding the economy and the propensity to consume major households' items. Consumers also anticipate changes in interest rates, unemployment, inflation, real gross domestic product (GDP) and house sales (Lemmon and Portniaguina, 2006). It is possible to have insight into the marginal irrational investor beliefs about the fundamentals of the economy and about their sentiment, by asking them about their optimism on the stock market. This happens because those investors are more likely to be bullish about the economy when they are bullish about the stock market, and vice-versa. General exuberance is transmitted to both consumption and investment optimism (Qiu and Welch, 2004). There is evidence that this indicator has a related component with investor sentiment and it depends on more than economic or financial variables (Vuchelen, 2004). Qiu and Welch (2004) noted that, changes in the *MCCI* are highly correlated with changes in the *UBS Index of investor optimism*, which means that *MICC* is a good proxy for investor sentiment. Knowing that answers come from different respondents and from different surveys, their correlation is only possible if they are linked to a third variable, the investor sentiment. When comparing the *MCCI* with the *UBS Index*, the *MCCI* has the advantage of being available for a greater number of countries and has a long, stable, regular, and professionally executed history, appropriate for financial research (Qiu and Welch, 2004). The results of Qiu

and Welch (2004) using the *CCI* were similar. Otoo (1999) and Schmeling (2009) have used the *CCI* as a proxy for investor sentiment while Lemmon and Portniaguina (2006) have used the *MCCI*[6]. On the other hand, Fisher and Statman (2003) described a positive relation between the measures of consumer confidence and other type of survey, the *Investors Intelligence (II)*. In the US, aligned with the *II*, there is also a survey conducted by *American Association of Individual Investors (AAII)* (see more details in Appendix 4). They compile the responses of participants regarding their expectations about future market movements. The difference between them is the target. The first, is targeted toward individuals and it is a measure of individual investor sentiment and the second, is a measure for institutional sentiment, since the target are the current or retired market professionals[7] (Brown, 1999).

Nevertheless, direct measures of investor sentiment have some disadvantages. First, surveys are not available for every country. Second, sometimes conducting a survey is problematic, especially because it has a cost associated which may not lead to favorable outcomes. Third, surveys' questions are submitted during a period, which causes a dispersion in time, instead of having the result of investor sentiment at a given point in time. Lastly, they may excessively measure the sentiment of small investors instead of measuring the investor sentiment of other investors' groups, with more importance in the market. In fact, Brown and Cliff (2004) defended that survey data alone is an incomplete way of measuring investor sentiment and Baker and Wurgler (2006), following the same idea, argued that this measures are biased, due to the problem concerned with the actions of agents in the market, which sometimes differs from what is answered on surveys, leading to measurement errors.

On the other hand, there is a second way of measuring investor sentiment, with implicit sentiment *proxies*. It is known as an indirect way to measuring investor sentiment because of the necessity to establish a theory that relates them to the sentiment. Baker and Wurgler (2007) presented a group of potential economic sentiment proxies that have come into use: retail

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[6] The difference is that, *CCI* focuses more on macroeconomic conditions while *MCCI* focuses more on financial conditions.

[7] Although, the recommendations made by investment advisory services influence the trade of individual investors as they are the primary target of these advisory services. Therefore, changes in independent advisors' sentiment lead to the changing mood of individual investors (Lee et al., 2002).

investor trades, mutual fund flows, trading volume, dividend premium, closed-end fund discount, option implied volatility, IPO volume and IPO first-day returns, equity issues over total new issues and insider trading.

Retail Investor Trades Retail or individual investors are more likely to be affected to sentiment than institutional investors. Barber et al. (2009) and Kumar and Lee (2006), with micro-level trading data, discovered that retail investors trade in a correlated and continuous way, which is consistent with systematic sentiment. Kumar and Lee (2006) suggested that it is possible to construct sentiment measures, for retail investors, according to their buying or selling movements.

Mutual Fund Flows Brown et al. (2003) suggested that there is a relation between investor sentiment in the stock market and the daily mutual fund flows. Frazzini and Lamont (2008) revealed evidence of the use of fund flows as a proxy for the sentiment of individual stocks. There is the *Mutual Flow Index (MFI)* which is a momentum indicator to measure the inflow and outflow of money in a security, at a specific period of time, indicating if the security is overbought or oversold. The *Relative Strength Index (RSI)* is also a momentum indicator used to measure the speed and the change in price movements of a security, showing whether the market is oversold or overbought (Chen et al., 2010). Furthermore, *MFI* measures trading pressure using prices and also consider the volume of stocks reason why it is referred as a volume-weighted RSI.

Trading Volume Baker and Stein (2004) referred to trading volume as a noisy measure of liquidity related with market confidence. The existence of liquid markets is caused by the noise trading (Black, 1986). According to the behavioral finance field, it is the existence of irrational traders that add liquidity to the market, mostly when they are optimistic, with short-sales constraints. They tend to overreact to information and enthusiastically trade, increasing the liquidity in the market and make the securities overvalued, especially in the bull market states (Pagan and Sossounov, 2003). The two common liquidity measures are the natural logarithm of trading volume and the natural logarithm of turnover ratio. Baker and Wurgler (2006) included the NSYE turnover (TURN), which is positively correlated with sentiment, having into account the ratio of reported share volume to average shares listed from the *NYSE Fact B,* using monthly data. Hudson and Green (2015) and Baker et al. (2012) followed their approach to the UK, using weekly and annually data, respectively.

Dividend Premium Dividend paying stocks are similar to bonds when their predictable income stream is considered, representing a characteristic of safety. The premium for a dividend paying stock, the dividend premium (*PDND*), is negatively correlated with sentiment, and it is defined as the log difference of the average market-to-book ratios of payers and nonpayers by Baker and Wurgler (2004).

Closed-End Fund Discount Inversely related to the sentiment, there is closed-end fund discount (or occasionally premium) (*CEFD*). Closed-end funds are publicly traded investment companies who raise an agreed amount of capital by issuing a fixed number of shares which are traded as a stock on stock exchanges. It is given by the average difference between the net asset values (NAV) of closed-end stock fund shares and their market prices. It is one of the earliest indicators of market sentiment and it is considered as an individual investor sentiment index by authors, such as, Lee et al. (1991) and Neal and Wheatley (1998). Most holders of closed-end funds are individual investors and, when they are pessimistic, the discount increase. On the other hand, hot issue periods are aligned with low discounts on closed-end funds (Lee et al., 1991; Lowry, 2003). Brown (1999), Brown and Cliff (2004), and recently, Hudson and Green (2015) also used it to measure investor sentiment.

Option Implied Volatility As a derivative variable, more associated with institutional investor sentiment, there is the option implied volatility. When it is expected that the value of an underlying asset has greater volatility, options' prices increase. The CBOE's Market Volatility Index (VIX) is a popular measure of the expectation of volatility implied from the prices of Standard and Poor's 500 stock index options[8]. It is often referred as the "*investor fear gauge*" and Whaley (2008) considered it as a barometer of investor fear. There is greater fear of the unknown, when the VIX is higher.

IPO Volume and IPO First-Day Returns Positively correlated with sentiment, there is the IPO Volume (NIPO) and IPO first-day-returns (RIPO)[9]. NIPO and RIPO are correlated

[8] Although, the original index was based on S&P 100 stock index options.

[9] Institutional investors have more importance as buyers of IPOs than what they had in closed-end-funds. However, individual investors still represent for over 75 percent of the buyers of IPOs, and make their sentiment affect stock prices.

in the sense that IPO volume follow IPO first-day-returns tendency, this is, after periods of high initial returns, more firms go public (Benveniste et al., 2003; Ibbotson and Jaffe, 1975; Lowry and Schwert, 2002). Sentiment could be seen as a measure of investor enthusiasm related with the information collected during the registration period partially included in the offer price. If there is positive information, this will be associated with high first day returns (and lead to an increase in the IPO volume, with a delay.) IPOs with low idiosyncratic[10] returns could be seen as a symptom of market timing. There are cycles in the returns and in the volume of IPOs (Lowry and Schwert, 2002; Ritter, 1991; Stigler, 1964).

Equity Issues Over Total New Issues Considering not just IPOs but all equity offerings, there is the share of equity issues in total equity and debt issues as a proxy for sentiment. Firms shift between equity and debt as a response to the observable mispricings occurred due to demand pressures formed from investor's beliefs.

Insider Trading Inside investors, such as, corporate executives, board members and large shareholders have more information than outside investors about the true value of the firm. The portfolio of executives' decisions may reveal their views about the mispricing of their firms and insider trading patterns may have a systematic sentiment component.

There are other economic variables that have been presented, by Brown and Cliff (2004), Wang et al. (2006) and Hudson and Green (2015), as proxies for investor sentiment, such as the advances-declines ratio, expected volatility relative to current volatility, put-call volume ratio, call-open interest ratio, percentage changes in margin borrowing and percentage change in short interest.

Advances-Declines Ratio (AVDC) Within the market performance indicators, the *AVDC* is considered a "*market strength*" indicator. It is the ratio of the number of rising stocks to the number of declining stocks in the market. It is used by Hudson and Green (2015), but also by Brown and Cliff (2004) and Wang et al. (2006) who modified the *AVDC*. Brown and Cliff (2004) has done a modification of the indicator to incorporate volumes, presenting the ratio of the number of advances to declines standardized by their respective volumes, the *ARMS* index.

[10] Not explained by common factors.

Expected volatility relative to current volatility Within the derivative variables, Brown and Cliff (2004) constructed a measure of expected volatility relative to current volatility. The expected volatility is given by the *VIX* and the Realized Volatility *(VOLA)* is calculated according to the extreme value method of Parkinson (1980), calculated from Open-High-Low-Close data on the S&P 100 Index. The higher the realized volatility, the lower the investor sentiment. Baker et al. (2012) also used volatility premium as a proxy for investor sentiment. It states the time when valuations on high idiosyncratic volatility stocks are high or low comparing with valuations on low idiosyncratic volatility stocks. It is similar to the Baker and Wurgler's (2004) U.S dividend premium, which corresponds to the valuation of dividend- and non-dividend-paying stocks. These two variables are highly inversely related. Small stocks with low growth potential and non-dividend-paying stocks tend to be high volatility stocks. High volatile stocks are less attractive to arbitrageurs since they are more affected by noise trader sentiment and are riskier to trade. More volatile stocks are associated with fundamental and arbitrage risk according to Pontiff (1996) and Wurgler and Zhuravskaya (2002).

Put-Call Volume Ratio (PCV) The ratio of the trading volume of put options to the trading volume of call options is also a measure derived from derivatives data. It is considered a bearish indicator that provides information about the investor sentiment in the market. It is used by Brown and Cliff (2004) in the US and by Hudson and Green (2015), who calculate the *PCV* for the UK, using data of FTSE100 index option. **Call Open Interest Ratio (PCO)** is the ratio of put open interest to call open interest. Wang et al. (2006) indicated that this measure is more accurate to predict volatility rather than *PCV*, being a better measure of investor sentiment.

Percentage Changes in Margin Borrowing Within the measures regarding the type of trading activity, Brown and Cliff (2004) used the percentage changes in margin borrowing as a sentiment proxy. It is a bullish indicator of the money borrowed by investors to purchase stocks. They also used the **Percentage Changes in Short Interest** which is a bearish indicator of the number of shorted shares divided by the number of shares outstanding.

Market based variables have the advantage of being objective indicators measured with a high degree of accuracy since they are real time observable data, showing the market power of market participants and the intensity of bullishness or bearishness. They are also available at higher frequencies. However, the relation between the theory and the data could be weak and,

those variables could capture a stock price movement, rather than measure investor sentiment exclusively, because they are endogenous to the market activities.

2.1.3. Composed sentiment indexes

The literature presents several economic and financial market variables as potential proxies for investor sentiment, however there is no conclusive and uncontroversial measure for investor sentiment. The most widely used method is the combination of several imperfect measures. Using either direct or indirect measures and, based on their combination, it is possible to extract their common factors and compose a sentiment index, which avoids the problem of the low frequency and possible inaccuracy of direct survey measures and overcomes the weak relation between theory and market measures. Though, there are some controversies on the construction of these composed indexes.

Brown and Cliff (2004) extracted the common factors from a group of selected sentiment proxies to construct a US investor sentiment index, with weekly and monthly frequencies, using two different methods, the Principal Component Analysis method and the Kaman Filter method. Baker and Wurgler (2006), focusing on the principal component analysis method, chose 6 proxies, according to the availability of data, measured annually from 1962 to 2001, to construct a monthly US composite investor sentiment index, relative to the common variation of the chosen proxies: the closed-end fund discount, the dividend premium, NYSE share turnover, IPO first day returns, IPO volume and equity issues over total new issues.

After choosing the variables to include, they controlled to several macroeconomic conditions because sentiment indicators could also be a proxy for macroeconomic factors (Baker & Wurgler, 2006). The chosen proxies have idiosyncratic components which exceed the sentiment and to remove those economic fundamentals, they regress each proxy according to macroeconomic indicators – growth in industrial production, real growth in durable, nondurable, and services consumption, growth in employment, a NBER recession dummy indicator and consumer price index. The achieved residuals are considered cleaner proxies to measure the investor sentiment. Brown and Cliff (2005) also controlled the variable sentiment for rational factors that the variable might contain. They used the stochastically detrended 1-month U.S.

Treasury bill return, the difference in monthly returns on 1 and 3-months T-bills, the term spread[11], the default spread[12], the dividend yield and the inflation rate.

Following the Baker and Wurgler (2006) approach, Baker et al. (2012) used several proxies to measure sentiment in 6 international stock markets, being the UK market one of them, developed an annual market-wide index with the number and average first day returns of IPOs over the year, the turnover and the volatility premium, as proxies for sentiment. They could not use every proxy used in the US investor sentiment literature due to their unavailability in other markets. They also orthogonalized those proxies to several macro series and their first principal component was the total sentiment for each market in analysis. Bai (2014), also based on Baker and Wurgler's (2006) approach, constructed a weekly-wide index to 8 main EU stock markets. Corredor et al. (2013) measured the UK sentiment as a part of the European stock market using volatility premium, turnover and consumer confidence as proxies. In the same logic, Hudson and Green (2015) used several proxies, most of them already used by Brown and Cliff (2004), to construct an UK sentiment index in a context of international sentiment, using weekly data (see Appendix 5). Chen et al. (2010) composed an investor sentiment index for the Hong Kong and Chen et al. (2014) for the China.

