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An Investigation of Underpricing and the Role of Clusters in Initial Public Offerings in the UK.

A dissertation submitted to Waterford Institute of Technology in fulfilment of Doctor of Philosophy Degree.

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"We are only beginning to understand…a communication system which we call the market and which turns out to be a more efficient mechanism for digesting dispersed information than any man has deliberately designed."

Friedrich A. von Hayek

Declaration of Authenticity

I declare that this dissertation is wholly my own work except where I have made explicit reference to the work of others. I have discussed, agreed and complied with whatever confidentiality or anonymity terms of reference were deemed appropriate by those participating in the research.

Oksana Akhmadzyanova

October 2019

Dedication

To my Mum, Irina Akhmadzyanova, who through her childhood dream of being able to go to school, and unrealised aspiration of being able to continue her education further, inspired me to reach high and achieve the highest level of academic education.

Dear Mum, this dissertation is for you! Please be proud of who you are, how much you have given to all of us and please acknowledge that all our achievements are your achievements and our dreams are reality thanks to you!

Дорогая и Любимая моя Мама! Эта докторская написана для тебя, из-за тебя и ради тебя. Пожалуйста, гордись собой, гордись тем, как много ты нам дала! И знай и поимни, что все наши заслуги – это твои заслуги, все наши реализованные мечты стали реальностью благодаря тебе. Все наши взятые вершины, взяты благодаря твоей любви и твоей вере в нас.

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Abstract

An Investigation of Underpricing and the Role of Clusters in Initial Public Offerings (IPOs) in the UK.

The concept of efficiency is central to finance as it relates to the primary role of capital markets, the efficient allocation of capital. The persistence of anomalies in stock markets, such as the abnormalities relating to the equity trading: the underpricing, the long-term underperformance of the new issues, and the waves in the issuing activity contradicts the efficient market hypothesis and causes continuous debate. Furthermore, the behaviours and roles of the different groups of market participants involved in the IPO process are constantly being questioned and analysed. Understanding these behaviours can help avoid speculations leading to losses, and, thus, devise an appropriate wealth management strategy.

To this end, this dissertation investigates the three anomalies relating to the IPO settings and IPO performance in the UK market: short-term underpricing, long-term underperformance and clustering of new issues. Furthermore, it aims to fill the research gap relating to the formation and development of IPO clusters by analysing factors facilitating the creation of a wave and examining how investment and issuing decisions are affected by the stage of a wave development.

The dissertation shows that the performance of IPOs in the UK is changing. The average level of IPO underpricing is 19 percent and it is primarily driven by the AIM market with the average IPO underpricing on that market of 21 percent. It is higher for local offerings and is reduced with geographical dispersion of the investor base. Also, the IPO issuance follows highly seasonal patterns. The findings indicate that the majority of the waves begin in just two periods: quarter one or quarter four. The study identifies innovation and technological change as the most influential factors in facilitating a wave. Additionally, the changing role of underwriters in the overall process and in marketing of IPOs depending on the prevailing market conditions is illuminated. Furthermore, the study draws attention to the quality of issuing firms, suggesting that firms having an IPO issued during a wave are more likely to delist or bankrupt than those issued out of the wave or as pioneering IPOs.

The study concludes that the issues of uncertainty, informational asymmetry among market participants, and the role of underwriters in the IPO process remain critical. The quality of the disclosed information, the seasonality of the IPO patterns, the IPO marketing strategy, the industry characteristics, the use of price as an incentive or a reward, and the use of IPO proceeds should be implemented as guidelines in designing the regulatory requirements for the IPO process.

List of Abbreviations

AAR	-	Average Abnormal Returns
AIM	-	Alternative Investment Market
BHAR	-	Buy-and-Hold Abnormal Returns
CAPM	-	Capital Asset Pricing Model
CAR	-	Cumulative Abnormal Returns
CEO	-	Chief Executive Officer
CFO	-	Chief Financial Officer
D&O	-	Directors and Officers
DR	-	Depository Receipt
EMH	-	Efficient Market Hypothesis
FSA	-	Financial Services Authority
FSMA	-	Financial Services and Markets Act
FTA	-	Financial Times Actuaries All Shares (index)
FTSE	-	The Financial Times All Share Index
HGSC	-	Hoare Govett Smaller companies (index)
IPO	-	Initial Public Offering
LSE	-	London Stock Exchange
M&A	-	Mergers and Acquisitions
MM	-	Main Market
MNC	-	Multinational Companies
MOL	-	Model of Observational Learning
NYSE	-	New York Stock Exchange
OL	-	Official List
R&D	-	Research and Development
RAST	-	Returns Across Securities and Times
RIE	-	Recognised Investment Exchange
RQ	-	Research Question
S&P	-	Standard & Poor (index)
SAD	-	Seasonal Affective Disorder
SEC	-	Securities and Exchange Commission
SEO	-	Seasoned Equity Offering

UK	-	United Kingdom
UKLA	-	UK Listing Authority
US	-	United States (of America)
USM	-	Unlisted Securities Market

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Chapter 1

INTRODUCTION

"Every once in a while, the market does something so stupid it takes your breath away."

Jim Cramer

CHAPTER ONE – INTRODUCTION

The thesis investigates underpricing and the role of clusters in the Initial Public Offering (IPO) market in the UK for the period of 1984-2016. The study will examine the initial and aftermarket performance of the new issues, the swings in the number of IPO transactions leading to IPO clusters and waves, the role of informational cascades in formation of those clusters and the potential factors influencing the development of an IPO wave. The objective of the first chapter is to provide the background and motivation for undertaking the research, introduce the concept of efficient markets and behavioural finance framing the context of the research. From this follows the rationale for investigating the new issue markets and anomalies currently present in the stock markets and particularly in the IPO settings. The chapter also presents the research objective and questions and provides an overview of the adopted methodology. Additionally, it outlines the contributions of the study, and presents the structure of the research.

1.1 Research context

The background of the investigation introduces the contextual settings underpinning this study. Anomalies currently existing in stock markets contradict the concept of market efficiency and thus require alternative explanations. A great number of research articles based both on the Efficient Market Hypothesis (EMH) tradition and the postulates of Behavioural Finance have attempted to explain these contradictions and the behaviour of market participants. Nonetheless, the field still remains one of the most exciting areas of economic and financial research.

The primary role of the capital market is allocation of ownership of the economy's capital stock. Selling stock to the general public is one important method by which firms get access to new equity capital. If the firm sells stock for the first time to the general public, it is called an Initial Public Offering (IPO). Subsequent to the IPO, firms may seek to raise further equity capital by offering to sell new shares through a Seasoned Equity Offering (SEO).

The term 'efficiency' denotes two facts. One is that investors have complete information and maximise their expected utility, i.e. they have no opportunity of obtaining abnormal profits from capital market transactions and cannot beat the market. The other is that security prices are rational, reflecting in a complete and rational manner all available information, therefore, representing the best estimate of the value of an asset. When an investor is aware of some information on the fundamental value of the share, he reacts to it quickly driving the offer price up if the news is ‘good’ or down if the news is ‘bad’. The hypothesis has its roots in the 1960s when most of the research studies considered the capital markets to be efficient, starting with Fama (1965) and Samuelson (1965) and is based on the Modigliani and Miller (1958) theorem on capital structures, the Sharpe-Linter capital asset pricing theorem, Markowitz (1952) portfolio selection theory, and Black and Scholes (1973) theorem of option pricing.

The EMH differentiates between three forms of efficiency: weak, semi-strong, and strong forms. In the weak form, the EMH confines itself to historical information about the share price implying that adjustment of the share price in response to the new information cannot be predicted from the past price movements and the price assumes the characteristics of the random walk. In the semi-strong form, the EMH claims that markets reflect all relevant publicly available information by moving a price to the new equilibrium revealing the change in supply and demand caused by the emergence of the news. In its strongest from, the EMH states that all information relevant to the value of the share, publicly available and privately held, is quickly and accurately reflected in the market price of an asset.

In the real world of investment, however, there are obvious arguments against the EMH. There are investors who have beaten the market, there are portfolio managers who have better track records than others, and there are investment houses with more renowned research analysis than others. Many of the disputes around the efficiency of the markets are linked to a series of abnormalities. For example, calendar anomalies suggesting higher average yields in certain calendar periods compared to others (‘weekend effect’, ‘month change effect’, ‘Halloween effect’) or fundamental anomalies referring to inconsistencies in trading financial instruments and to the elements of fundamental analysis (‘the momentum effect’, ‘the contrarian effect’, and ‘the size effect’).

Anomalies in financial markets are empirical results that seem to be inconsistent with maintained theories of asset-pricing behaviour. They indicate either market inefficiency (profit opportunities) or inadequacies in the underlying asset-pricing model (Schwert, 2003). The 1841 book of Charles Mackay, Memoirs of Extraordinary Popular Delusions and the Madness of Crowds, documents numerous examples of historic bubbles and manias that swept entire nations in search for quick and effortless gains.

The behavioural finance discipline was born out of the lack of evidence to support extant traditional finance explanation of these anomalies. In contrast to the classical assumptions of the EMH, behavioural finance studies show that investors are acting on the basis of emotional and instinctive components and are not necessarily optimizing and rational. The behavioural approach is informed by three strands of psychology. The first is cognitive psychology with focus on the process of how the wealth maximising decisions are made. The second is emotional response to the intensity of trading with focus on the decisions-making process being more than a strictly calculative process. The third is the social psychology which recognises the need to find acceptance and even encouragement of the chosen course of action (DeBondt *et al.*, 2010).

The main behaviours that may generate errors in decision-making are overconfidence (the attitudes of overestimation of their own abilities), anchoring (the tendency to cling to the original figures and reluctance to change the initial ideas on the basis of new data), representativeness (the tendency to make decisions on the basis of stereotypes), availability (the tendency to make decisions depending on the ease with which examples and associations come to mind of the individual), loss aversion (the asymmetry of individual behaviour in the treatment of losses compared to gains), under- and over-reaction (the tendency of prices of securities to "under-react" to the new information in the short term and to "over-react" to the new information in the long-term), conservatism (a resistance to change), and aversion to ambiguity (the typical attitude of individuals to refuse ambiguous situations).

According to Shefrin (2001), psychological forces intervene with the traditional paradigm. He identifies two key behavioural barriers, internal and external, to the process of value maximisation. The internal barrier, behavioural costs or losses in value associated with errors due to managers' cognitive imperfections and emotional influences, weakens value creation. The external barrier, behavioural errors by analysts and investors, leads to incorrect risk pricing by managers and gaps between fundamental values and market prices.

There is an underlying moral reality here: techniques of the behavioural psychology can be harnessed for good and for bad. It is useful not only in learning how to manipulate consumers (investors) but also for understanding damaging corporate behaviour.

1.2 Research rationale

In general terms, the ideal is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production-investment decisions and investors can choose among the securities that represent ownership of firms' activities under the assumption that security prices at any time "fully reflect" all available information (Fama, 1970). However, watching new issues in recent years has been like observing a game between different groups of market participants. The rollercoaster of price changes for the companies, such as Zynga, Groupon, and most notably Facebook, inevitably lead to questioning the mechanism of and the reasoning behind the price setting of a new issue.

There is little doubt that IPOs and SEOs are significant events in the life of a firm. Equity trading, buying and selling of company shares is possible through various stock exchanges such as the New York Stock Exchange, the London Stock Exchange or others. It has become increasingly common and is considered the most important element of the share market. More companies choose to enlist because of the increased possibility to grow larger, owing to the increased availability of new funds that the numerous shareholders offer. The exact underlying cause for issuing new shares might differ between companies; however, there is one common denominator, the need of funds.

Several advantages are associated with issuing equity for public, although it imposes costs as well. One of the most important benefits is the opportunity to raise capital necessary for funding the firm’s investment opportunities, expansion and growth or to cover debt repayments. However, a major cost for an equity-issuing firm is the cost associated with adverse selection. Adverse selection costs are indirect costs a firm pays to compensate for the existing information asymmetry. For IPOs they come in the form of underpricing (significant increase of the IPO market price over the first few days after the initial listing).