Those previous studies have found some results. First, investor sentiment seems to explain stock returns since it has been documented a positive correlation between the level of sentiment and the cross-section of stock returns (Baker and Wurgler, 2006). Xu and Green (2013) also found that investor sentiment influences future cash flows and affects investment decisions and stock returns.

Second, Baker and Wurgler (2006) found that securities dominated by more subjective valuations are more difficult to arbitrage and more sensitive to waves of investor sentiment. For example, stocks of younger, smaller, more volatile, unprofitable, non-dividend paying, distressed or with extreme growth companies will be more sensitive to investor sentiment. When investor

[11] Measured by the spread in yields on the 10-year U.S. Treasury bond vs. the 3-month T-bill (Fama and French, 1989).

[12] Measured as the difference in yields on Baa and Aaa corporate bonds (Fama, 1990; Keim and Stambaugh, 1986).

sentiment is low, subsequent returns will be relatively high for these stocks, on the other hand, the reverse happens when investor sentiment is high (Baker and Wurgler, 2006).

When investor sentiment is high, the propensity to speculate is also high and there will be a greater demand for speculative securities. Moreover, when the information asymmetry is higher the investor sentiment will play a more significant role in the valuations of stocks (Baker and Wurgler, 2006). Campbell et al. (2008) made a direct test on it and found similar results.

2.2. Initial Public Offering

When the common stock of a private company is launched to the public for the first time, there is an «IPO - *Initial Public Offering*», and the company that was initially private becomes public. After this phase, a capital increase may occur through the issuance of new shares but considering that, the company is already a publicly traded company, these are referred as «*SEO - Seasoned Equity Offerings*» or «*Secondary Equity Offerings*». However, either the IPO or SEO could be primary or secondary offerings, or a mix of both. In the primary market, the issuers sell the new securities while in the secondary market there will be transactions of those securities, that have already been issued. Here, existing shareholders could sell additional shares. In the case of a primary offering, with the issuance of new shares, each shareholder will hold a smaller percentage of the company's capital - there is dispersion of ownership, which is not the case in secondary offerings, where the rights remain. The issuers only benefit from revenues in primary offerings while in the secondary offerings the proceeds go to the shareholders who sell the shares (Fernandes et al., 2013).

2.2.1. Why open the capital to the public's investment

In fact, an IPO is associated with high costs, either direct or indirect[13], and because of that, it is important to understand the reasons behind the firms' decision to go public, which was analyzed by Ritter and Welch (2002). The most evident, which has already been pointed by

[13] Direct costs are associated to legal fees, underwriting fees, taxes, and accountancy costs and indirect costs are referred to the transfer of wealth from the owners to the initial shareholders of the company due to underpricing, a phenomenon that will be discussed later (Jenkinson, 1990).

Jenkinson (1990), is related to the need of raising (equity) capital for the firm, in order to expand or grant (future) investments more easily. Thus, it is possible to access a public market, where wealth could be transformed into cash, and to have more equity financing in secondary issues. Pagano et al. (1998), in their study, concluded that it is not the main motivation to attend in the decision to go public and pointed out the rebalancing of leverage and the obtaining of liquidity for the shareholders' with a management position, as alternative motivations. Kim and Weisbach (2005) concluded that, the sale of primary shares is correlated with increases in inventory, net property, plant and equipment (PPE), capital expenditures and R&D expenditures, up to 4 years after the IPO. However, the authors also confirmed the suggestion made by Pagano et al. (1998), of changing the financial structure of the company to reduce the level of debt, since the issuance of primary shares are correlated with subsequent higher repayments of debt and increases in cash, which possibly will be directed to investment-related activities.

Another reason to be considered is that, when a company starts to be publicly quoted, there is an evaluation of shareholders' capital, resulting in publicity and reputation benefits. With an IPO, the shareholders' structure changes and the companies are subject to corporate governance discipline and dissemination of information (Fernandes et al., 2013). On the other hand, an IPO lead to the exposure of the firm to takeovers and M&A procedures because it is easier to signalize the firm as a target when it is public (Zingales, 1995). Therefore, the stage of the firm in its life cycle is a factor which deserves attention in the decision to go public to Ritter and Welch (2002). If the firm is early in the cycle, it is better to keep being private but as it grows makes sense to turn it public to access more information (Chemmanur and Fulghieri, 1999).

2.2.2. The importance of market conditions in the decisions of go public

Without neglecting all the reasons mentioned above, Ritter and Welch (2002) defended that market conditions are the most important factor in the decision of going public. If at the time of the offering, there are favorable market conditions, it generates over optimism in investors who stay *bullish*[14] and interested in going forward with public offerings, either IPOs or

[14] Bullish investors are optimistic in relation to the market and believe that the stock price will be rise, allowing them to profit from an upward movement.

SEOs. These periods are referred as *hot markets* and are characterized by high IPO volume and high average initial returns. Loughran et al. (1994), Lee et al. (1991) and Brailsford et al. (2015) confirmed it, pointing that, in periods of high investor sentiment more firms go public, increasing the volume of IPOs. Baker and Wurgler (2007) said that it is also influenced by prevailing investment opportunities because a company might want to raise capital due to the belief in a brilliant future, since share indexes were growing in the past. Generally, in these periods, even analysts give strong buy recommendations and stay overoptimistic about the earnings and growth prospects of IPOs. Their mistakes in the forecasts are positively correlated with the IPO volume (Rajan and Servaes, 1997)[15].

It is said that a *window of opportunity*[16] for IPOs is created, in the sense that, it is possible to charge high prices for the shares issued when markets are hot (Aggarwal et al., 2002; Rajan and Servaes, 1997; Ritter and Welch, 2002). Ljungqvist et al. (2006) also showed that in a period of high sentiment, even "rational" investors, are willing to pay more for IPOs than what it is worth.

Market timing theories suggest that in periods of few volume of IPOs from other good-quality firms, the issue will be postponed and will be launch to the market when their equity may be overvalued by optimistic investors. Dorn (2009) said that sentiment investors are willing to overpay for IPOs that appear in the news and that follow periods of high returns in recent IPOs.

In fact, there is a pattern of cyclicality in IPOs, which is related with the market conditions. Fernandes et al. (2013) referenced this idea of waves in IPOs, noting that, from 2004 to the fourth quarter of 2006, there was an increase in the number of IPOs in Europe that contrasted with the decrease in activity in 2008 and 2009, associated with the financial crisis that was experienced on European stock exchanges.

Ritter (1991) suggested that there is also a pattern in the IPO returns. IPOs have high first day returns and low long run returns, which might be driven by the extreme expectations

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[15] To control it, Lee et al. (1991) included the dividend price ratio of the S&P500 since it is a measure of the expected growth rate of dividends, but they found that the dividend price ratio does not affect IPO volume.

[16] Windows of opportunity hypothesis was developed by Ritter (1991), Loughran et al. (1994), and Loughran and Ritter (1995).

about growth rates (Rajan and Servaes, 1997), that later are translated into low long run returns and even in long run underperformance, which was developed by authors, such as, Loughran (1993), Loughran and Ritter (1995), Brav and Gompers (1997), Brav and Gompers (2000) and Ritter and Welch (2002). This pattern is strong during *hot market periods* (see Appendix 6).

2.2.3. The IPO process

After the company decides to conduct the offering there is a process that the company must apply. The most frequent situation is when the issuer sub-underwrite the offer to an underwriter, who generally is an investment bank, to reduce the risk of an unsuccessful and unmarketable issue. It is easier to set the offer price of a SEO because there is information obtained by the market quotations already registered, rather than of an IPO, whose values have not yet been traded in the market. The offer price of an IPO, which had emphasis in Ritter and Welch (2002) analysis, will be established by the underwriter in negotiation with the issuer, according to the demand and interest of investors collecting in the *road shows*[17] through the world, to present the company and promote the offer with the intention of convincing potential investors. This collection of investor intentions is set in the *bookbuiding* period. Cornelli and Goldreich (2001) and Ljungqvist and Wilhelm (2002) refered to it as a procedure in which before the pricing of an equity, the investment banker asks institutional investors for bids for a quantity of shares, which allow them to collect information to construct the demand curve, to price and allocate shares on their best interests.

However, according to Stout (1988):

"Estimating the likely demand for an IPO is a notoriously difficult and an unscientific business".

Welch (1992), in their model of cascades, defended that, investors take in consideration the previously demand of earlier investors in their purchasing decisions and they also could be influenced to invest in the offer, if there is a discount in the offer price that makes the offer more attractive. When these transactions occurred in the secondary market, there are evidence of rising prices, which leads us to the concept of underpricing, explored in the next section.

[17] Informal pooling to know about the interests of investors.

2.2.4. Underpricing

Underpricing is a very well-known phenomenon pointed by different authors, such as Beatty and Ritter (1986), Loughran et al. (1994), Loughran and Ritter (2002) and Oehler et al. (2005). The concept of underpricing is the price of an IPO which is lower than its market value, this is, the owners of the company sell their shares for less than what it is worth, *leaving money on the table*[18], abdicating of the gains that they could receive if the offer price reflected more accurately the value of the firm. Since 1970s, it has been observed, in different stock markets around the world, that on average the offer price of an IPO in the primary market suffers an increase to its first day closing price in the secondary market, and this increase is an evidence of underpricing at the offer, which inspired a large theoretical literature in the 1980s and 1990s to study this phenomenon. Particularly, Jenkinson (1990), in the UK, observed that in the new equity issues[19], investment banks priced the shares at a discount relative to the aftermarket price. The misestimations about the aftermarket price are recurrent and they are not only attributed to the lack of information of the company.

In fact, there are several explanatory theories for underpricing, which can be distinguished between asymmetric information, institutional reasons, control considerations and behavioral reasons (Ljungqvist, 2005).

i. Asymmetric Information

In the models of information asymmetry is assumed that one of the parties in the transaction, which normally involves the issuing firm, the underwriter or the investor, knows more than the other. The best-known model belongs to Rock (1986) who presented the *winner's curse model*. According to this model, there are 2 groups of investors, the informed and uninformed investors. To the latter is imposed a *winner's curse* in the sense that they have all the access to the unattractive offerings they bid for, but they have restrictions in the access of attractive offerings of underpriced IPOs, where the informed investors concentrate their bids. The consequence is

[18] It could be given by the first day gain times the number of shares.

[19] Occurred via *offer for sale* which is a method of share sale through the exchange platform for listed companies, residing in the invitation to the public to buy shares from the company.

that, in the limit, uninformed investors only have allocations to overpriced IPOs which result in negative returns. In this case, they will not be interested to bid for IPOs. Nonetheless, the market has an insufficient demand if it is restricted to informed investors, reason why they need the participation of uninformed investors, so the underwriters press issuers to price the IPOs at a discount to encourage them to purchase the issue (Beatty and Ritter, 1986). Following the same line, Hanley and Wilhelm Jr (1995) found that there is not a significant difference between institutional and retail investors associated with the size of the allocations in underpriced and overpriced issues. However, Aggarwal et al. (2002) contradicted them by showing that institutional investors allocate more money in attractive offerings rather than retail investors. It is possible to make a connection between the Rock's (1986) *winner's curse* and the heterogeneity of investors because if the divergence of opinion between institutional and retail investors is low, the *winner's curse* disappears, and the underpricing is no longer needed. On the other hand, when there is divergence of opinion between rational and retail investors, there is greater underpricing (Ljungqvist et al., 2006).

There is also the hypothesis of *minimizing the risk of overpricing* (Rock, 1995). Smaller investors may find it risky to invest in an IPO because they have less access to costly information. Their strategy of minimization of risk is waiting and invest in the secondary market. In the case of risk averse investors, they prefer buying in the aftermarket. However, it is important to note that the market is dominated by uncertainty and there is the risk of the market price falling below issue price, and in this case the discount may be seen as a return for bearing risk.

In fact, Ritter (1984) studied the changing risk composition hypothesis which implicates that the greater is the ex ante uncertainty, the higher is the level of underpricing. Beatty and Ritter (1986) also formalized this hypothesis defending that the greater the valuation uncertainty, the more investors want to become informed, investing in a call option[20] on the IPO. Consequently, the *winner's curse problem* will be intensified, and will be required a higher level of underpricing. There is evidence of a positive relation between underpricing and ex ante uncertainty and, controlling for ex ante uncertainty is well-common in the empirical literature,

[20] The call option is exercised if the offer price exceeds the strike price. The greater the valuation uncertainty, the higher is the value of the option (Ljungqvist, 2005).

independently of the theory being tested. Considering that valuation uncertainty is impossible to observe directly, proxies for ex ante uncertainty are used and could be discriminated into four categories: company characteristics, offering characteristics, prospectus disclosure and aftermarket variables (Ljungqvist, 2005). Within the group of company characteristics, company age was one of the proxies pointed by Ritter (1984), Megginson and Weiss (1991) and Ljungqvist and Wilhelm Jr (2003) because if the operating history of a firm is short, there would be more uncertainty. It is possible to link the company age to measures of size, since bigger companies trade large amounts and are followed more cautiously by analysts. Furthermore, it is more likely that a larger company is also older. Alternatively, as a measure of size, there is the company's sales (Ritter, 1984) or the industry of the company (Benveniste et al., 2003). Within the group of offering characteristics, IPO gross proceeds is a common proxy for ex ante uncertainty (Beatty and Ritter, 1986; Miller and Reilly, 1987). Other proxies may include the number of uses of IPO proceeds or the number of risk factors obtained in the prospectus disclosures (Beatty and Ritter, 1986; Beatty and Welch, 1996). Lastly, there are aftermarket variables such as trading volume (Miller and Reilly, 1987) or volatility (Ritter, 1984, 1987), but there is no information about these variables at the time of the IPO.

By reducing the asymmetry between informed and uninformed investors, underpricing, which represents an involuntary cost to the issuer, could be reduced. This could be done by hiring a prestigious underwriter who certifies the quality of the offer (Booth and Smith II, 1986; Carter and Manaster, 1990; Michaely and Shaw, 1994). Logue (1973) and Beatty and Ritter (1986) were the firsts to develop underwriter reputation' proxies. Carter and Manaster (1990) provided an underwriter's ranking that have a negative relation with the underpricing, which later was updated by Carter et al. (1998) and Loughran and Ritter (2004). Beatty and Welch (1996) showed that the negative relation has reversed since the 1970s and 1980s and become positive. After 1990, Loughran and Ritter (2004), Hansen (2001) and Fernando et al. (2005) also recognized a positive relation. Loughran and Ritter (2004) advanced with a justification based on the will of banks to enrich themselves, thus enrolling into a strategic underpricing. Another reason has to do with a higher average risk profile resulted from low criteria when underwriters choose the IPOs, which leads to higher underpricing. Habib and Ljungqvist (2001) focused on endogeneity biases to justify the shift, arguing that issuers based their choices relative to the underwriter according to the underpricing they expect, showing that still in the 1990s, the relation returns to

be negative. It is possible to link it to the *Impressario* hypothesis of Shiller (1988) which defend that, with underpricing, there will be high first day returns, which increases the reputation of the underwriter responsible for the offer, translating in a greater demand of those underwriters for other events. However, Guo et al. (2006) did not find a relation between underwriter reputation and underpricing.

Information revelation theories are also based on the idea of informed investors who get access to more information. If those informed investors have incentives to reveal their costly information about the value of the IPO to the underwriters, they will be able to assess the demand for its stock and prevent suffers from a *placement problem* during the *bookbuilding* process. In the case of favorable information, with high demand, the IPO offer price will be greater and the informed investor get a lower profit. Consequently, they have interest in misrepresenting positive information in order to have a lower offer price settled by the underwriter (Beneviste and Spindt, 1989). Meanwhile, the main problem is to design a mechanism which incentivize the revelation of the true value of the stock. Underpricing is a way to compensate and maintain motivated those informed investors. The more favorable the information is, the more underpricing will exist to compensate them (Benveniste et al., 2003). Issuers could benefit from the extraction of favorable information, which allows them to increase the offer price - even though the price in the aftermarket increase even more. The price revision during the *bookbuilding* period is positively correlated with the first day underpricing return. The information extraction theory suggests a partial adjustment to the private information (Hanley, 1993).

Still in the information revelation theories, Chemmanur (1993), using a dynamic model of information production, mentioned that issuers have private information about the prospects, but as they sell equity both in the new issues market and in the secondary market, they benefit from the information that outsider investors may produce at a cost, in order to have a more precise valuation of their company in the secondary market. However, the greater the cost is, the less is the number of informed outside investors, and underpricing is a way to encourage them to learn more about the company going public.

Finally, the *signalling* theory proposes that underpricing is a signal of firm quality. The idea is that only high-quality firms could support selling shares at a lower price than the market price, leaving money on the table. (Allen and Faulhaber, 1989; Grinblatt and Hwang, 1989; Welch, 1989). Ibbotson and Jaffe (1975) said that this "*leaves a good taste in investors' mouths*" and

when the firm returns to the market at a later date, this money is recouped as the firm could issue additional shares at a higher price.

ii. Institutional Explanations

Within institutional explanations for underpricing, firstly, there is the litigation theory of Tinic (1988) and Lowry and Shu (2002), which defend that, with underpricing, underwriters difficultly will be sued by investors dissatisfied with losses in the post-IPO performance of their shares. However, countries differ significantly in their liability laws. Particularly, in the UK, the risk of being sued is not economically significant (Jenkinson, 1990). Secondly, there are price stabilizing activities in order to reduce price drops until the issue is fully sold. This is legal in many countries but in the UK it is allowed only for a period of 30 days (Exchange, 2010).

iii. Ownership and Control

When a company go public, there is a separation between the ownership and control responsibilities. In this context of an agency cost approach, there are two main points of view. First, underpricing can be used to retain control. Brennan and Franks (1997), using a data of 69 IPOs in the UK, confirmed that underpricing lead to excess demand and to greater dispersion of ownership. However, in order to retain control and protect private benefits they discriminate large bids in favor of small bids. Second, underpricing can be used to reduce agency costs, and Stoughton and Zechner (1998) defended that, agency costs are reduced when there is an allocation of shares to a larger outside investor who has interest in monitoring the company. On the other hand, there is less monitoring by the smaller investors, but they could also be *free riders* and benefit with the monitoring of the larger investors.

So far, we have analyzed the theories that belong to asymmetric information models, institutional explanations and ownership and control considerations, but, alternatively, there is a semi-rational theory, less related to public stock market and more to an internal perspective which are explored deeply in the following section.

2.2.5. Behavioral Explanations for Underpricing

i. Investor sentiment

Within the behavioral reasons, it has been debated the role of investors' behavior as the investor sentiment, on stock prices and more properly, in the IPO underpricing puzzle. The literature suggested a positive relationship between the price of the IPO on the first trading day and the demand of sentiment investors (Cornelli et al., 2006; Derrien, 2005; Ljungqvist et al., 2006).

Cornelli et al. (2006), using a sample of 486 IPOs in 12 European countries, during 1995 to 2002, investigated if post-IPO prices are driven by small retail investors and whether they should title them as sentiment investors. Miller (1977) has also defended that the price is driven by the overoptimistic investors, while other investors cannot express their pessimist due to short-sale constraints. Speculations about stock prices of companies that will suffer from an IPO are made in pre-IPO or *grey markets,* typically represented by small investors. Cornelli et al. (2006) used the pre-IPO or *grey* market prices as their proxy for firm-level investor sentiment[21], available in the European IPO market. The grey market price is indicative of the price that they will be willing to pay for that shares in the aftermarket. If they are irrational and overoptimistic, the grey market price is high, and the aftermarket price will be high correlated with the grey market price. In fact, they have found a positive relation between the grey market prices and the post IPO prices. However, when they used the return on the market index as a proxy for the market wide-investor sentiment, they did not find any relation with the IPO pricing process.

In fact, when there is optimism about the future of a company, the objective of the issuer is to maximize the surplus of the excess valuation over the stocks' fundamental value, as possible. As the stock number increases the price decreases, therefore, there is interest in restricting the supply of shares so that the price does not go down, allowing the firm to capitalize on that optimism. To do that, considering it is not possible to do it directly, in the first-stage of the model, underwriters allocate the shares to regular institutional investors who hold back and do not sell for a period of time, and, later, in the second stage, resell them to sentiment investors at

[21] Firm level investor sentiment is in the sense of retail or individual investor sentiment.

the maintained prices. Underpricing could be seen as a way to compensate regular investors who take the risk of holding back shares, loosing when *hot markets* end and the sentiment demand falls, being prevented from selling to the sentiment investors in those periods of time. It is predicted a positive relationship between underpricing and investor sentiment, especially during high sentiment periods. This happens since, in this period, issuers expand their offer size to maximize the funds raised from the issue, but since regular investors hold a greater proportion in the issue, they have to be compensated and the level of the underpricing also increases (Ljungqvist et al., 2006).

Dorn (2009), focusing on a narrow sample of German IPOs that are traded in the IPO issuing-market, during the period 1999 and 2000, found evidence that, using the grey market' pre-IPO trading as proxy for individual investor sentiment, it pushes aftermarket prices to above their fundamental values because they are acting on overoptimistic beliefs. Consequently, there is aggressive pre and post IPO purchases associated with higher first day returns and lower long-run returns. Additionally, he argued that sentiment has effect on the IPO pricing, however, it is not restricted to the internet bubble period. Sentiment impacts IPOs beyond the high sentiment periods contradicting the restriction to high sentiment periods of Ljungqvist et al. (2006).

Recently, Hrnjić and Sankaraguruswamy (2011) found a positive relationship between investor sentiment and IPO underpricing. They also found that the relation is not restricted to high sentiment periods, even though it is exacerbated during those periods[22] and in harder to arbitrage firms. They defended that it is hard to access to the demand of sentiment investors and they used the abnormal trading by retail investors on the first day of the IPO as a proxy for firm-level investor sentiment. After controlling for firm level investor sentiment, they found that the market wide-investor sentiment also has a positive relation with the IPO underpricing, adding it to what had been discovered by Cornelli et al. (2006).

Derrien (2005) also developed a model in which the information about the intrinsic value of the company, revealed by institutional investors, and the demand of sentiment investors,

[22] It is important to note that these findings also occurred in periods other than the years surrounding the burst of the Internet bubble because in these periods the behavior of market participants was atypical (Hrnjić and Sankaraguruswamy, 2011; Ljungqvist and Wilhelm Jr, 2003).

impacts the IPO price. In their model, underwriters access private information from informed institutional investors, namely about high investor sentiment but, it is only partially incorporated into the offer price, because underwriters are concerned with the aftermarket share price and they want to mitigate the risk of the market price being lower than the initial offer price which would impose costly price support in the aftermarket (Derrien, 2005). Using the oversubscription of the fraction of the IPO reserved for retail investors as proxy for the firm-level investor sentiment, in a sample of 62 French IPOs during the period 1999 to 2001, they found that it is positively correlated with underpricing.

Campbell et al. (2008) also found that underpricing is positively correlated to investor sentiment, using the Baker and Wurgler (2006) investor sentiment index to measure the investor sentiment. They also found that there are greater effects from the level of sentiment on underpricing, when information asymmetric is higher, according with the inferences of Baker and Wurgler (2006).

In a specific case, if there is an expectation that high pre-market sentiment in the aftermarket will be persistent, it is not necessary to compensate regular investors for the risk of deteriorating sentiment neither there is imposed costly price support to underwriters, and the underwriter is allowed to set a higher offer price in order to benefit from the surplus extracted from the sentiment investors.

Rajan and Servaes (2002) developed a model basing on the theoretical model proposed by De Long et al. (1990), but in a different context. They based on the irrational behavior of investors to conduct the model and assumed that the so called positive feedback traders varies over time and they will overpay for certain stocks. According to their model, the underwriter, acting on the interests of the company, want to sell a share of stock of the issuer firm, and there are three types of investors interested in the issue. First, the rational speculators, who want to maximize their wealth and set their demand according to this goal. Second, the passive investors who set their demand according to the difference between the price and their expectations about the intrinsic value and aligned with an insensitive portion of the demand, called *investor sentiment*. Lastly, the trend chasers or positive feedback traders, whose demand depend on the past price movements, also named as *feedback risk*. Initially, the underwriter set an offer price according to the demand of passive investors and then, the issue opens on the market and the trading between rational speculators and passive investors with the underwriter leads to an equilibrium market

price. Posteriorly, the positive feedback traders could see pricing movements[23] and formulate their demand. Well, the underwriter wants to set a higher offer price as possible, although, with an offer price higher than the intrinsic value the demand of passive investors is not likely to be high. If rational speculators speculate that the positive feedback traders will sell, they anticipate it selling first. This is the feedback risk, and the underwriter, who does not want to bear the cost of a falling price, buys insurance by underpricing. However, if the investor sentiment maintains the price high anyway, they do not need to buy insurance and there is a negative relationship between the investor sentiment and underpricing.[24]

Purnanandam and Swaminathan (2004), using comparable firm multiples, compared IPO offer prices to the intrinsic values of IPO firms and verified that the median IPO firm was priced above industry peers, that is, the IPO was overvalued[25] at the offer by 14-50%. However, Zheng (2007) disagreed with the valuation methods of Purnanandam and Swaminathan (2004), defending that IPOs are not overvalued on average because when they control for growth rate the overvaluation disappear. Cook et al. (2003) showed that overpricing at the offer only happen in hot markets, consistent with the approach of Ljungqvist et al. (2006).

ii. Prospect Theory

On the other hand, there could be agency costs concerning these arrangements between the issuer and underwriter which was pointed by some authors, such as, Loughran and Ritter (2004) who is based on the prospect theory. Issuers need underwriters to help them in the IPO process, although, underwriters want to minimize their efforts in the placement of stocks and particularly, they want to minimize their costs in obtaining information regarding the interest of

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[23] Underpricing secure the participation of positive feedback traders in the aftermarket since they had propensity to buy in response to past returns.

[24] As proxies for sentiment they used the relative market to book for the industry at the time of the IPO and a measure for whether the industry is trading at historically high multiples (Rajan and Servaes, 2002).

[25] Purnanandam and Swaminathan (2004) use the terminology of undervaluation or overvaluation because, in their approach, they did not assume that price equals to value. Therefore, to analyze if IPOs are underpriced in respect to their fair value, the concept of undervaluation seems to be more appropriate.

investors in participate in the IPO. Consequently, they make issuers sell the offer at a lower price than what could be obtained by issuers and it is intensified if there is a lack of competition in the underwriter's market (Logue, 1973). Investors also have interest in allocations of underpriced stocks and compete for it, resulting in rent-seeking behavior as they offer side-payments to the underwriters in the form of excessive trading commissions or with the practice of *spinning*, which is the allocation of underpriced stocks to institutional investors with the expectation of gain future business from them.[26] In this case, underwriters gain with the underpricing and deliberately leave money on the table as a compensation for their privileged information. Baron (1982) also constructed models focusing on the benefits of underwriters with underpricing, defended that they benefited by having more information than the issuers, using this to get offers at lower prices. On the other hand, issuers accept the underpricing and do not get upset about leaving money on the table because they anchor on the midpoint of a filing price range and the offer price is greater than this midpoint. Even though, issuers lose with the money left on the table, they have a positive net change in wealth as the positive offer price revision is larger. They sum the wealth loss due to underpricing with the wealth gain on retained shares, as prices increase in the aftermarket. Ritter and Welch (2002) also based on the prospect theory to refer to this relation between the money left on the table and wealth changes.

[26] This occurred predominantly on the 1990s and then, it was followed by more intense monitoring.

3. Data and Methodology

This section is divided in two main subsections. The first is the development of our sentiment measure, where we present the methodology regarding the principal component analysis (PCA), the description of the variables aligned with the respective data collection and the PCA's results. The second is focused on the underpricing, presenting the sample collection of the IPOs and methodology that will be used to test the impact of sentiment on underpricing.