In the traditional approach to finance managers are urged to act as if agents are rational and markets are efficient. Under these conditions, all decisions-makers act in a rational manner, markets have no ‘memory’, and a stock’s past prices are no indication of its future price behaviour. In reality, psychological phenomena prevent decision-makers from acting in a rational manner and market prices are regularly at odds with fundamental values. In relation to IPO markets, researchers point out three behavioural aspects that involve market memory and are inconsistent with the EMH. The first anomaly is the initial underpricing of the new issues resulting in the short-run abnormal returns. The second anomaly is the long-term underperformance (due to initial mispricing). The third anomaly is the hot/cold issue markets relating to significant swings in IPO activity.

The first anomaly, the *underpricing phenomenon*, represents the most researched IPO anomaly found by scholars. It refers to the statistically and economically significant positive initial returns of IPOs over the first few days (or just the first day) after the initial listing of the shares. Given the large degree of uncertainty regarding the true value of the newly listed shares, some significant degree of mispricing is to be expected. However, the typically large price increases of IPO shares in the immediate post-listing period suggest that IPOs are systematically underpriced. This anomaly was initially documented in the late 1960s in the US market by Reilly and Hatfield (1969) who found that from 53 sample firms that went public from 1963 to 1965, the initial (first-day) return ranged from 18.3% to 20.2%. In the years following the first paper, other researchers also discovered much the same underpricing phenomenon in other countries.

The second anomaly, the *long-run underperformance* of IPO shares was first documented by Aggarwal and Rivoli (1990) who find evidence of substantial negative abnormal returns over longer time horizons. By examining the returns of IPO firms after the first 250 trading days, they show that on average, the returns of IPO firms underperform the market index by 13.73%. Like underpricing, the IPO long run underperformance also exists in other markets. Levis (1993) claims that in the UK IPOs underperform the market on average by 8% to 23% after a three-year period. Studies of the aftermarket performance of IPOs provide inconclusive results. The biggest adjustment of IPO underpricing takes place in the first year. When a company offers shares in an initial public offering, insiders typically enter into a so-called lock-in agreement. Since the details of lock-in agreements including the expiry dates are public knowledge at the time of the IPO, no price impact is expected around the unlock date. Contrary to the theoretical predictions, negative abnormal returns following the lock-in expiration have been documented.

The third anomaly is the *hot/cold market*. This phenomenon was first documented in the US by Ibbotson and Jaffe (1975). According to the efficient market hypothesis, the timing of a financing decision should not matter since any offering will be fairly priced. This leads to the conclusion that IPOs occur randomly over time. However, evidence shows that there are substantial time-varying fluctuations in IPO activity in several international markets leading to IPO clusters. Although this phenomenon is very interesting, very few explanations have been suggested. The reasons or drivers of these swings are still under-investigated. To analyse the stages in the formation of an IPO cluster and to understand what initiates these swings in IPO activity, this study introduces a more formal definition of an IPO wave that has been adopted from the literature on the merger and acquisitions waves. An IPO wave is defined as '*a period of intense IPO activity separated by lengthy intervals of very low activity*' (based on Nelson (1959) and McNamara and Haleblian (2008) and Gärtner and Halbheer (2009). This definition formally describes an IPO cluster and relates it to the generally accepted ideas of cyclicality in IPO issuance activity. It also confirms the reference to the 'hot' IPO markets by Ibbotson and Jaffe (1975), Ritter (1984) and later research by suggesting two distinct states of IPO activity; 'high' and 'low'.

The existence of these waves in IPO activity adds a puzzling question to the IPO literature (Ibbotson *et al.*, 1994; Lowry and Schwert, 2002). According to Pagano *et al.* (1998), these fluctuations in equity issuance could not be attributed to the variations in investment opportunities and capital expenditure. Their study finds that most IPOs are firms without the need for urgent funding and, even more puzzling, their investments decrease after the issue. Conceptually, these changes in the IPO activity are related to 'market timing' resulting in 'hot issues markets', i.e. the time-varying fluctuations in the number of IPOs causing 'hot issues' and 'cold issues' markets are associated with the tendency of firms to time their share issues at the same time creating IPO clusters leading to formation of IPO waves.

There is evidence for equity market timing in four different kinds of studies. First, analyses of actual financing decisions show that in periods of high market values, companies tend to issue equity instead of debt, and in periods of low market value, they tend to repurchase equity. Both initial public equity and seasoned equity issues coincide with high valuation and repurchases coincide with the low valuation periods[1].Second, analyses of long-run stock returns following corporate finance decisions show that equity market timing on average is successful. Firms issue equity when the cost of equity is relatively low and repurchase equity when the cost is relatively high. Third, analyses of earnings forecasts and realisations around equity issues suggest that firms tend to issue equity at times when investors are rather too enthusiastic about earnings prospects[2].

Fourth, and perhaps most convincing, in anonymous surveys managers admit to market timing (Baker and Wurgler, 2002). Graham and Harvey (2001) surveyed 392 chief financial officers (CFOs) about the cost of capital, capital budgeting, and capital structure. They find that two-thirds of CFOs agree that the amount by which stock is undervalued or overvalued is an important or very important consideration in issuing equity. The survey shows that equity market prices are regarded as more important than other factors considered in the decisions to issue common stock, and more important than all other factors considered in the decisions to issue convertible debt.

Over decades, these IPO puzzles have inspired a large body of theoretical and empirical literature that has offered a wide range of interpretations and analyses of the anomalies; however, these phenomena are still a subject of intense debate. While the evidence for the second and third anomalies (the long-run underperformance and hot markets) is mixed, scholars have observed the persistence of the underpricing. Ritter and Welch (2002) indeed argue that the explanations behind the IPO anomalies lie between the offering day and the first trading day. Some studies even suggest that the IPO long-run

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[1]Seasoned equity issues: Taggart (1977), Marsh (1982), Asquith and Mullins (1986), Korajczyk, Lucas, and McDonald (1990), Jung, Kim, and Stulz (1996), Hovakimian, Opler, and Titman (2001). Initial public equity issues: Loughran, Ritter, and Rydqvist (1994), Ikenberry, Lakonishok, and Vermaelen (1995), Pagano, Panetta, and Zingales (1998).

[2]See Loughran and Ritter (1997), Rajan and Servaes (1997), Teoh, Welch, and Wong (1998a, 1998b), and Denis and Sarin (2001).

underperformance is a mean reversion of the underpricing (Ritter, 1991). Other studies also examine the relationship between the hot market and the underpricing and find that there is a significant difference in the degree of underpricing between the 'hot' and the 'cold' period in the market (Ibbotson and Jaffe, 1975).

Traditional finance offers asymmetric information and signalling theories as possible explanations; however, these models appear to play a limited role in understanding and linking these phenomena. Recently, it has been argued that if the IPO decisions are behaviourally timed to coincide with the periods of high investor optimism and favourable market conditions, then the main empirical implication is the poor post-issue stock performance, i.e. post-issue returns will be poor following the high optimism and high IPO volumes as investors realise their mistakes in overpaying for the shares (Ritter, 1991; Lowry, 2003). Consequently, an alternative way to empirically test the behavioural timing theory is to examine the IPO performance in and out of IPO waves.

1.3 Research objective, research questions and research methodology

The objective of the study is to investigate the clusters in IPO markets through examining the initial and aftermarket performance of IPOs and the role of informational cascades in IPO waves in the UK during the period of 1984-2016. To address this objective three main research questions have been identified:

1. Research Question 1: What is the performance of IPOs in the UK market and what are the potential factors influencing it?
2. Research Question 2: Are there IPO waves in the UK market?
3. Research Question 3: How IPO waves are formed?

The analyses of *IPO performance* in the UK market is carried out through three research sub-questions addressing the short-term underpricing, the aftermarket performance of IPOs, and the potential factors influencing IPO underpricing. They are:

(i) RQ 1a: Is there evidence of IPOs underpricing in the UK?
(ii) RQ 1b: What is the aftermarket performance of IPOs in the UK?
(iii) RQ 1c: What are the factors influencing IPO underpricing in the UK?

The levels of underpricing are calculated for the first day of trade and one calendar week after the offer date. The findings for the UK market are then compared to the previous research. The aftermarket performance of IPOs is analysed through calculating Cumulative Abnormal Returns (CAR). To reflect the change in IPO performance the timeframe for measuring aftermarket returns is set at one month (30 calendar days) following the IPO date and six months (180 calendar days). For the purpose of this study three factors that potentially influence ex-ante uncertainty and underpricing have been identified: (i) size of the firm, (ii) reputation of the employed underwriter, and (iii) offer price. The relationship between these factors and IPO underpricing is examined though a regression analysis.

To investigate *IPO waves* in the UK market, three research sub-questions are examined:

(i) RQ 2a: Is there evidence of IPO waves in the UK?
(ii) RQ 2b: When do IPO waves occur in the UK?
(iii) RQ 2c: What industries are more prone to the IPO waves?

To analyse the evidence of IPO waves in the UKthe methodology for the wave identification has been adopted from the research in the mergers and acquisitions (M&A) literature. Carow *et al.* (2004) and McNamara and Haleblian (2008) offer a comprehensive technique for wave identification that takes into account not only the periods of 'hot' and 'cold' markets, but also the comparison between new issues that took place in and out of IPO waves and also the dynamics of IPO activity within a wave. For a more detailed picture of the IPO activity within a wave, IPO transactions measured by yearly monthly and quarterly intervals were added to the analyses. Jain and Kini (2006) identify industry conditions that influence IPO clustering and find that IPO clustering is more likely to occur in high-growth and fragmented industries characterised by strong investment opportunities, favourable investor sentiment and higher requirement of investment in research and development (R&D). The process of wave identification by industry follows the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008) as mentioned earlier. Monthly and quarterly overviews of the IPO transactions are added to the analyses for a more detailed picture. The occurring waves then are examined according to the industry characteristics.

To answer the last question of the research, how IPO waves are formed, it is necessary to examine what facilitates the formation of an *IPO cluster*. In order to analyse this, the research question is broken into three sub-questions:

(i) RQ 3a: Is there evidence of market timing in the UK?
(ii) RQ 3b: What are the potential factors initiating an IPO wave?
(iii) RQ 3c: What are the characteristics of pioneering IPOs?

Relations between the number of IPOs and external factors have been investigated by many researchers. For example by Loughran *et al.* (1994) review the IPO timing in fifteen countries in relation to inflation-adjusted stock price indexes and GDP growth rates. Breinlinger and Glogova (2002) investigate the explanatory power of selected macroeconomic factors influencing IPOs by analysing a data set of annual IPO volumes for six developed continental European countries over a time period of 18 years. The authors investigate for stable indications that IPOs depend on stock index returns. Peterle and Berk (2016) report on the incentives for IPOs in the CEE in the 2000s and proved that IPO cycles in the region exist. The authors suggest that IPO activity is driven by macroeconomic conditions and the investor sentiment.

Benveniste *et al.* (2003) argue that a firm's decision to complete or withdraw its IPO is influenced by the indirect learning from a prior IPO. According to Draho (2000), IPO clusters form due to informational cascades and as a consequence of informational externalities. An informational cascade relates to the observational learning in which the observation of others is so informative that an individual's action does not depend on his own private signal. An informational cascade forms when the spillover information dominates the issuer's private information on the expected value of the IPO. When this happens, potential issuers, after seeing a few successful IPOs, decide to proceed with an IPO irrespective of their initial expectations forming an IPO cluster and the subsequent IPO wave. Once this informational cascade starts, subsequent issuers blindly follow their predecessors.

The potential factors influencing the formation of a wave have been identified based on the previous research. Studies have shown that IPOs tend to cluster because of prior underpricing (Lowry and Schwert, 2002) and underwriters' ability to bundle IPOs (Benveniste *et al.*, 2002). Benveniste *et al.* (2003) find evidence that indirect learning from a prior IPO influences a firm's decision to complete or withdraw its own IPO and determines how the offer is priced relative to prior expectations. To analyse the stages in the formation of an IPO cluster and to understand what initiates a wave a number factors potentially influencing the formation of a wave have been identified. In order to understand the influence of these factors on the formation of an IPO wave, each of the factors has been examined separately and jointly through multivariate probit regression models.