3.1. Investor Sentiment

3.1.1. Principal Component Analysis

A composite measure of investor sentiment is developed using a set of sentiment proxies, applying a principal component analysis (PCA), which captures the common component of those variables rather than using them as raw variables. It is a statistical procedure that, using orthogonal transformation, transform those variables into a set of values, named *principal components*. The transformation is defined in such a way that the first component explains the most variation and each succeeding component accounts for the highest variance possible. This method of extracting common features of variables has already been used by some authors (see Appendix 5). The variables that we choose to include are the market share turnover, the volatility premium, the number of IPOs on the last 6 months and the consumer confidence, described in the next section.

3.1.2. Description of variables

Market Share Turnover (VO) Generally, market turnover is a measure of market liquidity. It is possible to distinguish market share turnover in trading values[27] and in trading volumes. For the UK, in terms of volumes, it is given by the number of total share traded on the LSE, over the month, divided by the total number of shares listed. We concentrate our attention on the FTSE100, an index of 100 stocks listed on LSE, and we collected monthly data

[27] In terms of values, it corresponds to the total sterling value over the month divided by the total capitalization of the London Stock Exchange (LSE).

of the turnover by volume for the FTSE100 from *Datastream*. VO shows the aggregation of the number of shares traded for each stock in the index, in thousands, and represents our monthly market share turnover by volume.

Volatility premium (PVOL) The volatility premium could be calculated from the difference between the expected volatility and the realized volatility. The expected volatility, in the UK, is given by the FTSE100 Index option volatility, which applied the CBOE methodology. The FTSE100 Index option volatility was retrieved from *Datastream*. The realized volatility was calculated from the closing prices of the FTSE100 Index to obtain daily volatilities, and then, take the monthly average to avoid biases related with different numbers of monthly trading days. PVOL represents the monthly volatility premium.

Number of IPOs (NIPO) Considering the dynamics of the IPO market cycle, there is an evidence of the firms timing an equity offer to a period associated with higher valuations, to take advantage of the greater sentiment in the market, representing a *window of opportunity*. When investors are overly optimistic, the number of IPOs is greater and the market is hot (Ibbotson and Jaffe, 1975). To account for the issuing activity, the monthly number of IPOs was extracted from a spreadsheet of *London Stock Exchange website* which have an IPO summary, since 1995. NIPO represents the number of IPOs on the last 6 months.

Consumer Confidence (CCI) Direct measures of sentiment through monthly surveys data also could be used to measure investor sentiment. The UK consumer confidence index is conducted by the European Commission for Economic and Financial Affairs, based on the monthly surveys of consumer confidence. CCI represents the consumer confidence index through monthly survey data, retrieved from the OECD[28].

We expect all variables to be positive related with sentiment.

3.1.3. Principal Component Analysis' results

In the Table 1, we present the summary statistics of the raw measures used to construct the investor sentiment index. All these variables have 156 observations occurred between 2004

[28] OECD (2018), Consumer confidence index (CCI) (indicator). doi: 10.1787/46434d78-en (Accessed on 04 April 2018).

and 2016, with a skewed and leptokurtic pattern, rejecting the hypothesis of normality. Regarding the VO, the average was 240400000 thousand, and it was slightly greater than the median, and the distribution is somewhat positive skewed. The minimum was reached on January 2013 and the maximum on Abril 2016. The average PVOL of 0.9% is smaller than the median, which means that the distribution is negatively skewed also verified by the negative sign of skewness. The minimum is negative, which means that the realized volatility is greater than the expected, and it occurred on October 2005. The maximum was on February 2009. NIPO has a mean of 81.481 IPOs greater than its median, being positive skewed. The minimum of 3 IPOs was on May 2009 and the maximum of 256 IPOs was on July 2005. Their standard deviation is quite high (64.612) which indicates that the NIPO sometimes spread far from the mean.

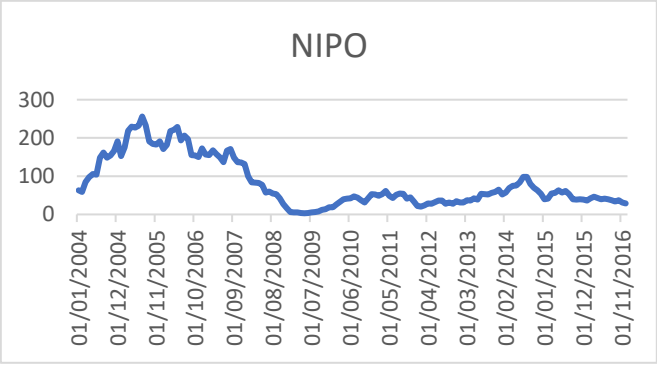
Table 1 - Descriptive statistic of monthly investor sentiment raw measures

	N	Mean	Median	Min	Max	Sd	Skewness	Kurtosis
VO	156	24040000	20700000	9556000	43650000	9001000	0.468	1.964
PVOL	156	0.009	0.0101	-0.109	0.063	0.018	-2.141	14.368
NIPO	156	81.481	54	3	256	64.612	0.981	2.710
CCI	156	100.114	100.631	96.486	102.466	1.493	-0.520	2.150

Table 1 presents the descriptive statistics of the raw measures used to conduct the principal component analysis. VO is the market share turnover by volume. PVOL is the volatility premium. NIPO is the number of IPOs on the last 6 months and CCI is the consumer confidence index. All the measures are on monthly basis.

In fact, as we can see in Figure 1, there is an evident cyclicality on NIPO. Most of the IPOs were conducted on the early part of the sample and minimum historic values were reached, during 2008 and 2009, compatible with the period of the financial crisis in the world economy. Afterwards, the cyclicality remains but with shorter amplitude.

Figure 1 – NIPO



We found that NIPO has a high positive correlation with the other measures, especially with VO (0.656) and with CCI (0.433). On the other hand, it is negatively correlated with PVOL (-0.128).

Lastly, CCI is slightly negatively skewed as the mean is 100.114 and the median is 100.631 and it ranged between 96.486 and 102.466.

In the literature, some adjustments to raw measures are usually made. Baker and Wurgler (2006, 2007) and Baker et al. (2012) used the detrended logarithm turnover to control for the verified exponential positive trend of market share turnover and also applied the logarithm transformation to the number of IPOs variable. Therefore, we followed the same idea and we started by doing the logarithm of those variables, obtaining the logarithm of the market share turnover by volume (lnVO) and the logarithm of the number of IPOs on the last 6 months (lnNIPO), to test if we achieve better results when we consider these transformations.

On the other hand, the authors pointed that some variables take longer to reveal sentiment comparing to others[29].

Therefore, we kept the current measures and computed the 1-period lagged version of each measure and then we normalized each of them.

To compute the 1st stage of the principal component, we included the log and non-log variables of market share turnover by volume (lnVO, VO) and the log and non-log variables of the number of IPOs on the last 6 months (lnNIPO and NIPO), aligned with the current and lagged measures of all variables, all normalized. Then, we proceed to choose those that have greater correlation with the first-stage index. The first-stage index was given by the weighted-average of the 3 principal components, that have eigenvalues greater than 1, which is generally accepted by the literature to be significant. These three components contribute with an explanation of 81.95% of the sample variance, as we can see in Table 2. In the Table 3, we have the first-stage index correlations with its variables.

[29] Proxies related with firm supply responses lag proxies based directly on demand or investor behavior (Baker and Wurgler, 2006).

Table 2 – Principal Components to construct the 1st stage index

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	6.1478	3.5620	0.5123	0.5123
Comp2	2.5858	1.4854	0.2155	0.7278
Comp3	1.1003	0.1776	0.0917	0.8195
Comp4	0.9227	0.2319	0.0769	0.8964
Comp5	0.6909	0.3542	0.0576	0.9540
Comp6	0.3367	0.1855	0.0281	0.9820
Comp7	0.1511	0.1223	0.0126	0.9946
Comp8	0.0288	0.0144	0.0024	0.9970
Comp9	0.0144	0.0048	0.0012	0.9982
Comp10	0.0097	0.0027	0.0008	0.9990
Comp11	0.0070	0.0022	0.0006	0.9996
Comp12	0.0048	.	0.0004	1.0000

$$1^{st} stage\ index \quad (1)$$
$$= comp_{1_{1st\ stage}} * \left(\frac{0.5123}{0.8195}\right) + comp_{2_{1st\ stage}} \left(\frac{0.2155}{0.8195}\right)$$
$$+ comp_{3_{1st\ stage}} * \left(\frac{0.0917}{0.8195}\right)$$

Table 3 - Correlation between the first-stage index and the log and non-log variables of VO and NIPO, and the lagged and non lagged version of each variable, all normalized.

Component	First-stage Index
First-stage Index	1
VO	0.6463
lnVO	0.6042
lagVO	0.6484
laglnVO	0.6056
NIPO	0.9432
lnNIPO	0.9193
lagNIPO	0.9326
laglnNIPO	0.9035
CCI	0.6323
lagCCI	0.6606
PVOL	-0.1635
lagPVOL	-0.1486

Table 3 presents the correlations between the first-stage index and the different versions of the variables. VO is the turnover by volume, lnVO is the respective logarithm, lagVO is the lagged turnover by volume, laglnVO is the respective lagged logarithm, NIPO is the number of IPOs on the last 6 months, lnNIPO is the respective logarithm, lagNIPO is the lagged number of IPOs on the last 6 months, laglnNIPO is the respective lagged logarithm, CCI is the consumer confidence index, lagCCI is the lagged consumer confidence index, PVOL is the volatility premium, lagPVOL is the lagged volatility premium, all normalized and with monthly frequency.

The variables with greater correlation with the first-stage index, that will be included in our PCA analysis, are the lagged market share turnover by volume (lagVO), the number of IPOs on the last 6 months (NIPO)[30], the lagged consumer confidence index (lagCCI) and the volatility premium (PVOL), each of them was previously normalized.

The following parsimonious index is representative of the PCA using the chosen variables, obtained by doing the weighted average of the two components, which have eigenvalues greater than 1, explaining 73.29%.

$$SENTIMENT_t = 0.5305VO_{t-1} + 0.4661NIPO_t + 0.0919CCI_{t-1} + 0.1658PVOL_t \quad (2)$$

VO_{t-1} represents the lagged and normalized turnover by volume

$NIPO_t$ represents the normalized number of IPOs

CCI_{t-1} represents the lagged and normalized consumer confidence index

$PVOL_t$ represents the normalized volatility premium

We verified that the correlation between the first-stage index and the sentiment index with the 5 chosen variables is 0.869, which means that there is not much information lost when we did not use all variables and centralize the analysis on the lead or lag variables.

Afterwards, it is important to control each proxy with variables that are known to influence sentiment, but are not directly related with it, to obtain clearer proxies, reason why we follow Baker and Wurgler (2006, 2007), Baker et al. (2012) and Brown and Cliff (2005) approach to orthogonalize each of the 5 proxies with macroeconomic variables. We used 2

[30] Therefore, we opt by exclude the logarithm variables for VO and NIPO, used by Baker and Wurgler (2006, 2007) and Baker et al. (2012) because the non-logarithm variables have a greater correlation with the first-stage index.

macroeconomic variables: the industrial production indicator[31] and the real consumption[32]. Additionally, we included business cycle variables: the 3-month Treasury Bill rate[33], the term spread, defined as the difference in yields between the 10-year Gilt[34] and the 3-month T-Bill and the inflation rate[35].

Table 4 presents the correlations between each variable that we choose to do the PCA, before being orthogonalized with its orthogonalized variable. Generally, the correlations are quite high which means that the used macro and business variables explain slight of the variation in the sentiment measures, especially in the case of the PVOL variable, since it has the greater correlation with its orthogonalized variable. On the other hand, the macro and business variables explain comparatively more of the variation in the lagVO variable, which has the smaller correlation.

Table 4 - Correlations of the raw proxies and its orthogonalized variables

	lagVO and lagVO $^{\perp}$	NIPO and NIPO $^{\perp}$	lagCCI and lagCCI $^{\perp}$	PVOL and PVOL $^{\perp}$
Correlation	0.451	0.593	0.729	0.946

Table 4 presents the correlation between raw and orthogonalized variables, where lagVO is the lagged turnover by volume, lagVO $^{\perp}$ is the orthogonalized lagged turnover by volume, NIPO is the number of IPOs on the last 6 months, NIPO $^{\perp}$ is the orthogonalized number of IPOs on the last 6 months, lagCCI is the lagged consumer confidence index, lagCCI $^{\perp}$ is the orthogonalized lagged consumer confidence index, PVOL is the volatility premium and PVOL $^{\perp}$ is the orthogonalized volatility premium, all normalized and with monthly frequency.

[31] Following Chen et al. (1986), Baker and Wurgler (2006, 2007) and Baker et al. (2012). Data retrieved from OECD (2018), Industrial production (indicator). doi: 10.1787/39121c55-en (Accessed on 04 April 2018).

[32] Following Chen et al. (1986), Baker and Wurgler (2006, 2007) and Baker et al. (2012). Data retrieved from Bank of England, Real Consumption Expenditures in the United Kingdom [RLCMEXUKQ], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/RLCMEXUKQ, April 4, 2018.

[33] Following Campbell (1987) and Hodrick (1992). Data retrieved from OECD (2018), Short-term interest rates (indicator). doi: 10.1787/2cc37d77-en (Accessed on 04 April 2018).

[34] Following Chen et al. (1986). Data retrieved from OECD (2018), Long-term interest rates (indicator). doi: 10.1787/662d712c-en (Accessed on 04 April 2018).

[35] Following Brown and Cliff (2005). Data retrieved from OECD (2018), Inflation (CPI) (indicator). doi: 10.1787/eee82e6e-en (Accessed on 04 April 2018).

Moreover, after the variables' orthogonalization our final PCA is computed. The PCA output is presented in Table 5.

Table 5 – Output of Principal Component Analysis

Panel A				
Component	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
Comp1	1.6274	0.5741	0.4069	0.4069
Comp2	1.0533	0.1342	0.2633	0.6702
Comp3	0.9191	0.5190	0.2298	0.9000
Comp4	0.4001	.	0.1000	1.0000
Panel B				
Variable	**Comp1**	**Comp2**	**Comp3**	**Comp4**
lagVO	-0.1193	0.7434	-0.6532	0.0805
NIPO	0.6823	0.2076	0.0253	-0.7005
lagCCI	0.6930	0.1044	0.0796	0.7089
PVOL	-0.1998	0.6272	0.7526	0.0185

Table 5 presents the output of the PCA. Panel A has the 4 components associated with their eigenvalues, differences, proportions and cumulative proportions. Panel B is the correlation of each variable with each component.

Since component 1 and component 2 have eigenvalues greater than 1, we have to consider both to construct a unique sentiment index, where each of the variables have been firstly standardized and orthogonalized. To do so, we have to do a weighting average of the two components. The first component explains 40.69% of the total variation while the second component explains 26.33%. We use the proportion of these percentages on the total of the two components, which is 67.02%, to develop our weighted sentiment measure. Following, we have the equations representative of the single components' index and the final weighted sentiment index.

$$SENTIMENT^{\perp}_{comp1_t} = -0.1193VO_{t-1} + 0.6823NIPO_t + 0.6930CCI_t - 0.1998PVOL_t \quad (3)$$

$$SENTIMENT^{\perp}_{comp2_t} = 0.7434VO_{t-1} + 0.2076NIPO_t + 0.1044CCI_t + 0.6272PVOL_t \quad (4)$$

$$SENTIMENT^{\perp}_{\frac{Comp1}{Comp2}} = comp1 * \left(\frac{0.4069}{0.6702}\right) + comp2 * \left(\frac{0.2633}{0.6702}\right) \quad (5)$$

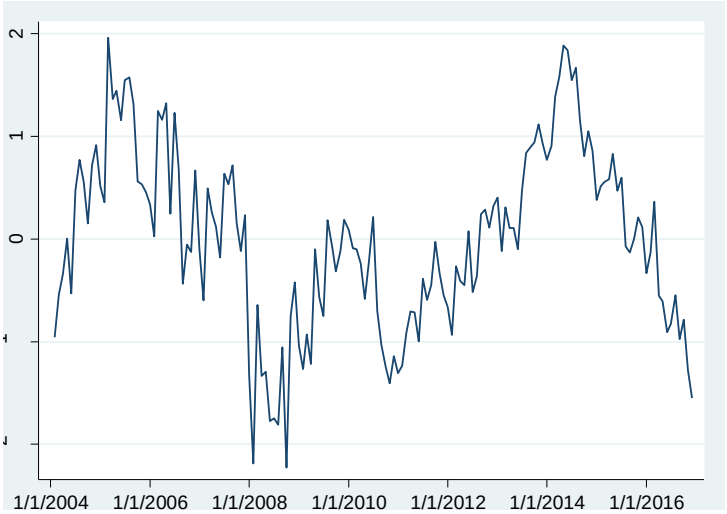
$$\Leftrightarrow SENTIMENT^{\perp}_{\frac{Comp1}{Comp2}} = comp1 * 0.6071 + comp2 * 0.3929$$

$$\Leftrightarrow SENTIMENT^{\perp}_{\frac{Comp1}{Comp2}} = VO_{t-1} * (-0.1193 * 0.6071 + 0.7434 * 0.3929) + NIPO_t * (0.6823 * 0.6071 + 0.2076 * 0.3929) + CCI_{t-1} * (0.693 * 0.6071 + 0.1044 * 0.3929) + PVOL_t * (-0.1998 * 0.6071 + 0.6272 * 0.3929)$$

$$\Leftrightarrow SENTIMENT^{\perp}_{\frac{Comp1}{Comp2}} = 0.2196VO_{t-1} + 0.4958NIPO_t + 0.4618CCI_{t-1} + 0.125PVOL_t \quad (6)$$

The large proportion of the variation in investor sentiment is explained by the number of IPOs and consumer confidence variables. We verify that all variables have a positive influence over sentiment, as expected. Our index, which is our representation of sentiment, is shown in the Figure 2.

Figure 2 – Investor Sentiment Indicator



However, the sentiment values range from negative to positive values that makes the index hard to interpret. In order to give a clearer visual interpretation of the indicator we transformed it into a standardized index (Figure 3) which aggregates the values between 0 and 100, following the formula:

$$SI = \frac{Sent - Min\ Sent}{Max\ Sent - Min\ Sent} * 100 \qquad (7)$$

$$\Leftrightarrow SI = \frac{Sent - (-2.2271)}{1.9607 - (-2.2271)} * 100$$

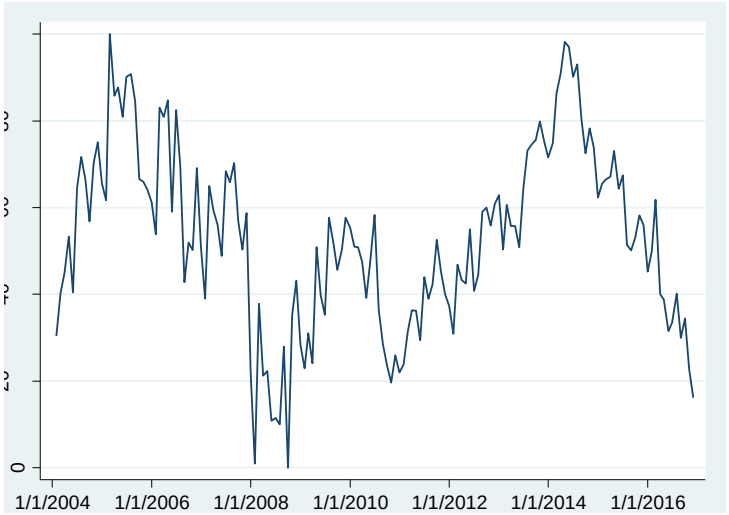
As we can see in Table 6, from the 155 observations of the variable sentiment, through 2004 to 2006, the average corresponds to 53.181% which is slightly greater than the median of 53.131%. The minimum value corresponds to October 2008 and the maximum to March 2005. The standard deviation is 20.851% which shows some deviation from the mean. The representation of sentiment' distribution is made in Figure 3.

Table 6 – Descriptive statistic of Sentiment Index

	N	Mean	Median	Min	Max	Sd	Skewness	Kurtosis
SENT	155	53.181	53.131	0	100	20.851	-0.051	2.648

Table 6 presents the main descriptive statistics of the variable sentiment, SENT, ranged from 0 to 100.

Figure 3 – Sentiment Index



From Figure 3, we can we can make an association with what has been happening in the UK stock market, in terms of levels of sentiment, in the recent years. We observe an initial increasing path in sentiment levels until mid-2005, followed by a period of decline which is exacerbated with the crash of 2008. The financial crisis in the world economy has contributed to a less favorable scenario in terms of sentiment levels in the UK. However, there is a recovery in the following years, reaching a positive peak again around 2014.

3.2. Underpricing

3.2.1. Sample Collection

The IPO data was retrieved from *Zephyr* database. We started by collecting 1550 IPOs occurred between 2004 and the end of 2016, in the United Kingdom. Our sample search procedure is presented in Table 7.

Table 7 – Sample selection

		STEP RESULT	**SEARCH RESULT**
1.	Deal types: IPO, Initial public offering	38,347	38,347
2.	Time period: on and after 01/01/2003 and up to and including 31/12/2016	145,678	31,898
3.	Target country: United Kingdom (GB)	16,537	2,148
4.	All target stock exchange: London AIM Stock Exchange, London Stock Exchange	26,199	1,550
		Total	**1550**

Then, we limited the sample according to several considerations. From the initial 1550 companies, we filtered it by deal-subtype removing 46 observations of demergers since they had already a value in the market. The second listings have already been eliminated when we chose the deal types in the *Zephyr,* following the same logic.

We eliminate 21 observations of utility firms (SIC Codes between 4900 and 4999), 614 observations of financial firms (SIC Codes between 6000-6999) and ADRs (SIC Code 8880), although we have not excluded any in this case. We follow Hrnjić and Sankaraguruswamy (2011) to proceed with this exclusion because they said that these industries have special directions once they are regulated by the government. REITs, partnerships, unit offerings and closed end funds were also eliminated from our sample.

In some cases, *Zephyr* did not provide the information about the offer price and we complement the missing data with the information available in the *London Stock Exchange* website

and in the IPO prospectuses in order to have as large a sample as possible. Using the ISIN code associated with each of the IPO, obtained in *Zephyr,* we also could retrieve the offer and the first day closing prices from *Datastream,* essential to calculate the underpricing. From here, we could also get the data about the market capitalization for each observation. The company's age was obtained by computing the difference between the completed date and the incorporation date, both retrieved from *Zephyr*. We also got the gross proceeds and the percentage of capital retained by each company. Therefore, we collected the US SIC codes for each observation to discriminate the companies that belong to the technology industry. Working through each prospectus and consulting the *Thomson Reuters Eikon Database*, the data about each IPO underwriter have been gathered manually to, therefore associate it to the Migliorati and Vismara (2014) underwriter ranking . Finally, we retrieved the number of IPOs from the *London Stock Exchange* website and the FTSE 100 price index from the *Datastream*.

Finally, we eliminated IPOs with missing data for offer and first day closing prices and we restricted the sample to issue prices greater than £1 and the new money raised above £1.5m, staying with 668 companies.

3.2.2. Methodology

Our research attempts to study the determinants of underpricing focusing on the relationship between the investor sentiment and underpricing. We have chosen the Ordinary Least Squares method to conduct the regression, that allow us to estimate the relation between the independent variables and the level of underpricing (UND), which is our dependent variable. Beyond the explanatory variable related with hypothesis that we want to study, the investor sentiment, we include several control variables which capture the effect on the dependent variable and does not affect our research variable.

$$\begin{aligned} UND_{i,j,t} = {} & \beta_0 + \beta_1 SENT_{t-1,i} + \beta_2 NIPO_{t,i} + \beta_3 \mathrm{AGE_i} + \beta_4 MCAP_i \\ & + \beta_5 GPROC_i + \beta_6 SENTMACP_i + \beta_7 SENTGPROC_i \\ & + \beta_8 UNDRANK_i + \beta_9 CAPRET_i + \beta_{10} TECH_i \\ & + \beta_{11} SENTECH_i + \beta_{12} BULL_{t,i} + \beta_{13} PRECRISIS_{t,i} \\ & + \beta_{14} CRISIS_{t,i} + \varepsilon_i \end{aligned} \qquad (8)$$

Where *i* refers to the firm and *t* to the period.

4. Descriptive Statistic

4.1. Variables Description

Underpricing (UND) The first day's initial return on the IPO stock is a common measure of underpricing, assuming that the larger the initial return, the greater the underpricing. In the case of a negative initial price, there is overpricing. Equation 9 refers to the initial return R_i, and reflects the percentage change from the offering price to the close price on the initial date.

$$R_i = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \quad (9)$$

R_i = Initial return of stock "i".

$P_{i,t}$ = Closing price of stock "i" on first day of trading.

$P_{i,t-1}$ = Offer price of stock "i" at the last day of the offer period.

Some literature has adjusted the initial return to control for the effect of positive or negative market movements on initial returns, as the main objective is to focus on the initial return, which comes from the underpricing. This control is done because there might be some days between the issue price and the closing price on the first day of trading in which market movements impacts the initial return. However, in our sample the period between the offering date and the first day of trading is short, and we choose to do not adjusted for the market movements as several other authors have already done (Derrien and Womack, 2003; Ljungqvist, 2005; Ljungqvist and Wilhelm Jr, 2003; Loughran and Ritter, 2002; Lowry and Schwert, 2002).

Investor Sentiment (SENT) As an explanatory factor for underpricing we include the investor sentiment, using the index constructed by us in the previous section. Assuming that investors consider the market sentiment with a delay in time, we lagged the sentiment index by 1-month. Later, we associate it to each IPO. This is aligned with the literature review, which defends that the effect of sentiment is absorbed with a delay, either on individual firms or on the stock market as a whole (Baker and Wurgler, 2007). In fact, stock markets take 1 to 12 months to reflect new information and the sentiment in the market could be seen as information

that investors will consider slowly, based on the theory of underreaction[36]. In fact, investors are reluctant to immediately change their own sentiment based on changes in the market wide sentiment, taking time to adapt, meaning that those investors only incorporate the sentiment of the market, variable that we constructed, with a delay. Hence the usage of the lagged version of market sentiment in our regression, named as SENT (Barberis et al., 1998). However, parallel to our main analysis we also conduct estimations using the non-lagged version of sentiment to checks if there is a significant difference between both. The majority of the literature found a positive relationship between investor sentiment and IPO underpricing (Cornelli et al., 2006; Derrien, 2005; Dorn, 2009; Ljungqvist et al., 2006). However, Rajan and Servaes (2002) developed a model which defends a negative relation.

Number of IPOs (NIPO) As a measure of the IPO activity, we include NIPO, which measures the number of IPOs in the last 6 months prior each individual IPO. Fluctuations in the IPO volume were pointed by Ibbotson and Jaffe (1975) in their theory of hot markets. Lowry and Schwert (2002) defended that this volume is higher following periods of high underpricing. When general economic conditions are favorable, there is a higher demand for capital and the number of companies going public increases. IPO volume is negatively correlated with information asymmetry and positively correlated with investor sentiment (Lowry, 2003). A greater number of IPOs means that the market is "hot" which should be exploited by companies that time their IPOs to issue during high underpricing periods. Therefore, when we are in the presence of a high recent number of IPOs, it is expected large levels of underpricing.

Company age (AGE) Considering that valuation uncertainty is impossible to observe directly we need to include a proxy to it, in order to control their impact on the dependent variable. AGE is the natural logarithm of one plus the difference between the completed date of the IPO and the foundation date of the company. Ritter (1991) introduced the age of the firm as a proxy for ex-ante uncertainty as less established firms are more likely to have uncertain prospects (Bilson et al., 2003). Younger companies exhibit higher ex-ante uncertainty when compared to older companies and this is because younger companies are less likely to be assessed

[36] Theory of underreaction (Bernard, 1992; Bernard and Thomas, 1989, 1990; Chan et al., 1996; Cutler et al., 1991; Jegadeesh and Titman, 1993; Rouwenhorst, 1998).

by financial analysis and have less historical financial data available due to their lack of seasoning. On the other hand, older companies have more information that investors can assess which will reduce the asymmetric information around the IPO (Hensler et al., 1997; Ritter, 1984, 1991). The literature found that underpricing increase as the company is younger because the uncertainty is reflected on higher underpricing (Cliff and Denis, 2006; Ljungqvist and Wilhelm Jr, 2003; Loughran and Ritter, 2004; Lowry and Shu, 2002; Megginson and Weiss, 1991).