A quantitative approach is adopted to address the research questions. Descriptive statistics, independent samples test, univariate analysis and multiple regressions are used to address the relevant research question.

1.4 Research contributions

The contribution of this study is set at academic and practical levels. From an academic perspective, this study adds to the existing evidence on IPO performance in general and to the existing evidence on IPO waves, informational cascades in particular, and herding in general. Although numerous studies have been conducted on IPO underpricing in different countries, few studies have been conducted on the UK market. Furthermore, studies that address the issues of IPO performance and clustering do so from the standpoint of traditional economic theory. Few researchers base their investigation on the theories of behavioural finance. Overall, the empirical evidence on informational cascades remains inconclusive; perhaps due to the fact that while herding in general has attracted substantial attention in empirical literature, informational cascades remain an area of largely experimental research. Also, existing measures of informational cascades in financial markets have limitations that do not allow for a direct test of cascading behaviour. The current study offers a review of the main theoretical model of informational cascades and its application to the IPO settings. It also outlines the main criticisms of the original model of social learning relating to the discreteness/boundedness of the action space; externally determined sequential decision making; Bayesian rationality; and fixed price, thus ensuring better explanatory power of the findings.

Additionally, the study offers a formal definition of an IPO wave and introduces a new methodology for identifying waves in IPO markets. The technique has been adopted from the previous research in the mergers and acquisition markets and is consistent, easily replicated and objective. The suggested methodology is different to the previous attempts to define patterns in IPO issuance activity in that besides classification of IPO transactions into the periods of 'hot' and 'cold' markets it also describes different types of waves. Furthermore, the method distinguishes between different stages of a wave and offers a more detailed examination of wave formation and development through classification of the new issues according to their timing (early-movers and followers).

From a practical perspective, research provides an insight into the financial environment and workings of the stock exchanges in the UK market. It contributes to the understanding of the behaviours of market participants and investigates the role of public information and public information releases with implications for designing policies and regulatory requirements, as well as for the design of collective decision making processes. The performance of IPOs in the UK market can be used as bases for investment decisions and choice of investment strategies. Understanding the behavioural biases behind investment decisions is a necessary pre-requisite of investing in IPO markets and it can become a source of competitive advantage both for investors and issuers.

There is a number of issues and gaps both in the theoretical and empirical research that are addressed in the current research. The study differentiates between different industries and the types of issuers. It examines in detail the communication and informational exchanges between market participants, such as different types of investors and/or different financial agents. In addition, the research examines the mispricing of the new offers in and out of IPO waves and looks at the behavioural mechanisms of asset pricing.

The study is of interest to the academic practitioners and also to the active market participants: firms, investors and regulators. The research addresses a number of research gaps in the academic literature. Furthermore, by analysing the development of an IPO cluster the study can shed light on the behaviour of market participants within the cluster and also in and out of an IPO wave and provide basis for designing a regulatory framework for the IPO process.

The research also lays out the basis for the future research. Designing more accurate models and methods for empirical testing for informational cascades could provide more conclusive evidence on the matter. Furthermore, more profound research is needed on the role of information in financial markets. If information releases are manipulated in order to induce cascades and create short-term profits, then there is a greater need for information disclosure, information gathering and dissemination.

1.5 Research structure

The remainder of the thesis is organised as follows. Chapter two presents literature relating to the IPO process and an overview of the issuance mechanism in the UK. It outlines the existing evidence of IPO performance and theories explaining the anomalies relating to IPO underpricing and aftermarket performance.

Chapter three reviews research and literature surrounding the third anomaly in the new issues markets, the IPO clusters. It begins with an overview of herding and informational cascades in capital markets in general and introduces a model of observational learning. It proceeds then by relating the model to the settings of an IPO market and concludes with existing evidence on informational cascades in the equity markets.

Chapter four depicts the research questions and sub-questions and the methodology used to address these questions. It also describes the data sample and the data collection process. Additionally, it addresses the issues of data reliability and validity. The data sample of the research includes IPOs from the UK Main Market (MM) and the Alternative Investment Market (AIM) for the period of 1984 to 2016.

Chapter five reports the findings of the research. The findings are summarised in relation to the research questions. The performance of IPOs in the UK market is presented in section 5.1. The section begins with an overview of the IPO activity in the UK throughout the specified time period and proceeds with describing the levels of IPO underpricing and the aftermarket performance of IPOs in the UK. The findings are classified by the type of offer and by industries sectors. Subsection 5.1.3 summarises the findings relating to the potential factors influencing the levels of IPO mispricing in the UK. Section 5.2 reports the findings relating to the evidence of IPO waves in the

UK. It identifies patterns in IPO issuance according to the type of offer and examines these patterns for different time intervals (yearly, quarterly, and monthly). Subsection 5.2.3 examines IPO issuance activity by industry sectors and identifies industries more prone to IPO waves. Section 5.3 depicts findings relating to the formation of a wave.

Chapter six provides detailed and in-depth discussion of the empirical findings of the research. The layout of the chapter follows the research questions. Section 6.1 discusses the changing nature of the performance of IPOs in the UK outlining that levels of IPO mispricing are different for different types of offers and for different industries. Underpricing is higher for local offerings and is reduced with geographical dispersion of the investor base. The section also states that traditional theories based on EMH and information asymmetry do not provide the explanation for the levels of IPO mispricing in the UK. Section 6.2 highlights the seasonality in the patterns of IPO issuance and describes the characteristics of industries more prone to informational cascades and IPO waves. Section 6.3 discusses how the IPO waves are formed and what are the potential factors influencing it. The findings point to the importance and the influence of the underwriter and the underwriter’s reputation in the process.

Chapter seven, the final chapter, restates the main objective of the research, outlines the main findings, and addresses the implications of the research for different groups of practitioners and academics. It also outlines the limitations of the research and suggests avenues for future investigations.

1.6 Chapter summary

The introductory chapter presented the context and the rationale for the investigation. It highlighted the existing anomalies in the stock markets and the ongoing debate between the traditional school of thought and the behaviouralist approach in finance. Explaining the core concepts of both is crucial in understanding the nature of stock markets and the behaviour of market participants. This section of the thesis also introduced the overall research objective and research questions sought to be answered and highlighted the potential contributions of the thesis. It concluded with summarising the structure of the dissertation.

Chapter 2

INITIAL PUBLIC OFFERING (IPO) PERFORMANCE

"In investing, what is comfortable is rarely profitable."

Robert Arnott

CHAPTER TWO – INITIAL PUBLIC OFFERING (IPO) PERFORMANCE

The chapter presents an overview of the Initial Public Offering and the IPO short-term and aftermarket performance. It begins with the overview of the IPO process and the motivations for going public, followed by the description of IPO clusters and the pricing of the new issues. Evidence of IPO performance is also reviewed. The last section of the chapter provides an overview of the traditional and behavioural theories of the initial IPO underpricing and the aftermarket performance.

2.1 Initial Public Offering Overview

The overall objective of this research is to investigate the pricing and performance of new offers in IPO clusters. The first step in achieving this objective is to understand the motivations for going public, the stages of the process, the price setting for the new issue, and the development of IPO clusters.

An Initial Public Offering refers to the first time offer of a firm's shares to the public. This process is known also as a public offering, or "going public" (Atrill, 2009). Undertaking an IPO moves a firm from the private to the public domain. As argued by Ritter and Welch (2002), the motivation to go public is stronger in some situations than in others. It is often a result of the firm's need to increase equity financing combined with the intention to develop a market where shareholders can exchange their paper wealth for cash at a later date.

2.1.1 Initial Public Offering and motivations for going public

According to Daily *et al.* (2003), there are generally two primary reasons for a firm to undertake an IPO. One is to assist the firm's initial shareholders to diversify their holdings; the second reason is to help managers in accessing the funding necessary for new projects. Managers, who often coincide with the firm's founders, typically have a significant portion of their personal wealth invested in the firm. The sale of a portion of their holdings through an IPO enables them to diversify their investment risks. Thus, both goals could be achieved simultaneously as managers divest some of their ownership interest in the firm and use the generated funds to diversify their personal portfolio and pursue new ventures at the firm level[3].

Academic literature identifies two perspectives that explain motivations to go public: (a) Life Cycle argument and (b) Market-Timing argument. According to the life-cycle argument, early in its life cycle a firm is privately-owned, but once it grows sufficiently large it becomes optimal for the firm to go public. IPOs are also often used as exit strategies by entrepreneurs. Market-timing perspective argues that IPOs are initiated by firms in accordance with the bull and bear market trends (Ritter and Welch, 2002). Table 2.1 summarises the main arguments of the two perspectives.

In general, the timing of the offer is determined by the macroeconomic environment, business cycles, and stock market phases (Atrill, 2009). However, decisions to go public are primarily based on the actual capital requirements and growth plans of a firm. Arkebauer (1991), cited by Daily *et al.* (2003), finds that the need to generate additional revenue in order to fund new projects dominates portfolio diversification. As entrepreneurs routinely reach a point where a further increase in their own or the firm's debt is problematic, they turn to an IPO. This enables them to pursue growth opportunities that they would otherwise be unable to fund. For many entrepreneurial ventures, even though additional commercial credit is available, the restrictions attached to the loan may hinder the entrepreneur's ability to pursue high-growth but also high-risk opportunities (Rock, 1986; Pagano *et al.*, 1998). Thus, an IPO is beneficial in serving the dual purpose of reducing the debt to equity ratio of a firm and providing necessary funds (Daily *et al.*, 2003).

Although public listing results in many indirect advantages, such as the raised capital, different shareholder structure, increased publicity of the firm, there are costs associated with these benefits. Ljungqvist *et al.* (2006) point out that as companies become public they face increased responsibilities concerning transparency and disclosure obligations.

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[3]There are limits on the amount of equity that the firm owners can sell at the time of IPO. Lock-up provisions restrict owners for a certain post-IPO period from selling some portion of their equity (Lange, Bygrave, Nishimoto, Roedel, and Stock, 2001). Also, the amount of equity sold at an IPO by the owners is limited due to the negative signalling that the sale of large portions of the owner's equity sends to the potential investors (Daily *et al.*, 2003).

Investors require information concerning the business operations and management on a regular basis. Ritter (2003) highlights legal, auditing and underwriting fees as direct costs of the IPO process. Indirect costs include the manager's time and efforts required to organise the initial listing, and the expense of underpricing.

Table 2.1: Academic perspectives on motivations for IPOs
The table presents the two main theoretical arguments of the motivations to go public.

Argument	Description
Life Cycle Argument	Entrepreneurs use IPOs to facilitate the acquisition of their firm for a higher value than what they would get from an ordinary sale (Zingales, 1995). IPOs are used as exit strategies for venture capitalists and for entrepreneurs (Black and Gilson, 1998). IPOs allow more dispersion of ownership. Initial 'angel' investors hold undiversified portfolios and are not willing to pay as high prices as diversified investors. Therefore, early in life cycle a firm is private and if (when) it grows sufficiently large going public becomes optimal (Chemmanur and Fulghieri, 1999). Public trading in itself can increase status and credibility of the firm for investors, customers, creditors, suppliers. It has the potential to add value to the firm (Maksimovic and Pichler, 2001).
Market-Timing Argument	Managers postpone the equity issue if they believe that their firm is currently undervalued (Lucas and McDonald, 1990). Managers avoid having an IPO in the period where few other good-quality firms have initial issue (Choe *et al.*, 1993). Entrepreneurs respond to the growth opportunities signalled through the information provided by the markets, such as higher prices (Subrahmanyam and Titman, 1999). Entrepreneurs adjust their valuation with a lag as their sense of enterprise value is derived from their day-to-day involvement with the business and internal perspective rather than from the markets (Ritter and Welch, 2002).