Market capitalization (MCAP) We choose a size measure, the natural logarithm of the market capitalization, giving in thousands £, for all companies of our sample at the date of the IPO. Market Capitalization is considered as being a signal about the quality of the company (Mezhoud and Boubaker, 2011), which is in line with the signaling hypothesis of Allen and Faulhaber (1989) and Welch (1989). Sohail and Raheman (2009) found a positive and highly significant relation between market capitalization and the level of underpricing. Bundoo (2007) and Bansal and Khanna (2012) also found that the largest companies are the most underpriced, both supporting those signaling hypothesis. However, Bundoo (2007) also realized that companies with small market capitalization have greater levels of underpricing as well, supporting the ex-ante uncertainty hypothesis. Bigger companies trade large amounts and are followed more cautiously by analysts. It is more likely that larger firms have better assess to investment capital with more diversified products which leads to their profitability and longevity (Finkle, 1998). Furthermore, it is more likely that larger firms are also older. Considering that, with an increase in market capitalization, uncertainty is expected to decrease, leading to a decrease in (short run) underpricing (Carter et al., 1998; Ibbotson et al., 1994).

Sentiment and Market Capitalization (SENTMCAP) In order to see how sentiment interacts with information asymmetric and their impact on underpricing, we include a variable, named as SENTMCAP, for the interaction between the lag sentiment and the market capitalization, a measure that link with the information uncertainty. Campbell et al. (2008) found the level of sentiment prior to the offering is positively correlated with the level of underpricing and the explanatory power is even higher when information asymmetric is higher. This is aligned with the inferences of Baker and Wurgler (2006, 2007) who defended that investor sentiment is higher when information asymmetric is higher.

IPO Gross Proceeds (GPROC) Beatty and Ritter (1986) tested the relation between uncertainty and underpricing, using an alternative proxy for ex-ante uncertainty, which is the

inverse of the IPO gross proceeds. In our analysis, we also include a variable for the inverse of the IPO gross proceeds, the GPROC. The IPO gross proceeds measure the number of shares offered times the offer price, which is the issue size in thousands £. Miller and Reilly (1987) also supported the proposition of Beatty and Ritter (1986) and referred that the issue size is a measure for ex-ante uncertainty. They defended that smaller offerings are more speculative than larger offerings, and the latter are associated with more established firms. Consequently, these firms will contribute to reduce the perceived risk of potential investors (Boudriga et al., 2009; Carter et al., 1998; Jain and Kini, 2000). There is evidence of a negative relationship between the IPO gross proceeds and the level of underpricing (Chalk and Peavy, 1990; Clarkson and Merkley, 1994). Therefore, when we apply the inverse of IPO gross proceeds, we expect a positive relation.

Sentiment and IPO Gross Proceeds (SENTGPROC) There is evidence of a relation between sentiment, IPO gross proceeds and underpricing, suggested by the literature. According to Ljungqvist et al. (2006), if there is high sentiment in the market, the size of the offer increases and it is necessary to compensate regular investors to hold a greater proportion in this larger offer, increasing the level of underpricing (Ljungqvist et al., 2006). To study this relation between sentiment, the size of the offer and underpricing we include a variable with an interaction between sentiment and gross proceeds, SENTGPROC.

Underwriter reputation (UNDRANK) The literature, such as, Beatty and Ritter (1986), Carter and Manaster (1990), Carter et al. (1998), Jain and Kini (1999) and Loughran and Ritter (2004), proposed that investment bankers with higher reputation achieve higher offer prices, when working for the issue firms. Therefore, the authors have found a negative correlation between underwriter reputation and the level of underpricing. The recognized Carter-Manaster measure is not directly applicable to European markets. Therefore, as our research is conducted in the UK, we include a variable respecting to the underwriter reputation ranking, UNDRANK, according to the ranking underwriters of European IPOs of Migliorati and Vismara (2014).

Retained Capital (CAPRET) To test the impact of the percentage of capital retained on underpricing, we create a dummy variable which carry the value 1, if the percentage is above 10% and 0, otherwise. Keasey and McGuinness (1992) showed that the percentage of shares

retained signal the firm value. If there is a higher percentage of shares retained, this means that the owners are confident about the future of the company, signaling a positive value of the firm. The firm value is higher, as the greater level of retained capital, bring into line the interests of managers and new shareholders, reducing the agency costs predicted by the agency theory (Jensen and Meckling, 1976). In this case, it is possible to have a higher offer price leading to lower underpricing (Mroczkowski and Tanewski, 2004). However, Bozzolan and Ipino (2007) mentioned the other side of a higher retained capital associated with the higher risk of expropriation of cash flow rights of minority shareholders leading to higher underpricing.

Technology Industry (TECH) It is assumed that the technology industry is tremendously volatile and technology firms incorporate more risk than non-technology firms, because they are younger when become public and much arduous to value. Hence, a greater return is required from investors, potentiating a positive relation with underpricing. We choose a dummy variable to refer to the technology industry, using the US primary Standard Industrial Classification (SIC) codes. The variable assumes the value of 1, in the case of a technology company, and the value of 0, otherwise. We follow Loughran and Ritter (2004) to identify the US primary SIC codes associated with technology[37].

Sentiment and technology industry (SENTECH) Stocks included in high technology industry are difficult to value and difficult to arbitrage and the effect of sentiment on underpricing is likely to be higher in these stocks (Baker and Wurgler, 2007). Therefore, we decided to include a variable with an interaction between sentiment and high technology industry, SENTECH.

Bull Market (BULL) Schultz (2003) define a bear market as a depressed or declining market which may vary in a range of 13.9% to 90%. Generally, it is said that we face a bull market

[37] SIC codes 3571, 3572, 3575, 3577 and 3578 are relative to computer hardware, 3661, 3663 and 3669 to communications equipment, 3671, 3672, 3674, 3675, 3677, 3678 and 3679 to electronics, 3812 to navigation equipment, 3823, 3825, 3826, 3827, 3829 to measuring and controlling devices, 3841 and 3845 to medical instruments, 4812 and 4813 to telephone equipment, 4899 to communication services, and 7371, 7372, 7373, 7374, 7375, 7378, and 7379 to software. Ritter (2016) added the SIC codes 3559, 3576, and 7389 relative to special industry machinery, computer communications equipment and business services, respectively.

when an index rises 20% of its low and a bear market when it falls 20% of its peak. In the case of the FTSE100 Index, we represented the bull and bear market periods in Appendix 7. We created a dummy variable to refer to the bull market period, carrying the value of 1 in that case, and the value of 0, otherwise.

PreCrisis/Crisis (PRE_CRISIS; CRISIS) Knowing the possible impact of the financial crisis that devastated the European markets, we divide our sample in three different periods: pre-crisis, from 2004 to 2007, crisis that ranges between 2008 and 2010 and pos-crisis between 2011 and 2016. We created two dummies, one for the pre-crisis, carrying a value of 1 in that case, and a value of 0 otherwise, and one for the crisis, assuming a value of 1 in that period, and a value of 0 otherwise.

4.2. Descriptive Statistic

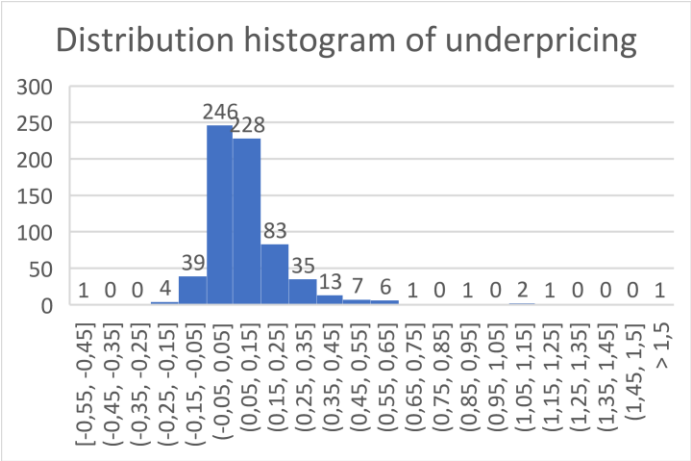
As shown in Table 8, the average offer price was £112.43 and its median was £91.625. It ranged from the minimum of £1, due to the imposed restriction of offer prices above £1, corresponding to the Bluebird Energy Plc IPO, and the maximum of £1300 in the case of the Betfair Group Plc IPO. Regarding the first day closing price, the average was £119.969 and the median £97.375. It ranged from a minimum of £1.13 and a maximum of £1550, corresponding to the Sports Stars Media Plc and the Betfair Group Plc IPOs, respectively. In percents, the average underpricing was 9.897% and the median was 6.402%, meaning that half of the 668 observations have a greater initial return than 6.402%. Since the median is lower than the mean, it seems that the sample is skwed to the right and the skweness of 3.530 confirms it. The kurtosis of 27.968 is also indicative of a greater deviation from the normality. The distribution histogram of the underpricing is pictured in Figure 4.

Table 8 - Descriptive statistic of the dependent variable

	N	Mean	Median	Min	Max	Sd	Variance	Skewness	Kurtosis
Offer Price	668	112.430	91.625	1	1,300	120.982	14636.6	3.910	29.637
1stDayPrice	668	119.969	97.375	1.13	1,550	128.447	16498.58	4.369	37.964
Underpricing	668	0.099	0.064	-0.55	1.75	0.163	0.026	3.530	27.968

Table 8 presents the descriptive statistics of the dependent variable, underpricing (in decimals), which is constructed as the percentage difference between the offer price (in £) and the first day closing price (in £), which are also included in this table.

Figure 4 – Distribution histogram of underpricing



We can see that there is extreme values in the sample and the minimum was -55% which respects to the overpriced IPO of Worldlink Group Plc while the maximum was 175% of the Regency Mines Plc IPO. The standard deviation was 16.247%. A simple t-test shows that underpricing is statistically different from zero on the 1% significance level. However, this test just works optimally in the case of a normally distributed sample. Performing a Jarque-Bera test to test for the normality, it rejects the null hypothesis of normality at the 99% confidence level. As an alternative to the t-test we perfomed a non-parametric Wilcoxon Signed Rank test which confirms the results of the t-test showing that underpricing is stastiscally different from zero on the 1% significance level.

As we observe in Table 9, in respect to sentiment, on a scale between 0% and 100%, the minimum of 0% was associated to the Mountfield Group Plc IPO occurred on October 2008 and the maximum of 100% to a set of 11 IPOs occurred on March 2005. The average was 63.383% and the median was 64.578% with a standard deviation of 19.901%. Regarding the NIPO, the average was 128.847 and the median was 148 IPOs occurred within the prior 6 months of a specific date of an IPO. The minimum was 4 IPOs in the last 6 months of the Allocate Software Plc IPO realized on June 2009, and the maximum was 256 IPOs in the last 6 months of the 11 IPOs conducted on July 2005. The companies that went public were founded, on average, 4.171 years before and the median was 1 year before. The minimum of 0 means that some companies went public in the same year that they were founded. There are 266 companies that went public in the same year that they were founded. The market capitalization was on

average (median) £669751 (£39289) thousands and ranged between £886 and £209400000 thousands, which belongs to the Big Sofia Technologies Group and to the Polymetal International, respectively. The IPO raised on average (median) £75096.85 (£11550) thousands being the smallest amount of £1500 thousands and the largest of £5781000 thousands of the ITV Plc IPO. The underwriter reputation was ranged between 0 and 1. The minimum (very close to 0) corresponds to the Verdant Holdings Plc IPO and to the Cambria Automobiles Plc IPO, underwritted by Fairfax IS, and the maximum was 1. The average underwriter reputation was 0.232, the median was 0.135 and the standard deviation was 0.262. Out of the 531 IPOs of the sample, 60.5% have a percentage of capital retained above 10%. Out of the 668 IPOs, 24.9% were listed as tech companies, while 92.1% of these IPOs were issued during bull periods. Of the 668 IPOs, 404 IPOs occurred in the pre-crisis (2004-2007) period, 54 IPOs were issued during the crisis (2008-2010), while the remaining 210 IPOs occurred afterwards.

Table 9 – Descriptive statistic of the explanatory variables

	N	Mean	Median	Min	Max	Sd
SENT	668	63.383	64.578	0	100	19.901
NIPO	668	128.847	148	4	256	70.626
AGE	661	4.171	1	0	193	12.060
MCAP	659	669751	39289	886	209400000	8351427
GPROC	580	75096.85	11550	1500	5781000	291452.638
UNDRANK	452	0.232	0.135	0	1	0.262
CAPRET	531	0.605	0.652	0	1	0.216
TECH	668	0.249	0	0	1	0.432
BULL	668	0.921	1	0	1	0.270
PRE_CRISIS	668	0.605	1	0	1	0.489
CRISIS	668	0.081	0	0	1	0.273

Table 9 presents the descriptive statistics of the explanatory variable, over the period of 2004 to 2016. SENT is the lagged investor sentiment index (in %). NIPO is the number of IPOs in the last 6 months prior each individual IPO. AGE is the natural logarithm of one plus the difference between the completed date of the IPO and the foundation date of the company. MCAP is the natural logarithm of the market capitalization, giving in thousands £. GPROC is the inverse of the IPO gross proceeds, in thousands £. UNDRANK is the underwriter reputation ranking. CAPRET is a dummy which carry the value 1, if the percentage of capital retained is above 10%, TECH is a dummy which has the value of 1, in the case of a technology company. BULL is a dummy which carry the value 1 in the case of a bull market period. PRE_CRISIS and CRISIS are also dummies.