IPOs carry potential risks for both issuers and investors. Issuers may miscalculate the value of the firms and the optimal timing of the offer. The amount of capital raised through the IPO may be less than expected. The ownership control may be diluted through the different post - IPO shareholding structures of the firms. Investors, on the other hand, have limited access to historical data on the firms and may also incorrectly assess their values (Atrill, 2009). Moreover, the majority of IPOs are firms going through a transitioning stage and there is high uncertainty about their future value. On the other hand, stock markets pre- and post- IPO can be very erratic and volatile, which in short period of time may lead to either unexpected profits or unexpected losses (J. Ritter, 2003).

2.1.2 IPO Process

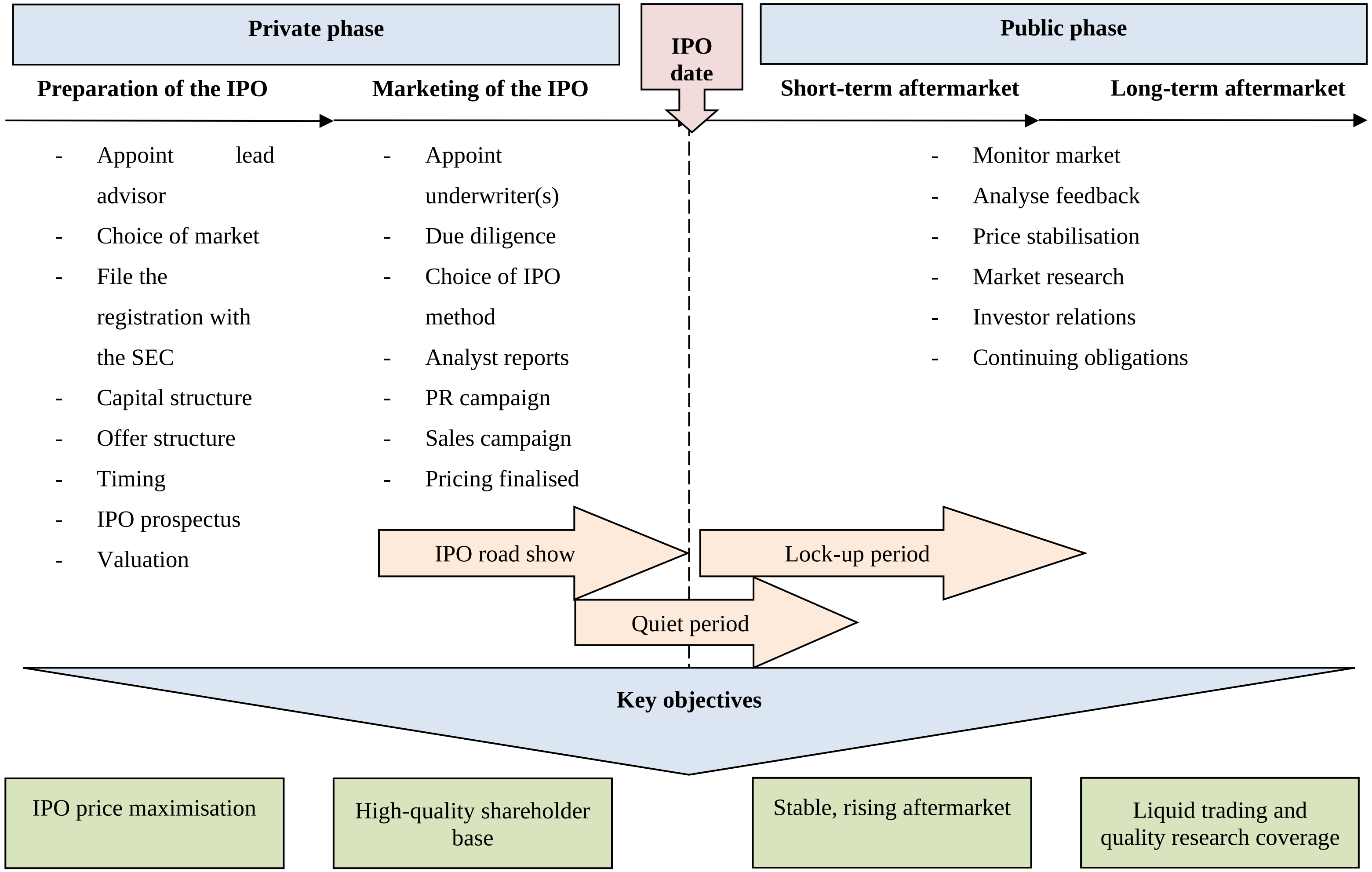
Issuance of publicly traded stock is a milestone for any firm. While motivations for an initial public offering are straightforward, the mechanism of doing so is complex (Atrill, 2009). Figure 2.1 presents the overview of the different stages of the IPO process.

2.1.2.1 Overview of the IPO Process

A number of papers have documented the decline of fixed-price mechanisms and auctions for selling IPOs in Europe, and the growth of bookbuilding (Biais and Faugeron-Crouzet, 2002; Ljungqvist *et al.*, 2003). Biais and Faugeron-Crouzet (2002), Vandemaele (2003), and Derrien and Kent (2003) all examine the choice of mechanism for selling IPOs in France. More than any other country in the world, the French IPO market has been characterized by multiple mechanisms being used to sell IPOs without government interference in the choice. Fixed price (offre à prix ferme), auction (offre à prix minimal), and increasingly, bookbuilding (placement garanti) mechanisms have been employed by companies going public. Fixed price offerings have become uncommon in recent years, not only in France, but in other European countries as well. By fixed price mechanisms refers to contracts where the offer price is set relatively early, before much information about the state of demand is known. Loughran *et al.* (1994) show that this tends to result in a high level of underpricing.

Figure 2.1: Overview of the IPO process

The figure presents the IPO process identifying the main stages, objectives, and tasks in the preparation and the post IPO periods.



The process starts when the firm files a registration statement. IPOs can be self-administered or involve a syndicate of investment banks referred to as ‘underwriters’ who enter a contract with the issuer. The underwriters alleviate some of the risks of undersubscription, and secure the distribution of the new shares for a premium (Pilbeam, 2010). The selection process relies on the underwriters’ general reputation and expertise, as well as on the quality of its research coverage in the firm’s specific industry. IPOs can be managed by a single underwriter or by a syndicate of underwriters. When there are multiple underwriters, one investment bank is selected as the lead underwriter or book-running manager. The most common type of underwriting arrangement involved with large issues is the ‘firm commitment’ underwriting (Brau and Fawcett, 2006)[4].

According to Ritter (2003), an important difference between the European and the US practice is that class action lawsuits are common in the US, but rare in Europe. A class action lawsuit overcomes the free-rider problem where the suing party (the plaintiff) bears all of the costs but receives only part of the benefits if all shareholders are harmed. In the US, several law firms specialise in suing corporations and their officers and directors, in what are sometimes referred to as “strike suits,” where the lawyers will receive large payments if they win their case or induce a target firm to settle. If a firm does lose a suit, the shareholders lose twice. The first loss is what motivated the suit, and the second loss is from the payments made to the winning shareholders and their lawyers. Van der Goot (2003) argues that legal risk is one of the reasons that higher quality underwriters are less likely to take riskier companies public in the Netherlands.

In practice, almost all publicly traded US firms pay for insurance, known as D&O (directors and officers) insurance, to minimize the impact if they are successfully sued. The insurance premia do reflect company-specific risks. While there are many abuses with class action lawsuits, it is also true that there would be more corporate fraud and insider trading if this threat did not exist. Keloharju (1993) and others have argued that the threat of lawsuits cannot be an

[4]Underwriter's agreement to assume all inventory risk and purchase all securities for an IPO directly from the issuer for sale to the public. It is also known as "firm commitment underwriting" or "bought deal."

important motivation for underpricing in European countries like Finland where class action lawsuits are rare.

The underwriter leads the preparation of the IPO, carries out the due diligence and prepares an IPO prospectus. With the help of underwriters companies choose between different methods of going public (Atrill, 2009). There are four general IPO methods: (i) fixed-price offer, (ii) book-building method, (iii) Dutch auction, and (iv) hybrid method. Table 2.2 presents their overview.

Table 2.2: IPO methods
The table presents the overview of the four general methods of IPO.

IPO Method	Description
Fixed-price Offer	Shares are sold at a pre-determined price based on the value of the firm. However, fixed pricing has a potential of undervaluing the issuing firm (Pilbeam, 2010).
Book-building Method	The issuer sets a price range within which the investors are allowed to bid for the shares (Atrill, 2009).
Dutch Auction	The firm announces the maximum amount of shares being sold and sometimes a potential offer price. Investors then state the number of shares they are prepared to buy and at what price. Once the minimum clearing price is determined, investors who bid at least that price are awarded shares. If there are more bids than shares available, allotment is made on a pro-rata basis (Atrill, 2009).
Hybrid Method	A combination of methods. The book building/fixed price offer combination is the most commonly used. The former is used for price-setting and allocation of shares to institutional and foreign investors, while the latter is reserved for local retail investors that do not participate in the price-setting process (Pilbeam, 2010).

The underwriters also assist firms' managers in preparing the extensive paperwork involved in complying with the Securities and Exchange Commission (SEC) guidelines, including the registration statement, of which the Red Herring prospectus is a part. It is these materials that serve as the primary marketing tool for the firm's securities. Using the preliminary prospectus as a selling tool, companies engage in what is called a 'road show'. Road shows involve the lead underwriters and key firm managers marketing the firm to prospective investors (largely prominent institutional investors) via presentations in major cities and one-on-one meetings with targeted investors such as mutual/hedge fund managers. The road show is designed to assess the anticipated demand for the firm's stock and serves as a key input in the investment banker's final determination of the price at which the firm's stock will initially trade (Daily *et al.*, 2003).

When the price and offering size have been finalised and the regulatory review completed the final prospectus is filed and the selling and distribution of shares begins. Prior to the IPO date underwriters sign lockup agreements with managers, employees, and venture capitalists for the duration of lockup period (Atrill, 2009).

Once the shares start trading on the market the firm becomes a publicly traded company. The final stage of the IPO begins at the expiration of the quiet period and lasts until the expiration of the lock-up period (Ritter and Welch, 2002).

One area of research that has recently been booming is that focusing on the role of analyst conflicts of interest. In the US, issuing firms are subject to a "quiet period," whereby from the decision to go public until 40 calendar days after going public, analysts that are affiliated with underwriters are prohibited from issuing research reports or recommendations. The rationale for the quiet period is that all relevant information should be contained in the written prospectus, rather than other written documents (J. Ritter, 2003).

The reason that analysts are important is that, with few exceptions, issuing firms place great importance on favourable analyst coverage once they are public. Because of the importance of analyst coverage in the issuing firm's objective function, investment bankers have found that they can effectively compete for deals by either implicitly or explicitly committing to have a highly regarded analyst cover a stock and issue positive recommendations. Evidence in Dunbar (2000), Krigman *et al.* (2001), and other studies indicates that this desire by issuing firms is so strong that underwriters with top-ranked analysts are able to charge high direct fees (gross spreads) and leave more money on the table, and still have high market shares for IPO underwriting. Quiet period restrictions do not exist in Europe, so that both affiliated and unaffiliated analysts can and do issue research reports while an IPO is being sold, as well as immediately after going public.

The performance of IPO after the effective date is referred to as after-market performance. The underwriter has several additional responsibilities during this period. After-market price support requires the underwriter to support the stock by buying shares if order imbalances arise.

The underwriter is also responsible for the provision of analyst recommendations and for 'making a market in the stock'. By making a market in the stock, the underwriter essentially guarantees liquidity to the investors, and, thus, again increases demand for the shares (Aggarwal *et al.,* 2002).

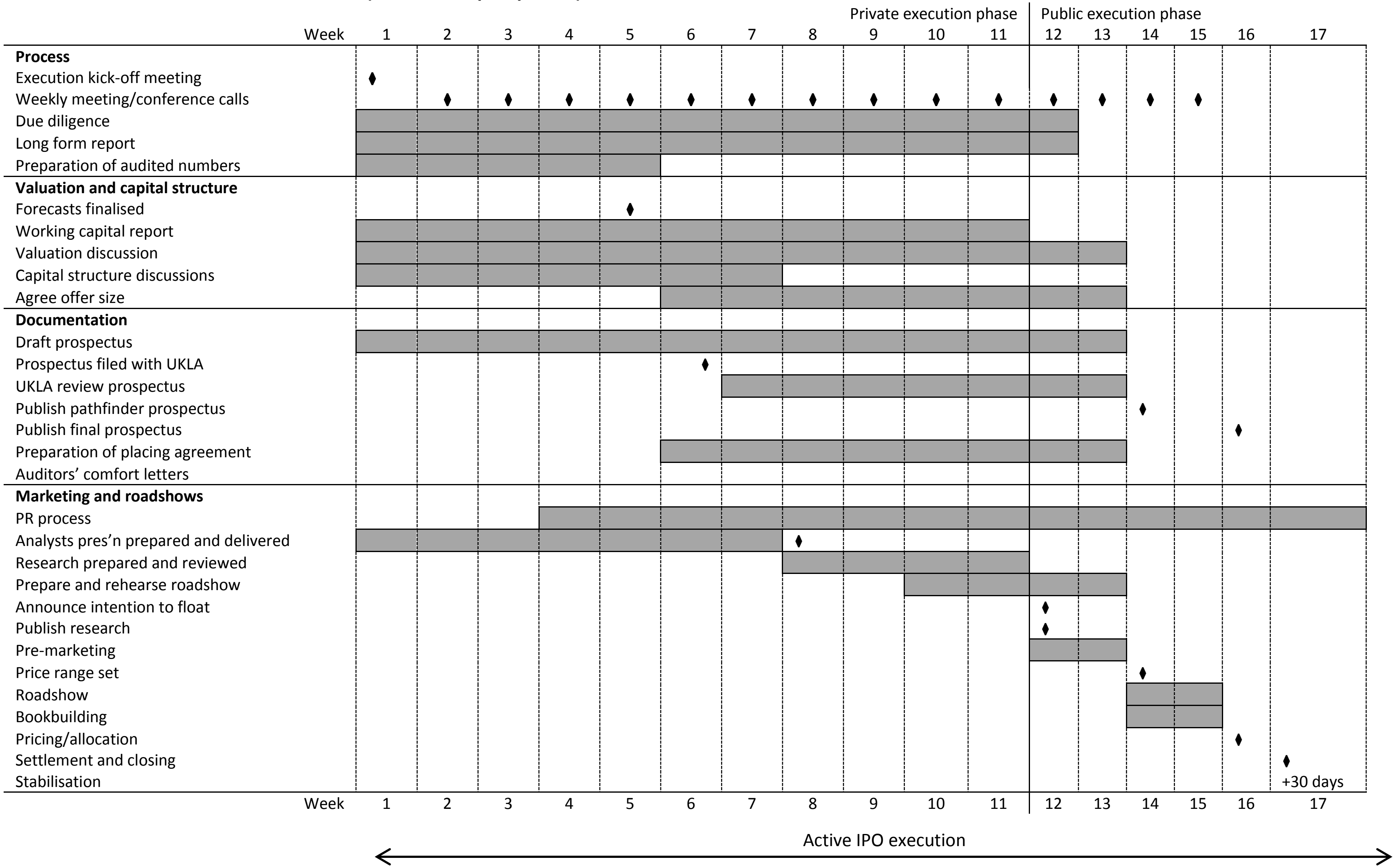
2.1.2.2 IPO process and new issues regulations in the UK

The overview of the IPO process and timetable for the UK listings is presented in figure 2.2.

Issuing firms in the UK have a choice between two principal stock markets: the Official List (or the Main Market) and the Alternative Investment Market. In terms of requirements and regulations, the Official List (OL) is the most demanding UK market. Companies choosing to place their offer through the OL are required to have a minimum of 25 percent of their shares in the public hands, a trading record of at least three years and must comply with the rules of the UK Listing Authority (UKLA). These rules are subsequently monitored by the Exchange, ensuring that shareholders are kept informed about company activities and major developments. The Official List is currently the largest and longest established market, with approximately 1800 UK and international companies on its list. As a specially developed segment of the LSE's Main Market, techMARK was launched in 1999. This submarket was created in order to provide new opportunities for companies at the forefront of innovative technology. For companies working on innovation in the healthcare sector the techMARK mediscience was added two year later.

The Alternative Investment Market is the LSE's market for smaller companies and for growing firms. AIM was opened in 1995 and is a replacement of the Unlisted Securities Market (USM). The Unlisted Securities Market, launched in 1980s and replaced by the AIM fully by the end of 1996, was the LSE's market for all the companies that did not qualify for a full listing, such as the companies that did not have the full three year trading history required by the main market, or those which wished to float less than 25 percent of their share capital.

Figure 2.2: IPO Process and timeframe in the UK (source: LSE prospectus)



The AIM market is designed as a more suitable alternative for the needs of smaller and fast growing companies (i.e. lightly regulated comparing to the main market). Since its launch, over 3,000 companies from across the globe have chosen to join AIM, raising over 67 billion pounds through new and further issues.

More recently, other specialised markets have been developed, such as the PLUS market, the Professional Securities Market, and the Specialist Funds Market, providing more flotation alternatives to issuing firms. The PLUS Market that was granted "Recognised Investment Exchange (RIE)" status by the Financial Services Authority (FSA) in 2007 represents a specialist market for smaller domestic and international companies across a number of sectors and in all stages of a company's development, with lighter regulations than on the AIM. The Professional Securities Market was launched in 2005 as an innovative, specialised market designed to suit the specific needs of issuers, facilitating the raising of capital through the issue of specialist debt securities or depository receipts (DRs) to professional investors. In 2007 the Specialist Fund Market has opened as the LSE's regulated market that is designed for the needs of highly specialist investment funds, targeting institutional, professional and highly knowledgeable investors.

In general, the regulatory procedure for the UK IPOs has two mechanisms: a securities regulator represented by the Financial Service Authority, and the stock exchange represented by London Stock Exchange. The shares of an issuing company need to be admitted to the Official List by the UK Listing Authority[5], which is a part of the FSA and then admitted to trading by the LSE. When both procedures are finished, the shares are formally schedules and can be exchanged on the stock exchange.

The UKLA has two principal roles to perform: (i) to review and approve the issuer's prospectus and (ii) to admit those securities to listing after ensuring that the issuer complies with all relevant eligibility criteria. In complying with these rules, issuing firms typically

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[5]The UK Listing Authority 'UKLA' is the name used by the Financial Services Authority 'FSA' when it acts as a competent authority for listing, as competent authority for the purpose of the European Prospectus and Transparency Directives, and as competent authority for certain aspects of the Market Abuse Directive. These roles have a statutory basis in Part VI of the Financial Services and Markets Act 2000 (FSMA). Three source books in the FSA Handbook implement the relevant rules: listing rules, prospectus rules and disclosure and transparency rules. For more details see a guide to listing on the London Stock Exchange (2010).

seek the help of a number of experts, such as the sponsor (underwriter) who is usually a merchant bank or a stockbroker.

The sponsor hired for the purpose of the IPO under the guidance rules of the LSE framework analyses all aspects of the company and guides the issuer on matters, such as the composition of the board of directors, the method of share issue and the contents of the prospectus. In addition, the sponsor helps the company set the issue price and the floatation time, insuring against the risk of undersubscription (situation when not all the shares are taken up by investors).

2.1.2.3 IPO Flotation methods on LSE

A company seeking admission to the LSE can use one of the following methods of obtaining a listing and issuing new equity capital: ‘introduction’, ‘placing’, ‘offer for sale by subscription or tender’, and ‘offer for sale at fixed price’.

Under an ‘offer for sale at fixed price’, the company usually sells all the shares to the sponsor (issuing bank) which in turn arranges for the issue to be sub-underwritten, for a fee, by other financial institutions and large investors. So, the issuing bank reduces the risks that will be born in case of the issue failure. Once the issuing house fixes the price of the issue (usually about two weeks before dealings on the issues), it can neither be changed in response to emerging demand, nor can it be withdrawn. The public then is invited to send the requests for allocations directly to the issuing bank. The remuneration of the sub-underwriters is related to the size of the issue. If there is excess demand, the issuing bank must allocate the shares according to some "fair" scheme. Generally, the offer for sale at a fixed price eliminates the price uncertainty associated with tender offers, yet it might be costly if the issuing bank underestimates the market value of the new issue (Levis, 1993; Brennan and Franks, 1997).

In a tender offer (‘offer for sale by subscription or tender’), the public is invited to tender for shares at any price over a stated minimum. A single striking price is set to ensure that the issue is sold. In the UK most of the tender offers are simultaneous uniform price auction, in which each investor submitted a single sealed bid for a block of shares at a specified price or above a minimum tender price. After all bids are submitted, investors, who tendered for shares at this price, or above it, receive shares at the striking price. In case of oversubscription, the strike price is set above the minimum price (but below the market-clearing price) and shares are rationed to investors. If the offer is undersubscribed, the offer price is fixed at minimum tender price and the residual is taken up by the underwriter (sponsor) at this minimum price (Levis, 1993; Brennan and Franks, 1997). Although a tender offer involves certain level of price uncertainty, it still offers a chance to sell shares at a price closer to its fair value (defined by initial trading in the shares on the stock market) and to estimate the demand for the shares as the time of IPO.

In a ‘placing’, the sponsor also technically underwrites the entire issue for a short period of time but the sponsor’s main function is to act as a distributor. Normally, the sponsor buys the issue from the issuing company and arranges to place the majority of the shares with investors. The price of the issue is fixed about five days before the shares start trading. Placing of shares is normally completed by the end of the first day of trading. If the sponsor fails to place an agreed minimum number of shares the offer is withdrawn (Brennan and Franks, 1997). Therefore, a placing does not provide a guarantee like other types of offers. In a placing the shares are sold to a restricted number of large (institutional) investors, and the offer price is set after the information about the demand for shares is disclosed. Also, as placing does not normally involve underwriting fees, it is generally associated with lower direct costs than that of public offers, however, the process and structure of this type of offering can result in significantly higher indirect costs.

‘Introduction’ represents another way to come to the market, in which a company joins the market without raising any new capital. UK introductions usually result from companies moving their listing from the AIM to the Official List, from the demutualisation of building societies or insurance companies, or when the 25 percent of the firm’s shares are already in public hands and there is a fair spread of shareholders. Introductions also include the listing of foreign companies that do not raise funds through the LSE. An introduction involves no underwriting fees and has little requirement for advertising.

Other methods of going public include ‘mixed offerings’ in which an initial tender is followed by an offer for sale, and so-called ‘intermediaries offers’ in which intermediaries (stockholders and banks) apply for shares on behalf of their individual or retails clients, allowing them to participate in offering that they would normally have no access to (Espenlaub *et al.*, 1998).

2.1.3 Pricing of IPOs

Pricing the stock of a firm making its initial public offering is a difficult task. The final offer price must be attractive to investors, provide the required capital, ensure that the offer is fully subscribed and there is little or no ‘money left on the table’ (Pilbeam, 2010). The valuation of shares of an unlisted company is challenging due to the absence of current market prices and trading history. Information asymmetry between market participants surrounding the value of these shares leaves the new issues market subject to classic adverse selection problem which manifests itself in persistent average initial return across capital markets (Reber and Vencappa, 2016).

The preliminary ranges for the offer price are submitted to the SEC with the initial prospectus. The ‘road show’ is used to build a book of orders for the new issue and to get a better understanding of the actual demand for the IPO. According to the feedback from the road show, the offer price is adjusted either below (in case of low demand) or above (in case of high demand) the initial range (Thornton *et al.*, 2009).

In the US, bookbuilding typically starts with the setting of a file price range, say $14-16 per share, and the commencement of a road show that might last two weeks. The difference between the minimum and maximum price is almost always two US dollars. During the road show, institutional investors are canvassed in regard to the state of their demand. If there is unusually weak or strong demand, a revised price range might be filed with the US Securities and Exchange Commission, say $16-$18. At the pricing meeting, which typically occurs in the late afternoon prior to the start of trading, the offer price can be set at up to 20% above or 20% below the most recent price range. For example, with a price range of $16-18, the offer price can be between $12.80 and $21.60 without a further pricing amendment. Loughran and Ritter (2002) report that the final offer price is set within the original file price range about 50% of the time, with about 25% of IPOs priced below the range and 25% above the range.