As we can see in Table 10, we split the sample between high sentiment period using a dummy variable that takes a value of 1, if investor sentiment for that month is greater than the value of the 75th percentile of the issues with greater investor sentiment, and low sentiment period with a dummy variable that takes the value of 1, if the investor sentiment for that month

is less than the value of the 25th percentile of the issues with lower distribution. When we conducted the Wilcoxon Rank Sum Test we found that the differences of medians in high and low sentiment periods are significant in NIPO at 1% level of significance and in MCAP and GPROC at 5% level of significance. The differences of medians in NIPO are aligned with the theory of Ibbotson and Jaffe (1975) which defend that investors may be able to concentrate their purchases in months when they expected to have highly positive returns, this is, in high sentiment months. Further, the median market capitalization of companies going public in high sentiment is lower than in low sentiment periods. This is consistent with the idea that stocks of smaller companies will be more sensitive to investor sentiment defended by Baker and Wurgler (2006). Thus, knowing the market conditions, only bigger companies can go public in low sentiment periods without suffering much of the impact that smaller companies would suffer. Therefore, as we saw before, there are way less IPOs in low sentiment periods and it is expected that those IPOs are made by greater companies. Lastly, the median gross proceeds follow the same logic and it is higher in low sentiment periods rather than in high sentiment periods because high issues usually represents bigger companies which are less affected by sentiment.

Table 10 – Descriptive statistics for both dependent and independent variables considering the full and divided sample

	Full Sample		High Sentiment Period		Low Sentiment Period		Wilcoxon Rank Sum Test	
	Mean	Median	Mean	Median	Mean	Median	Diff. in Median	Prob>|z|
UND	0.099	0.640	0.0807	0.0617	0.0966	0.0611	0.0006	0.5474
NIPO	128.847	148	181.592	221	74.814	53	168***	0.000
AGE	4.171	1	5.204	1	3.720	1	0	0.6836
MCAP	669751	39289	260630.9	31639.5	675856.9	56424	-24784.5**	0.0171
GPROC	75096.85	11550	101762.5	10000	75455.4	15000	-5000**	0.0403
UNDRANK	0.232	0.135	0.252	0.175	0.250	0.175	0	0.7235
CAPRET	0.605	0.652	0.617	0.667	0.597	0.641	0.026	0.4816
TECH	0.249	0	0.268	0	0.230	0	0	0.4234

Table 10 presents the main descriptive statistic of the mean and median. Column 1 shows the mean and median for the full sample. Colum 2 is the subsample for the issues within the 25th percentile with higher investor sentiment. Colum 3 is the subsample for the issues within the 25th percentile with lower investor sentiment. In the last column are the results of the Wilcoxon Rank Sum Test. *, ** and *** represents the 10%, 5% and 1% significance levels, respectively.

5. Results

In this chapter we present the results of our research. We estimate several regression equations to analyze the marginal effect of each relationship explanatory variable on the dependent variable. As we noticed along the literature review, there are some variables with ambiguous effects on underpricing, therefore, we found interesting to study if and how these variables affect the level of underpricing. In Table 11, we present the results of the OLS regressions. The underpricing is the dependent variable and more explanatory variables will be added along the 10 models. Every model was tested against heteroscedasticity, which is a frequent regression problem that heavily affect all the inferences from the model. However, we verify that any of our models is heteroscedasticity, using the White test. Our regressions also appear to have no problems of multicollinearity. What could lead us to suspect about this problem would be high R-squares, but few significant t-ratios, but as we can see in Table 11, our R-squares are quite low. On the other hand, when we look at the zero-order correlation coefficients, both negative and positive, between the explanatory variables (see the correlation matrix in Appendix 8) the most correlated variables are SENT and NIPO with 42.82%, which is not considered a larger correlation coefficient. Another concern is the endogeneity, and, in our research, we noticed that there are some disagreement in what variables should be selected to explain and control to underpricing. When a relevant variable is omitted this could translate in an omitted variable bias, therefore, we will include different sets of control variables along the models in order to shed light on the most common determinants of underpricing.

Table 11 – Regression Equations

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SENT	-0.011	-0.003	-0.005	-0.007	-0.008	-0.009	-0.016	-0.025**	-0.034**	-0.033**
	(0.008)	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)	(0.010)	(0.012)	(0.015)	(0.015)
NIPO	0.000*	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AGE		-0.008	-0.009*	-0.009*	-0.011*	-0.011*	-0.012**	-0.012**	-0.012**	-0.011*
		(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
MCAP		0.009	0.010*	0.010	0.027***	0.026***	0.027***	0.026***	0.025***	0.024***
		(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
GPROC		0.022***	0.022***	0.023***	0.034***	0.033***	0.033***	0.033***	0.033***	0.032***
		(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
SENTMCAP			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SENTGPROC				0.000	0.000	0.000	0.000	0.000	0.000	0.000
				(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
UNDRANK					-0.059**	-0.057**	-0.059**	-0.056**	-0.054**	-0.050*
					(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)
CAPRET						0.012	0.012	0.012	0.008	0.007
						(0.015)	(0.015)	(0.016)	(0.017)	(0.017)
TECH							-0.002	-0.002	-0.003	0.010
							(0.014)	(0.014)	(0.014)	(0.019)
SENTECH							0.025	0.027	0.029*	0.028*
							(0.016)	(0.016)	(0.017)	(0.017)
BULL								0.024	0.005	0.002
								(0.024)	(0.033)	(0.033)
PRE_CRISIS								-0.026	-0.014	-0.013
								(0.030)	(0.061)	(0.062)
CRISIS								-0.039	-0.078	-0.086
								(0.027)	(0.072)	(0.073)
CONSTANT	0.077***	0.212***	0.208***	0.216***	0.142**	0.133**	0.127**	0.115*	0.104	0.151
	(0.014)	(0.042)	(0.042)	(0.043)	(0.057)	(0.058)	(0.059)	(0.063)	(0.073)	(0.115)
Observations	665	568	568	568	409	409	409	409	409	409
R-squared	0.006	0.042	0.045	0.047	0.095	0.097	0.103	0.111	0.120	0.128
Adj R-squared	0.003	0.033	0.035	0.036	0.077	0.076	0.078	0.079	0.068	0.058
F-value	1.98	4.86***	4.44***	3.98***	5.28***	4.75***	4.13***	3.50***	2.29***	1.84***

This table presents the results of the OLS regressions. The dependent variable is the underpricing, regressed on several explanatory variables. SENT is the lagged investor sentiment index. NIPO is the number of IPOs in the last 6 months prior each individual IPO. AGE is the natural logarithm of one plus the difference between the completed date of the IPO and the foundation date of the company. MCAP is the natural logarithm of the market capitalization, giving in thousands £. GPROC is the inverse of the IPO gross proceeds. UNDRANK is the underwriter reputation ranking. CAPRET is a dummy which carry the value 1, if the percentage of capital retained is above 10%, TECH is a dummy which has the value of 1, in the case of a technology company. BULL is a dummy which carry the value 1 in the case of a bull market period. PRE_CRISIS and CRISIS are also dummies. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

The model 1 includes SENT and NIPO as explanatory variables for underpricing and while SENT is not statistically significant, NIPO is statistically significant at the 10% level. The coefficient of NIPO is positive, meaning that there is a larger underpricing when there is a greater number of IPOs and the market is hot, according to the theory of hot markets of Ibbotson and Jaffe (1975). These greater underpricing comes from the side of the offer price since NIPO and offer price have a negative relation[38].

As we can see in the Table 12, we split the NIPO in percentiles for a clear analysis, and we observe that by increasing the NIPO, the average and median offer price decreases. That might happen because the underwriters understand the companies' motivation to engage in an IPO, which results from the hot market period, and decrease the offer price to protect themselves from the company profiting from the hot market.

Table 12 – NIPO and Offer Price relation

NIPO		N	Mean	Median	Min	Max
P25	Offer Price	178	138.036	100	1	1,300
P50	Offer Price	169	122.202	109	1	555
P75	Offer Price	184	101.578	67.385	1.1	773.5
P100	Offer Price	137	81.683	67	2.5	600
Total	Offer Price	668	112.430	91.625	1	1300

Table 12 presents the descriptive statistic of the offer price within the 25th percentile (P25), 50th percentile (P50), 75th percentile (P75) and 100th percentile (P700) of the NIPO. NIPO is the number of IPOs in the last 6 months prior each individual IPO.

In this model, the F-statistics of 1.98 is not statistically significant, which means that there is not global significance when we consider these explanatory variables together. The R-Squared of 0.006 implies that these variables only explain 0.6% of the variation on underpricing. Therefore, it is important to reconcile the effect of these variables with some variables supported by a strong empirical evidence as the case of the AGE, MCAP and GPROC and the model 2 conjugates the explanatory variables of model 1 with these recognized variables. Within this set of new variables included, only the GPROC is statistically significant at the 1% level and keep this significance across all models with a positive coefficient, as the AGE and MCAP are not statistically significant and NIPO lost its significance in this model and kept being insignificant across the remaining estimations. The literature expects a negative relationship between the IPO gross proceeds and the level of underpricing (Chalk and Peavy, 1990; Clarkson and Merkley,

[38] We tested that this relation show significance at the 1% level.

1994) and as GPROC refers to the inverse of IPO gross proceeds, our results are supported by them. Our results show that smaller offerings have higher levels of underpricing, as the Beatty and Ritter (1986) and Miller and Reilly (1987) predicted.

In the model 3, it is added the variable SENT multiplied by the MCAP to analyze how asymmetric information (using the MCAP as proxy for uncertainty) interacts with investor sentiment in order to investigate the theory of Baker and Wurgler (2006), who defends that investor sentiment increases when asymmetric information increases, relation that has already been studied by Campbell et al. (2008). However, in our models, this variable is not statistically significant, which does not allow us to draw the same conclusions. In the model 3, the AGE and MCAP turned statistically significant at the 10% level. The MCAP lost its significance in the model 4 but, in all other models it is statistically significant in the 1% level while the significance of AGE is more constant along the models. The coefficient of AGE is negative, indicating that older firms are less subject to underpricing, in accordance with the literature (Cliff and Denis, 2006; Ljungqvist and Wilhelm Jr, 2003; Loughran and Ritter, 2004; Lowry and Shu, 2002; Megginson and Weiss, 1991). The coefficient of MCAP is positive which is in accordance with the signalling hypothesis and with the findings of Sohail and Raheman (2009) Bundoo (2007) and Bansal and Khanna (2012) who defended a positive relation between market capitalization and the level of underpricing.

In model 4, we included a new variable focusing on the interaction between investor sentiment and the size of the offer. We found that there is a negative correlation between investor sentiment and the size of the offer, incompatible with the idea that the size of the offer increases with sentiment defended by Ljungqvist et al. (2006). However, the coefficient sign of the estimation of the interaction between these variables is positive, aligned with Ljungqvist et al. (2006) theory, but insignificantly so.

After that, we included the underwriter rank which restricted our sample to 409 observations, although it is statistically significant at the 5% level in all models. The coefficient of UDRANK is negative in all models meaning that the reputation of prestigious underwriters signals the firm's quality, reducing underpricing, and it is in accordance with the literature review (Beatty and Ritter, 1986; Carter and Manaster, 1990; Carter et al., 1998; Jain and Kini, 1999; Loughran and Ritter, 2004). CAPRET, the dummy for the percentage of capital retained, that we included in model 6, did not show any statistical significance to explain the level of underpricing. TECH was included in the following model and it is also not statistically

significant. We also included a variable to the interaction between tech and investor sentiment in this model, but it only gains significance after we control for yearly and industry fixed effects (model 9 and 10, respectively). The coefficient regression of this variable is positive which is in accordance with Baker and Wurgler (2007) who defended that the effect of investor sentiment on underpricing is likely to be higher in stocks of the high technology industry.

When we include BULL, PRE-CRISIS and CRISIS variables, the R-squared increases although they are all statically insignificant, in the model. According to the R-squared the variables of this model explain 11.1% of the variation on underpricing. Interestingly, the variable that we concentrated our attention along the research, SENT, turn out to be statistically significant at the 10% level and maintains its significance when we introduce yearly dummies to control for the yearly and industry fixed effects. However, the coefficient of SENT is the opposite of what most of the theory predicts, since it is negative in all our models and several authors predicted a positive relation with underpricing (Cornelli et al., 2006; Derrien, 2005; Dorn, 2009; Ljungqvist et al., 2006).

Nevertheless, in the model developed by Rajan and Servaes (2002), the results were consistent with ours, suggesting a negative relation between investor sentiment and underpricing. In their model, they argue that since the underwriter must bear the cost of the issue in a case of overpricing the stock, they are incentivized to lower the offer price to protect themselves from a fall in the price, creating underpricing. However, they defend that if the investor sentiment is high, the underwriters need to underprice the stock less because the investors willingness to pay higher prices for the stock is greater.

In our case, we opt for a different point of view associated with information asymmetry and timing. Earlier in our study, we mentioned several proxies for uncertainty assessment such as company characteristics, offering characteristics, prospectus disclosure and aftermarket variables. Yet, these variables provide only a measure of uncertainty for the company itself. However, even though we associate the sentiment measure with each individual IPO, it remains as a temporal variable related with timing. As Inklaar and Yang (2012) said, the times of higher uncertainty usually happen in hard economic times, such as deep crisis, which matches with our lowest sentiment periods as we mentioned in our PCA procedure. Bloom (2009) also showed that in times of higher uncertainty, typically, firms avoid engaging in new investments or projects. Therefore, it is known that greater uncertainty is associated with higher risk and, implicitly, greater underpricing. This way, following asymmetric information models, greater uncertainty

associated with hard economic times and thus, low sentiment periods, will be associated with higher levels of underpricing, achieving a negative relation between sentiment and underpricing as we got in our results.

Moreover, we are aware that our results might also be biased due to a heavy crisis period. No other relevant study found significance on the investor sentiment including the crisis period in the US or European market, which might have heavily affected our results due to a low amount of IPOs during that period. In the 3 years of the 2008-2010 period, which corresponds to approximately 23% of the 13 years of our study, we have only 26 issues, corresponding to only 6% of our total IPO sample, meaning that we have a non-linear number of issues across our sample period. Furthermore, the crisis period holds most of the low sentiment periods, being responsible for 51% of the low sentiment months[39] during those 3 years. In fact, using again our sentiment index for a clear interpretation, we have only 46 IPOs happening on the bottom 25th percentile of the index against 158 IPOs on the top 25th percentile. However, considering our issues, the 25th percentile with lower sentiment corresponds to 48.873 from 0 to 100 which cannot be truly considered as a low sentiment period. Moreover, the issues made during that time span contradicted very well accepted theories in the literature regarding the expected positive relation between the investor sentiment and issue size and market capitalization (see Table 10) which turned out to be negative in those issues.