By contrast, in German IPOs the price range is typically set after bookbuilding has started, with the pricing typically occurring seven trading days later (Aussenegg *et al.*, 2006). The price range is frequently more than two euro, but once set, IPOs never price above the maximum (Ljungqvist *et al.*, 2003) in Germany, and rarely in other countries. According to Aussenegg *et al.* (2006), Cornelli *et al.* (2006), and Loffler *et al.* (2005), when-issued trading frequently occurs after the price range has been set, especially in Germany, where the practice appears to be most common. In general, short positions are taken by institutional investors and long positions are taken by individual investors (Dorn, 2009). All of these studies have found that the final offer price is adjusted in the direction implied by the when-issued market price, but the adjustment is fairly modest, especially for upward revisions.

The money left on the table in an IPO is defined as the number of shares offered multiplied by the first day capital gain, measured from the offer price to the closing price. In 1999-2000, huge amounts of money were left on the table, and many IPOs were heavily oversubscribed. With bookbuilding, underwriters have discretion in allocating shares. There are three views about how IPOs are allocated: the pitchbook view, the academic view, and the profit-sharing view. The pitchbook view, named because it is found in almost all pitchbooks (the set of slides used by underwriters when they are making a presentation to the issuing firm explaining why this underwriter should be hired as the lead underwriter), states that underwriters will use their discretion to allocate shares to institutional investors who are likely to be buy-and-hold investors. The academic view, named because the vast majority of academics analysing discretionary allocation use the Benveniste and Spindt (1989) mechanism design model, states that “regular” investors will be allocated shares in return for truthfully revealing their estimate of share value. The profit-sharing view, exposited by Loughran and Ritter (2002; 2004), states that underwriters allocate hot IPOs to investors in return for commission business. The more money that is left on the table, the higher are the profits that the underwriter receives from the resulting commission business.

Over the last decade, a considerable body of literature has documented the relationship between institutional factors, such as legal origins, investor protection, corporate governance, corruption levels, political connections, rules and regulations, and their impact on the IRs of IPOs. In particular, La Porta *et al.* (1997) have highlighted the importance of the legal approach as the key mechanism to understand the patterns of corporate finance. Raising equity capital via initial public offerings (IPOs) and the current financial eco-system provide opportunities to firm owners to raise funds in multiple capital markets. Regulatory issues and market-seeking intentions are common reasons for firm owners to look out for such markets. Potential investors are also looking for multiple capital markets as they are exposed to additional risk in an IPO environment due to internal (firm specific) and external uncertainties, which affect the first day's initial returns (IRs). A positive IR (first day's closing price greater than offer price) is also known as IPO underpricing and in effect represents "money left on the table" by the IPO firms, i.e., the transfer of wealth from the issuing firm's shareholders to the first-day investors.

It has been widely documented that a good legal environment creates an efficient platform for companies to raise external capital via debt or equity financing (La Porta *et al.*, 1997; Sundarasen *et al.*, 2017). In law and finance theory, two main categories of western legal systems are discussed: common law and civil law[6].

Several cross-country studies have also confirmed that legal systems have contributed to fluctuations in IPO underpricing across markets (Hopp and Dreher, 2007; Banerjee *et al.*, 2011; Boulton *et al.*, 2010; 2011). The British common law countries are said to have more secure investor protection system in place and have proven to affect IPOs via shareholder protection (King and Levine, 1993). An investigation of 40 different countries by Kunt and Maksimovic (2002) supports the fact that the effectiveness of a nation's legal system reflects the ease with which a company can enter external financing. Weaker legal protections lead to higher capital costs, as the expected risk premiums are higher. Investors feel safer and more secure under the legal protection provided in countries that practice

[6]The common law system is implemented in the Anglo-Saxon nations, including the USA and the UK. It is also known as English law and used in numerous countries formerly held as UK colonies. Civil law, on the other hand, is separated into three parts, namely, French, German and Scandinavian civil law. Equity and debt markets from these varied legal contexts show significant differences in terms of cost and performance, as the markets in common law countries are very explicitly equity driven, while the nations with German legal origins convey a debt-orientated market.

common law (La Porta *et al.*, 1997; Hopp and Dreher, 2007). Additionally, Jones *et al.* (1999) documented the finding that companies operating in different legal systems underprice shares differently. Similarly, Dewenter and Malatesta (1997) also documented that companies in less developed markets tended to underprice more than their counterparts in developed countries.

The studies of Boulton *et al.* (2010), and Hopp and Dreher (2007) explored the direct relationship between country-level information asymmetry, effective contract enforcement (a reflection of legal framework), investor protection and transparency levels (from the perspectives of accounting disclosures) on IPOs' IRs. The authors advanced a "control motivation" for the underpricing of IPOs. They conjectured that underpricing of IPOs leads to excess demand for shares and encourages the presence of a wide tranche of players in the market. This eventually leads to a wider dispersion of shareholding and lowers incentives for outsiders to monitor the management. Transparency levels reflect the extent of corruption[7] prevailing in a country and it has been widely documented that corruption levels have inverse effects on the growth rate of a financial market. Corruption causes the expense of conducting any form of business transaction to increase, making it more complex. The level of transparency (vis-à-vis corruption) differs amongst countries with both similar and different levels of investor protection and also amongst common law and non-common law countries. Most of the countries that have a high level of transparency have a high level of investor protection.

Sundarasen *et al.* (2017) study the intentional act of 'leaving money on the table' within the boundaries of the institutional characteristics of investor protection, legal origin and transparency level on the sample of cross-sectional data comprising 4164 IPOs from 28 OECD countries (accounting for 59 percent of the world GDP and 75 percent of the world trade countries) during 2005-2010.

[7] Corruption stands beyond the reach of bribery; it also encompasses any act done under the discretion of obtaining favour in the public division. Abuse of a governmental department for personal benefit is also termed corruption.

Their study examines the relationship between investor protection and IPOs' IRs through examining investor protection (the extent of disclosure index (EDI), the extent of director liability index (EDLI) and the ease of shareholder suits index (ESSI)), legal origins (common law and non-common law countries), and the moderating effects of transparency on the relationship between investor protection and IPOs' IRs. These relationships are examined from both the demand side (investor's perception of risk/reward) and the supply side (compensation for uncertainty, managerial motives behind pricing decisions and the avoidance of litigation) relative to country-level institutional characteristics. Underpricing is a managerial decision relative to the notional/economic value of the firm and therefore, the supply side variable is pivotal, while the demand side determines the compensation for investor risk.

According to Sundarasen *et al.* (2017), managers underprice to raise investors' cost of monitoring and thereby earn freedom, discretion and entrenchment. Company founders may have similar motivations; they may need to balance the need for independence to pursue their vision with the need for financing to expand the scale of their execution. In general, the authors argue that high investor protection increases investors' confidence in being well compensated for the risk and uncertainty assumed in an IPO investment, as well as management's desire to underprice the IPO to ensure management control and avoid any future lawsuits.

The significance of this relationship is stronger in the non-common law countries, compared to the common law countries. This could be due to the weaker legal structure in non-common law countries, which warrants the need for proper investor protection. In non-common law countries, managers would need to create a market for higher risk due to the uncertainty imposed by the legal system in these countries. In addition, managers may wish to underprice in non-common law countries to avoid the risk of investor lawsuits in countries where legal outcomes are much more contextualized, and therefore more expensive and risky (i.e. unpredictable). Investors demand more compensation, and managers underprice more to minimize the risk of becoming embroiled in investor litigation or lawsuits related to IPO pricing in non-common law countries. As for the moderating effects of transparency or corruption level, a negative moderating effect is present in the common law countries, indicating investors' perception of a favourable IPO environment and the reduced need for investor protection. As for non-common law countries, even in low corruption settings, investor protection seems to play a pivotal role in an IPO environment (Sundarasen *et al.*, 2017).

A number of empirical papers have focused on allocations between institutional investors and individuals (Jenkinson and Jones, 2004; Ljungqvist and Wilhelm, 2002). In general, the recent academic literature (Cornelli and Goldreich, 2001) has framed the allocation decision in terms of the Benveniste and Spindt (1989) mechanism design model, whereas the earlier literature (Keloharju, 1993) framed the decision in terms of the Rock (1986) adverse selection model. To date, partly because of the lack of data on commission business on a client-by-client basis, there have been no direct tests of the profit-sharing view of IPO allocations. Biais *et al.* (2002), analyse the optimal IPO pricing and allocation mechanism in a model where there is both asymmetric information and an agency problem between issuers and underwriters. They conclude that the discretion that underwriters have with book-building results in sub-optimal outcomes for issuers relative to using auction-like mechanisms.

Torstila (2001; 2003) and Ljungqvist *et al.* (2003) document that the fees charged by underwriters for the European IPOs are lower than those in the US. The fees, known as the gross spread, are higher when book-building is used than with auctions or fixed price offers. Holding other things constant, Ljungqvist *et al.* (2003) find that the gross spread is higher if there is a US tranche or if an American underwriter is the book-runner. They report that US underwriters are more willing to revise the offer price upwards, however, if there is strong demand, benefiting the issuer. Torstila (2001; 2003) finds that there is less clustering of gross spreads in Europe than in the US, where Chen and Ritter (2000) report that after 1994 almost all moderate-size IPOs have a seven percent gross spread, whether the firm going public is low risk or high risk, and whether the proceeds are $20 million or $80 million.

The literature examining gross spreads has noted that in a competitive equilibrium there is a trade-off between the gross spread charged and the amount of underpricing (J. Ritter, 2003). Furthermore, issuers are implicitly purchasing future favourable research coverage from the underwriter’s analyst in many cases. If issuers consider favourable research coverage by an influential analyst to be very important, then whichever underwriter has the most influential analyst in a given industry will have the market power, so it is not clear whether modelling the trade-offs in a competitive framework is appropriate. Loughran and Ritter (2004), in the context of the US IPOs, argue that issuers placed more and more attention on favourable analyst coverage as valuations increased during the 1990s, resulting in the IPO underwriting industry becoming less competitive. As a result of the reduced competition, underpricing increased, with the underwriters profiting by allocating hot IPOs in return for commission business offered by investors. An implication of this framework would be that favourable analyst coverage for the European IPOs would be positively related to underpricing. The author is not aware of any research that directly tests this implication.

While a number of countries have tried the use of sealed bid share auctions for initial public offerings (IPOs), few continue to use them. This is a puzzle, since auctions have been successfully used in a variety of situations for other financial securities, particularly for the sale of government bonds. Jagannathan *et al.* (2015) provide an explanation for this puzzle. Bidding in sealed bid auctions for new issues is complex, particularly when the underlying shares are difficult to value and the auction is open to large numbers of potential bidders, some of whom might be naïve. Participation fluctuations make it difficult for even sophisticated bidders to shave accurately for the winner’s curse, and mistakes by some bidders impose costs on all. Their findings suggest that a hybrid auction mechanism that limits participation in the auction tranche to sophisticated investors, along with a non-competitive tranche that is open to all investors, can reduce such mistakes while at the same time providing the necessary incentives for information gathering.

Tying initial public offering (IPO) allocations to after-listing purchases of other IPO shares as a form of price support has generated much theoretical interest and media attention.

Price support can take several forms, which can be legal (e.g., IPO price stabilization) or illegal (e.g., IPO laddering). Lead investment banks can secure after-listing price support for initial public offerings (IPOs) they underwrite by allocating shares to institutional investors whose secondary market trading they can influence. Investment banks can gain such influence from their power to exclude institutional investors from future IPOs.

In the past, obtaining data to investigate price support has proven to be difficult. Chen and Wilhelm (2008) explain theoretically that price support can be beneficial for issuers because it allows for an optimal response to new information and smoothes the transition to secondary trading. However, Fjesme (2016) argues that price support is price manipulation and may have a negative impact on non-IPO investors who buy shares in the secondary market immediately after the listing and reduce their return.

Using data from the Oslo Stock Exchange consisting of 187,570 investor–IPO pairs, as well as stock trading commissions and after-listing trading from 1993 to 2007, Fjesme (2016) shows that price support is harming secondary investor return and that investors who engage in price support are allocated more future oversubscribed allocations, whereas harmed secondary investors significantly reduce their future participation in the secondary market. He argues that the investors who provide immediate post-IPO price support receive allocations more than 3 times larger than those of non–price support investors in future oversubscribed IPO allocations from the same lead investment bank. Price support is mainly provided by large international institutions. Most secondary investors who are hurt by the price support are retail and small domestic nonfinancial institutions (such as privately held companies).

Fjesme (2016) shows that price support harms secondary investors and keeps these investors from participating in the secondary IPO market in the future. The author states that regulators should require the provision of more information to markets regarding price-support trades by investors to avoid possible harm to naïve secondary investors. Currently, investment banks are not required to disclose the price support given by investors. Obtaining data that would allow one to distinguish primary from secondary investors and secondary trading by allocated investors has proven to be difficult.

Price setting is a critical decision point for firm management because once the price has been set, shares cannot be offered to the initial investors at a higher price the first day of trading regardless of the level of demand. It is this initial stock price that forms the basis for underpricing given that underpricing represents the difference between the initial stock price set by IPO firm managers and the underwriters and the price of the stock at the close of the first day of trading (Daily *et al.*, 2003).

The literature offers three main explanations for persistent average initial return: deliberate underpricing in the premarket (henceforth deliberate underpricing), mispricing in the early aftermarket as a result of trading activity, and underwriter price stabilization in the early aftermarket[8]. The first strand of the literature ascribes initial return to deliberate underpricing as the outcome of information asymmetry surrounding IPO value among participants in the premarket. Grinblatt and Hwang (1989), Welch (1989), use deliberate underpricing as a costly and difficult to imitate signal in which firm insider's transmit positive information on firm value to outside investors. Baron (1982) explains deliberate underpricing and the persistence of the phenomenon as the outcome of a principal– agent conflict in which the issuing firm (principal) cannot directly observe the marketing and distribution efforts of the underwriter (agent). The underwriter can thus induce the issuing firm to agree to a relatively low offer price. Rock (1986) model assumes that IPOs have to be, on average, underpriced to compensate less-well informed investors for a winner's curse problem[9] and to induce them to participate in the new issues market.

The second strand of the literature assumes that IPOs are priced at their intrinsic value in the premarket and attributes initial return to trading activity in the early aftermarket as a result of, for example, overoptimistic investors and their valuations. Aggarwal and Rivoli (1990) focus on fads in the IPO market whereby new issues are possibly not priced at intrinsic values in early aftermarket trading. Ritter (1991) and Loughran and Ritter (1995) explain initial return as a consequence of investors being overoptimistic about firm value which creates excess demand in shares, pushes up prices and leads to high initial return in the aftermarket. Friesen and Swift (2009) attribute initial return to investor overreaction at the time of the IPO before prices revert back to fundamental firm value. Aggarwal (2000; 2003), Ellis *et al.* (2000; 2002) and Ellis (2006) find evidence that flipping is not solely responsible for high trading volumes in the early aftermarket. 77% of trades are investor-motivated, while interdealer trading accounts for the remaining 23%. Chahine (2007)

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[8]Premarket' indicates the time leading up to the IPO date (stock market flotation), whereas 'aftermarket' refers to the time once trading commences in the stock market.

[9]Awinner's curse arises here because less-well informed investors obtain a higher proportion of overpriced IPOs because better-informed investors only apply for underpriced new issues.

reports a positive relationship between the share demand-to-offer ratio in the premarket and the trading volume in the aftermarket.

The third strand of the literature attributes positive average initial return to underwriter price support. The price support leads to a censoring of the return distribution and the spurious impression of persistent average initial return. For example, Ruud (1993), Asquith *et al.* (1998) and Aggarwal (2000; 2003) find that underwriters stabilize the aftermarket prices at the offer price which results in very few IPO stocks being overpriced.

On the one hand, existing research explains positive average initial return and its persistence as a combination of deliberate underpricing and aftermarket mispricing as a result of trading in the early aftermarket. The most commonly held view is that deliberate underpricing is the main contributor towards persistent average initial return (Baron, 1982; Rock, 1986; Allen and Faulhaber, 1989; Grinblatt and Hwang, 1989; Welch, 1989). On the other hand, empirical studies do not distinguish between deliberate underpricing and aftermarket mispricing when testing competing theories. However, the lack of such a distinction is not surprising. Disentangling deliberate underpricing and aftermarket mispricing from initial return is difficult. To do so it requires a 'fair' offer price, which is not directly observable, in addition to the offer price and the closing share price in the aftermarket.

Reber and Vencappa (2016) separate deliberate underpricing in the premarket and the aftermarket mispricing from the initial returns, and test whether variations in these components can be explained by existing theories. Differentiating these components from observed initial returns relies crucially on being able to estimate a fair offer price for each IPO. They identify this 'fair' offer price using stochastic frontier analysis which estimates the maximum achievable offer price from given issuing firm attributes, deal characteristics, third-party certification, and IPO market conditions. The authors then uncover aftermarket mispricing, which allows them to explain aftermarket mispricing with the help of proxy measures that capture trading activity in the early aftermarket. They argue that IPO market value partly depends on this trading activity and find evidence that aftermarket mispricing is affected by trading volume in IPO shares on the first day of trading, the price adjustment between the filing price range and the offer price to reflect investors' demand for shares, equity retained by original owners, underwriter reputation, and offer size.

Analyses of Reber and Vencappa (2016) reveal that deliberate underpricing is the more dominant component that makes up initial return when compared to the fraction of aftermarket mispricing. This pricing inefficiency is not a challenge to the efficient market hypothesis in which prices quickly and accurately adjust to a new equilibrium as a result of trading, but instead confirms that information asymmetry between new issues market participants surrounding firm value in the primary market will lead to deliberate underpricing in the absence of trading. While outside investors benefit from deliberate underpricing, issuers leave money on the table which could potentially leave the IPO market subject to classic adverse selection problem.

As the authors argue, this adverse selection problem could lead to an inefficient functioning of the IPO market and — at the extreme — to market failure if IPO firms completely withdraw from the new issues market if deliberate underpricing reaches unsustainable levels. If issuers have to leave an excessive amount of money on the table, then firms might seek an alternative way to exit from their investment or other means of raising capital.

The study implies that new issues market participants can to some extent influence aspects of information asymmetry at different stages of the flotation process and hence deliberate underpricing, while other aspects are beyond the direct control of market participants. On the one hand, issuing firm attributes such as, for example, the amount of sales in the accounting period before flotation or firm age are factors beyond the direct control of issuers at the time of flotation. On the other hand, issuers appear to be able to more directly influence deliberate underpricing through decisions and actions relating to deal characteristics, third-party certification, and possibly market timing. For example, the presence of lock-in agreements by pre-IPO owners increases the level of demand for the shares and hence underpricing, while having no lock-in agreements increases information asymmetry between firm insiders and outside investors. Underwriter fees will be higher for those IPOs for which relatively little public information is available. Therefore, more direct disclosure by issuers during the flotation process will lead to lower levels of information asymmetry among new issues market participants and ultimately lower underpricing for IPOs of identical levels of business and financial risk (Reber and Vencappa, 2016).

An ability to take actions by market participants to influence the level of deliberate underpricing is important for the new issues market to continue functioning and to reduce the possibility of an adverse selection problem to minimize the danger of a complete withdrawal of all IPO firms from this market.

Underpricing is relatively straightforward in its calculation. This simplicity, however, is not transferred to the relationship between underpricing and its correlates. In fact, there is little consensus regarding whether underpricing is a preferred or unwelcomed outcome of the IPO process (Daily *et al.*, 2003; Ritter and Welch, 2002; Loughran and Ritter, 2004; Ritter, 2011). Initial shareholders, for example, may wish to minimize the potential for underpricing. For these initial owners, underpricing represents "money left on the table" i.e., underpricing is a firm value that accrues primarily to the underwriters' clients (typically institutional investors) as the initial purchasers of the firm's stock and not the initial shareholders. However, the underpricing is preferable for the firm if it guarantees the success of the issue. For example, Ritter (2011) reports that initial underpricing of IPOs in the US for 1960-2011 average level was 16.8 per cent, in the UK in 1959-2010 the levels were at 16.2 per cent, and France had 10.5 per cent on average for 1983-2010.

Underpricing is not uniformly irrational for the issuing firm's initial shareholders, particularly those who also serve as firm officers. Firms' managers have a legal obligation to disclose information relating to the stock offering. Underpricing offers these managers and the underwriters "insurance" against legal liability resulting from false or inadequate information in the registration statement. Stock that is underpriced (i.e., closes at a higher trading price than it opened on the first day of trading) would suggest no basis for damages.

Underpricing is generally believed to be rational from the perspective of the underwriters (Daily *et al.*, 2003). A stock that is either fairly priced (i.e., priced at the same level as the close of the first day of trading) or that is underpriced provides the underwriters a guaranteed payment from the stock's issuance. That is, the underwriters will be able to sell all of the available shares, thereby retaining their full commission rate.

Overpriced stocks, however, risk being undersubscribed, leaving the underwriters responsible for any loss associated with the stock offering[10]. An undersubscribed IPO

[10] This is true only in the case of a firm commitment offering where the underwriters guarantee the sale of a pre-specified number of shares at the agreed upon offering price (Ibbotson *et al.*, 1988).

leaves the underwriters holding these shares, with an after-market sale at a discount as their primary option for selling the unsold shares in the short term. An alternative to this is underwriters selling overpriced shares to their institutional investor clients. Hanley and Wilhelm (1995), for example, find that while institutional investor clients are favoured by underwriters in the distribution of the underpriced shares, this allocation is in exchange for institutional investors' purchase of shares in the overpriced offerings (Ritter and Welch, 2002). While institutional investors receive proportionately more underpriced, as compared to overpriced, shares, Hanley and Wilhelm's finding is evidence that underwriters occasionally transfer the cost of undersubscribed issues to their institutional investor clients. As noted by Daily *et al.* (2003), the loss to the underwriter is bigger with higher overpricing as less shares can be sold at the offering price.

There is a risk, however, of being associated with excessively underpriced deals. As noted by Beatty Beatty and Ritter (1986), if, on average, an investment banker does not underprice its offerings enough, the average initial return will be too low, and uninformed investors will cease doing business with this underwriter. On the other hand, if, on average, an investment banker underprices its offering too much, potential issuers will cease using this underwriter. This observation suggests that in order to protect their reputations with both sets of clients (issuing firms and investors), underwriters will seek some optimal level of underpricing.

2.1.4 IPO clusters

The IPO cycle refers to the tendency of IPOs to cluster together in time and to go through so-called "hot" and "cold" periods (Burhop and Chambers, 2016) . This refers to the periods of high and low volumes of IPO issues and industry clustering where disproportionate numbers of firms within an industry go public close together. IPOs tend to cluster in time and industries. Ibbotson and Jaffe (1975) find that periods of high IPO volume are often followed by further heavy IPO activity. Ritter (1984) argues that IPO waves can be attributed to certain industries. Prior research has indicated that a reduction in information asymmetry can lead to higher volumes of equity issuances and consequently clustering of seasoned offerings and IPOs (Lucas and McDonald, 1990; Bayless and Chaplinsky, 1996). According to Lowry and Schwert (2002), more firms go public after observing more underpriced IPOs because potential issuers learn from the experiences of previous issuers.