The instability characteristic of that crisis period, may have influenced the explicative power of our sentiment variable in our estimation, since it is exactly in the model when we add the dummy variables related with pre-crisis and crisis to our estimated regression that our sentiment variables turns statistically significant, remaining significant in the subsequent models.

Rajan and Servaes (2002), using their model did not find any statistical significance in their coefficients of investor sentiment, however, we were able to find a statistical significant coefficient for our sentiment measure, so it is plausible to assume that our sentiment measures brought better results, despite the negative coefficient sign. Additionally, our findings provide, against other studies, a negative relation between the investor sentiment and the underpricing that could be used as a base for further research on this topic.

[39] We considered low sentiment months, the months where the sentiment lied on the bottom 25th percentile, corresponding to 39 months out of 155.

6. Conclusions

When companies conduct an initial public offering, it is common to have high first day returns, meaning that companies leave money on the table when they go public. That is called the IPO underpricing. To address that phenomenon, we studied the relation of investor sentiment with the IPO market. Most of the literature has focused their attention on the effect of the firm level sentiment on the IPO pricing. However, we pondered that investors come and leave the market together and developed our analysis based on the market wide phenomenon of investor sentiment. To develop our sentiment measure we recurred to a principal component analysis (PCA), using three indirect measures for investor sentiment, the market share turnover, the volatility premium and the number of IPOs and, one direct survey measure, the consumer confidence index, on a monthly frequency from January 2004 to December 2016, for the UK. We also controlled for macro and business variables, orthogonalizing the measure in order to obtain a cleaner measure, removing the impact of fundamentals. Our results contribute to the literature on how to measure investor sentiment and has showed conformity with what been happening in the UK stock market, in terms of levels of sentiment, being evident the abrupt decline in the level of investor sentiment, during the period of crisis.

By studying 668 IPOs in the UK between 2004 and 2016, we found evidence that underpricing is affected by investor sentiment. This is aligned with Hrnjić and Sankaraguruswamy (2011) who were the first to provide empirical evidence that the pricing of IPOs is influenced by market wide sentiment in addition to the firm-level sentiment. Contradicting several of the literature, our results found a significant negative relation between the underpricing and our measure of investor sentiment, but it is in line with the negative coefficient found by Rajan and Servaes (2002), even though our data is not in accordance with its model. Following asymmetric information models, we hypothesized that our findings may result from the fact that greater uncertainty, allied with low sentiment periods, will be associated with higher levels of underpricing. We also pointed out the fact that part of our sample period includes the deep financial crisis that devastated the whole Europe.

This research presents some limitations. We focused our analysis examining the relationship between our investor sentiment measure, using a combination of proxies to investor sentiment, and underpricing. However, it could be interesting to study the impact of individual/retail investor sentiment on underpricing or control our investor sentiment measure

to the retail investor sentiment and verify if we would maintain the negative relation of our investor sentiment measure with underpricing.

Some authors, such as, Cornelli et al. (2006) or Dorn (2009) has already studied the retail investor sentiment, although, the main limitation in doing that, is the difficulty to access the demand of retail investors. Those authors resorted to the pre-IPO or grey market trading as proxies for retail investor sentiment, although it is hard to access those data. Derrien (2005) and Hrnjić and Sankaraguruswamy (2011), following a similar approach, used the fraction of IPO reserved for retail investors and the abnormal trading of retail investors as proxies for retail investor sentiment. However, ex ante retail trading and IPO prices are difficult to measure.

Another determinant of underpricing that could be interesting to analyze would be the percentage change from the midpoint of the filling range to the offer price, because underwriters adjust it during the *bookbuilding* process. However, we are restricted in terms of data to include this variable.

7. Appendixes

Appendix 1- Critics to rational finance

First, markets cannot be fully efficient, there must be some inefficiency, even if residual, to enable the search of new information by investors and allow institutional investors to generate capital gains. Second, the strong restrictions imposed to the hypothesis of efficient markets make it tautological (Lobão, 2012). Even in the most used evaluation model, the standard CAPM model, some fails were pointed out (see Roll (1977)). There are some asset-pricing anomalies that cannot be explained by the model, such as the size effect (Banz, 1981), value effect (Basu, 1977; Bhandari, 1988; Fama and French, 1992), the momentum effect (Jegadeesh and Titman, 1993) and the reversion to the median effect (De Bondt and Thaler, 1985). There is also evidence of market anomalies as the underreaction and overreaction of stock prices and the closed-end mutual fund premium/discount puzzle which challenge the efficient markets theory (Lee et al., 1991).

Appendix 2 - UBS Index of investor optimism

Initially, from 1996 to 2007, the Gallup organization has been concentrated on random interviews in US. This measure is based on surveys of investors with more than $10 000 in wealth, the interviews are conducted in the first two weeks of every month and the results are reported on the last Monday of the month, based on 1000 interviews. In 2002, it extended to include the five largest EU economies: France, Germany, Italy, Spain, and the United Kingdom. In each country and in each month, a sample of 200 investors was extracted and the results are reported monthly, for the aggregated region, and quarterly, for each country. Although the survey is restrained to the same profile of invertor each month, investors vary in each month what brings some noise to the measure, because there is no information about the respondents changing attitudes. Additionally, a wrong type of investors could be chosen to the sample or the respondents may respond to the survey in an inattentive way.

Appendix 3 - Consumer Confidence Index

MCCI began in 1947, on a quarterly basis and changed to a monthly basis from 1978, conducted on a sample of 500 households. On the other hand, ICC began monthly, in 1967, and changed to a monthly basis from 1978, with a larger sample of 5000 households.

The Consumer Confidence focuses on five questions:

1. "We are interested in how people are getting along financially these days. Would you say that you (and your family living there) are better off or worse off financially than you were a year ago?"
2. "Now looking ahead—do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now?"
3. "Now turning to business conditions in the country as a whole—do you think that during the next twelve months we'll have good times financially, or bad times, or what?"
4. "Looking ahead, which would you say is more likely—that in the country as a whole we'll have continuous good times during the next five years or so, or that we will have periods of widespread unemployment or depression, or what?"
5. "About the big things people buy for their homes—such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or bad time for people to buy major household items?".

Appendix 4 - Investors Intelligence (II) and American Association of Individual Investors (AAII)

On one hand, the editor of II reads and rates advisory services, weekly since 1964. The newsletters could be bullish, if the advisory services recommend buying stocks due to the prediction of rising in the market, could be bearish, if the recommendation is for closing long positions or opening short positions as the market is predicted to decline, or could be in a stage of waiting for a correction (Lee et al., 2002). On the other hand, AAII conducts the survey among a random sample of its members, weekly since 1987. They have to classify themselves as bullish, bearish or neutral towards their expectations for the market performance in the next 6 months.

Regarding the results of the application of these surveys, as measures to investor sentiment, Siegel (1992) found that investor sentiment, taken from II, correlate well with stock returns. Lee

et al. (2002), also used the II data as a measure for the investor sentiment to conduct their study and test the impact of noise trader risk on both the formation of conditional volatility and expected return and found that excess returns are positively correlated with shifts in sentiment. More recently, Ho and Hung (2009) also found that, using the II survey to measure investor sentiment, it influences the asset pricing models. With the AAII, Brown (1999) calculated the investor sentiment defined as the percentage of bullish or neutral responses relative to the total responses. However, they shed light on the volatility, instead of returns, to see the relation with the individual investor sentiment and have found that, during trading hours, shifts in the level of sentiment correlate with increases in funds' volatility.

Appendix 5 – Characteristics of studies reviewed

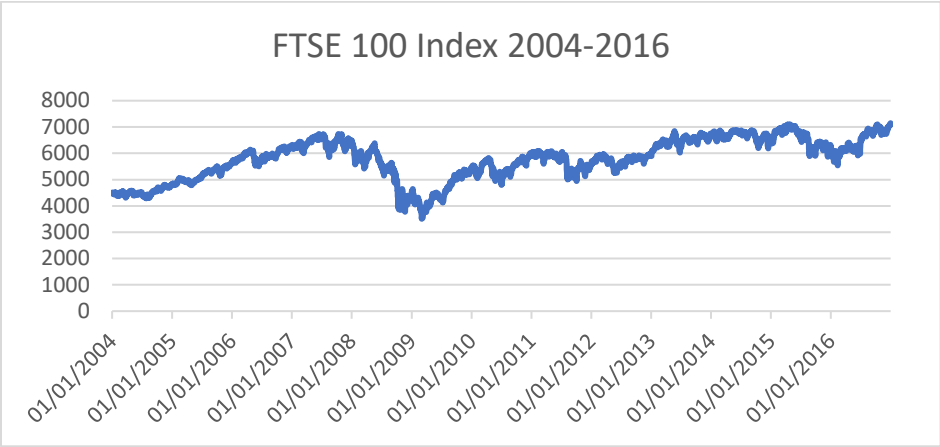
Authors	*Country of Study*	*Period*	*Variables*	*Methodology*
Baker and Wurgler (2006)	US	1962- 2000 Monthly data	Closed-end-fund discount in month t $(CEFD_t)$ NYSE average of monthly turnover in month t-1 $(TURN_{t-1})$ Number of IPOs in month t $(NIPO_t)$ Average first-day return on US IPOs in month t-1 $(RIPO_{t-1})$ Equity share in new issues in month t (S_t) Value-Weighted dividend premium in month t-1 (P_{t-1})	Principal Component Analysis
Baker et al. (2012)	Canada, France, Germany, Japan, UK and US	1980 – 2005 Annual data	Log ratio of the equal-weighted average market-to-book ratios of stocks with high idiosyncratic volatility (top three deciles) and stocks with low idiosyncratic volatility (bottom three deciles), volatility premium $(PVOL_t)$ Log number of initial public offerings over the year $(NIPO_t)$ Average first day returns of initial public offerings in the year $(RIPO_t)$ Log turnover over the year $(TURN_t)$	Principal Component Analysis
Brown and Cliff (2004)	US	1965 – 1998 1987 – 1998	**Market performance** Ratio of the number of advances to declines standardized by their respective volumes $(ARMS_t)$ Number of new highs to new lows (HI/LO) **Type of trading activity** Percent change in margin borrowing $(\Delta MARGIN)$ Percent change in short interest $(\Delta SHORTIR)$ Ratio of short sales to total sales $(SHORTSLS)$ Ratio of specialists' short sales to total short sales $(SPECIAL)$ Ratio of odd-lot sales to purchases $(ODDLOT)$ **Derivative Variables** Ratio of CBOE equity put to call (PUT/CALL) Expected volatility relative to current volatility (VOL_t) **Others Sentiment Proxies** Closed-end fund discount $(CEFD)$ Net purchases of mutual funds $(FUND\ FLOW)$	Kalman Filter Principal Component Analysis

			Proportion of fund assets held in cash ($FUNDCASH$) Initial public offering first day returns ($IPORET$) Number of offerings ($IPON$)	
Hudson and Green (2005)	UK	1996 – 2011 Weekly data	Advances to Declines ratio (AVDC) Closed-end fund discount (CFED) Money Flow Index (MFI) Put–call Trading Volume ratio (PCV) Put–call Open Interest ratio (PCO) Relative Strength Index (RSI) Realized Volatility (VOLA) Trading Volume (VRA)	Principal Component Analysis

Appendix 6 – Patterns of IPO returns

Consistent with this idea of higher first day returns and long run underperformance, De Long et al. (1990) and Daniel et al. (1998) defended that, in an initial phase, there are overreaction to the information due to positive feedback trading (De Long et al., 1990) or overconfidence of investors (Daniel et al., 1998), causing an increase in the stock prices. The overreaction to information about growth expectations is well common as IPO firms cannot access past accounting statements (Daniel et al., 1998), but in the long run, prices reverse to fundamentals, due to the public information they access. As information about the fundamental value of the company becomes available, e.g., through quarterly earnings reports or insider selling around the expiration of the lock-up period, prices should become better aligned with fundamentals (Ofek and Richardson, 2003). Here, the reverse happens due to the continue overreaction. Miller (1977) pointed that over optimist investors will buy the stocks initially and the strong demand lead to their overvaluation. Then, as time passes, pessimists start to sell, reducing the stock prices which approximate fundamentals. One explanation for the positive abnormal returns in the early aftermarket period is related with the overvaluation that IPOs suffer or with fads in the initial aftermarket trading, which was also studied by Aggarwal and Rivoli (1990).

Appendix 7 – FTSE 100 Index



During the period from 2004 to the end of 2016, there is evidence of a bull market from 2004 to 2008 and a bear market from 2008 to 2009, following the financial crisis. Thereafter, there is a bull market which started in early 2009 and extends over a long period of time. Between April 2015 and February 2016, there is a fall of 22% in the FTSE 100 (7100 to 5537), this is a short bear market, followed by a bull market and, because of that, some investors ignore it, considering just one very long bull market, since 2009.

Appendix 8 – Correlation Matrix

	SENT	NIPO	AGE	MCAP	GPROC	URANK	CAPRET	TECH	BULL	PRE CRISIS	CRISIS
SENT	1.0000										
NIPO	0.4282	1.0000									
AGE	0.0306	-0.0303	1.0000								
MCAP	-0.0227	-0.3679	0.1224	1.0000							
GPROC	0.0196	0.3760	-0.1362	-0.8795	1.0000						
UNDRANK	-0.0072	0.0347	0.0233	0.3835	-0.4034	1.0000					
CAPRET	-0.0606	-0.2421	-0.0050	0.1060	-0.0773	-0.0739	1.0000				
TECH	0.0045	-0.0233	0.0029	-0.0346	0.0844	0.0346	0.0901	1.0000			
BULL	0.1795	0.1928	0.0261	-0.0184	0.0512	0.0548	-0.1280	-0.0543	1.0000		
PRE_CRISIS	0.1362	0.8691	-0.0786	-0.3816	0.4032	0.0374	-0.2898	0.0048	0.1858	1.0000	
CRISIS	-0.3378	-0.3003	-0.0049	0.0682	-0.0967	0.0679	0.0998	-0.0279	-0.1729	-0.3201	1.0000

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