Benveniste *et al.* (2002) argue that firms going public produce information influencing their own production decisions as well as the production decisions of their rivals. If information production costs are borne primarily by pioneering firms, market failures can occur and firms remain private. Underwriters mitigate this free-rider problem by bundling IPOs within an industry, ensuring an equitable distribution of information production costs. The authors posit that firms attempting IPOs obtain indirect feedback by examining the filings of their industry peers and argue that this indirect feedback directly influences withdrawal decisions, pricing/underpricing and the rate of new registrations by related firms. Benveniste *et al.* (2002) and Yu and Tse (2003) find empirical evidence that firms condition their decision to proceed with IPOs and the terms of IPO offerings based on the experiences of their industry peers. In other words, indirect learning plays an important role in a firm's decision on whether to go public as well as the terms of the offering (Benveniste *et al.*, 2003).

According to Benninga *et al.* (2005), IPO activity begins once the firm with the largest cash flows in an industry decides to go public. The book-building process reveals valuable information regarding the firm's prospects and other industry opportunities. As a result, the benefits of remaining private in the industry are diminished, and the firm with the next highest cash flow is motivated to go public. This can lead to a number of firms in the same industry going public within a relatively short period of time.

Jain and Kini (2006) identify industry conditions that influence IPO clustering and analyse differences in characteristics of clustered and non-clustered IPOs. They find that IPO clustering is more likely to occur in high-growth and fragmented industries characterised by strong investment opportunities, favourable investor sentiment, and higher requirements of investment in research and development. The authors also find that clustered IPOs experience poorer long-run post-IPO performance compared to non-clustered IPOs. They argue that this is due to overinvestment in the industry.

Colaco *et al.* (2009) examine the IPO timing decision as a function of indirect learning from prior IPOs. They find that the willingness to file for IPO without the benefit of indirect learning is directly related to insiders' need for portfolio diversification and the firm's need to raise capital.

2.2 Evidence of IPO performance

Performance of IPOs has been studied from two perspectives: short-term performance (often referred to as underpricing) and long-term performance. This section provides an overview of the IPO performance for the developed and the emerging markets. It starts with an overview of the evidence on the short term underpricing and proceeds with the outlining the international evidence on the aftermarket performance of new issues. The section concludes with the overview of the previous research of IPOs in the UK.

2.2.1 International evidence of IPO performance

It is well known that firms going public tend to provide significant positive abnormal returns on the first day of trading, known as IPO underpricing (or IPO initial returns). It is measured as the percentage difference between the first trading day's closing market price and the offer price. IPO underpricing is an anomaly that has been widely explored by a huge number of theoretical and empirical studies on various international markets. In the US market, Reilly and Hatfield (1969), McDonald and Fisher (1972) and Ibbotson and Jaffe (1975) are all early studies that documented IPO underpricing. More recently, Ritter and Welch (2002) document an average underpricing of 7.4 percent in the 1980s, 11.2 percent in the early 1990s, 18.1 percent in the mid-1990s and 65 percent in 1999-2000 bubble years. Similarly, Loughran and Ritter (2004), investigating a sample of US IPOs over 1980-2003, find that IPO underpricing doubles from seven percent during 1980-1989 to almost 15 percent during 1990-1998 before reverting to 12 percent during the post-bubble period of 2001-2003. Information on the more recent international evidence on IPO underpricing is displayed in the table 2.3.

Generally, the underpricing phenomenon seems to appear consistent across countries. According to Jenkinson *et al.* (2006) the European IPO market differs from the US in that there is more information flowing between investors and the underwriter prior to the book-building period. This distinction has important implications because it is in this period that investors form their opinion about the correct price. Investors receiving more information at an early stage become more informed and, thus, can potentially become less prone to sentiment.

Jenkinson *et al.* (2006) find that in countries where more information is revealed the initial price ranges become 'sticky' and relatively unresponsive to demand as revealed through the book building process. According to Ljungqvist (2007),this reduces the winner curse problem[11] and can reduce the underpricing because the information gap between informed and uninformed investors is reduced.

Another difference between the European and the US market relates to the legal requirements. European underwriters are obligated to allocate a certain percentage of the shares to retail investors. According to Ljungqvist (2007), this reduces underwriters' ability to target allocations at the most aggressive (institutional) bidders and so may force them to rely more on price than on allocations. Unlu *et al.* (2004) investigate the difference in underpricing between the US and the UK market. They find that the relation between mean UK and US underpricing varies considerably over time.

The existence of underpricing in developed markets is well documented in the literature. The highest levels of underpricing, however, are found in emerging markets (Dimovski and Brooks, 2004). Loughran and Ritter (1995) provide a study of IPOs in 25 countries, including IPOs from seven Asian countries. The research finds high initial underpricing in these countries. It also suggests that the move by East Asian countries to reduce regulatory interference in the setting of offer prices results in less underpricing of IPOs. Ritter (2003) reports the extent of underpricing in 38 countries, including 11 Asian countries with average initial returns ranging between 256.9 per cent for China and 15.1 per cent for Indonesia. In general, Ritter reports that the average initial returns of Asian IPOs are significantly higher than the average initial return of the US IPOs. A recent report by Ritter (2011) documents that underpricing in China reached 137.4 per cent in the period of 1990-2010, in India in 1990-2007 it was 92.7 per cent, and in Brazil in 1979-2011 underpricing level reached 33.1 per cent. Table 2.4 summarises the empirical evidence of IPO underpricing in different emerging markets.

[11]The winner's curse is a tendency for the winning bid in an auction to exceed the intrinsic value or true worth of an item. Because of incomplete information, emotions or any other number of factors regarding the item being auctioned, bidders can have a difficult time determining the item's intrinsic value. As a result, the largest overestimation of an item's value ends up winning the auction.

Table 2.3: Equally weighted average initial returns for IPOs in different countries.
The table summarises the equally weighted average initial returns for a number of developed countries.
Source: Ritter (2018)

Country	Author(s)	Sample size	Time Period	Initial Return
Austria	Aussenegg	103	1971-2013	6.4%
Belgium	Rogiers, Manigart&Ooghe; Manigart	114	1984-2006	13.5%
Canada	Jog & Riding; Jog & Srivastava; Kryzanowski, Lazrak&Rakita; Ritter	743	1971-2016	6.5%
Cyprus	Gounopoulos, Nounis, and Stylianides; Chandriotis	73	1997-2012	20.3%
Denmark	Jakobsen& Sorensen; Ritter	164	1984-2011	7.4%
Finland	Keloharju	168	1971-2013	16.9%
France	Husson&Jacquillat; Leleux&Muzyka; Paliard&Belletante; Derrien& Womack; Chahine; Ritter; Vismara	697	1983-2010	10.5%
Germany	Ljungqvist; Rocholl;Vismara; Dealogic	779	1978-2014	23.0%
Greece	Nounis, Kazantzis& Thomas; Thomadakis, Gounopoulos&Nounis	373	1976-2013	50.8%
Hong Kong	McGuinness; Zhao & Wu; Ljungqvist& Yu; Fung, Gul, and Radhakrishnan; Dealogic	1,486	1980-2013	15.8%
Ireland	Dealogic	38	1991-2013	21.6%
Israel	Kandel, Sarig&Wohl; Amihud& Hauser; Ritter	348	1990-2006	13.8%
Italy	Arosio, Giudici&Paleari; Cassia, Paleari&Redondi; Vismara	312	1985-2013	15.2%
Netherlands	Wessels; Eijgenhuijsen&Buijs; Jenkinson, Ljungqvist, & Wilhelm; Ritter	181	1982-2006	10.2%
New Zealand	Vos& Cheung; Camp & Munro; Alqahtani; Dealogic	242	1979-2013	18.6%
Norway	Emilsen, Pedersen &Saettem; Liden; Dealogic	209	1984-2013	8.1%
Portugal	Almeida & Duque; Dealogic	32	1992-2013	11.9%
Spain	Ansotegui& Fabregat; AlvarezOtera; Dealogic	143	1986-2013	10.3%
Sweden	Rydqvist; Schuster; de Ridder	405	1980-2015	25.9%
Switzerland	Kunz, Drobetz, Kammermann&Walchli; Dealogic	164	1983-2013	27.3%
United Kingdom	Dimson; Vismara; Levis	4,932	1959-2012	16.0%
United States	Ibbotson, Sindelar& Ritter; Ritter	13,001	1960-2017	16.8%

Table 2.4: Empirical evidence of IPO underpricing in emerging markets
The table summarises the equally weighted average initial returns for a number of developing countries.
Source: Ritter (2018) and individual authors

Country	Author(s)	Sample size	Time Period	Initial Returns
Bangladesh	Islam	84	1994-1998	116%
Brazil	Aggarwal, Leal & Hernandez; Saito; Ushisima	275	1979-2011	33.1%
Bulgaria	Nikolov	9	2004-2007	36.5%
Chile	Aggarwal, Leal & Hernandez	19	1982-1990	16.30%
China	Chen, Choi, & Jiang; Jia, Xie, Zhang, & Ritter	3,116	1990-2016	145.4%
Hong Kong	McGuiness; Agarwal, Liu and Rhee	256	1980-1997	19%
India	Marisetty and Subrahmanyam; Dealogic	2,983	1990-2014	88.0%
Indonesia	Suherman	531	1990-2017	26.4%
Iran	Bagherzadeh	279	1991-2004	22.4%
Japan	Fukuda; Dawson &Hiraki; Hebner&Hiraki; Pettway & Kaneko; Hamao, Packer, & Ritter; Kaneko & Pettway	3,488	1970-2016	44.7%
Jordan	Al-Ali and Braik	53	1999-2008	149.0%
Korea	Dhatt, Kim & Lim; Ihm; Choi &Heo; Mosharian& Ng; Cho; Joh; Dealogic; Lee	1,758	1980-2014	58.8%
Malaysia	Isa; Isa & Yong; Yong; Ma; Dealogic	474	1980-2013	56.2%
Morocco	AlamiTalbi; Hearn	33	2000-2011	33.3%
Saudi Arabia	Al-Anazi, Forster, &Liu; Alqahtani	80	2003-2011	239.8%
Sri Lanka	Samarakoon	105	1987-2008	33.5%
Taiwan	Chen; Chiang	1,620	1980-2013	38.1%
Thailand	Wethyavivorn& Koo-smith; Lonkani&Tirapat; Ekkayokkaya and Pengniti; Vithessonthi	500	1987-2012	35.1%
Tunisia	Hearn, Dealogic	38	2001-2014	21.7%
Turkey	Kiymaz	163	1990-1996	13.10%
UAE	Alanzi& Al-Zoubi	24	2003-2010	270.1%
Vietnam	Tran, Le & Hoang	69	2005-2012	49.1%

The long-run underperformance of IPOs represents the second IPO-related puzzle that has been extensively investigated in the literature (Ritter, 1991)[12]. In his study Ritter (1991) was amongst the first researchers who documented the underperformance of IPOs in the long run. Following his study, a large number of researchers have measured, tested and analysed the IPO long-run underperformance in different international markets. In the US context, Loughran and Ritter (1995), examining a larger sample of 3556 IPOs in 1967-1987, reported substantial negative abnormal returns until the fifth year post-issue. Similarly, Rajan and Servaes (1997) study of IPOs in 1975-1987 found that IPOs exhibit strong underperformance over a five-year period (ranging from negative 17 percent to negative 47.1 percent against the benchmark). In international context, Keloharju (1993), based on a sample of 79 IPOs floated on the Helsinki Stock Exchange in 1984-1989, shows that IPOs on average exhibit returns of negative 22.4 percent over a three-year period. Kunz and Aggarwal (1994) report an underperformance of 6.1 percent for 42 Swiss firms that went public in 1983-1989. After surveying IPOs from 1980 to 1990, Loughran *et al.* (1994) reported that IPOs slightly underperformed on a three-year horizon by 1.2% (BHAR market-adjusted).

The long-term underperformance is not unique to developed markets. McGuiness (1993) reports market-adjusted returns of -18.26 per cent between the first and the 500th day of trading for IPOs in 1980-1990. Cai and Wei (1997) investigate Japanese IPO market and report five-year holding period returns of 62.1 per cent for IPOs and 101.4 per cent for matched firms in Japan in 1991-1992. Loughran and Ritter (1995), however, provide evidence of positive aftermarket returns of IPOs. They find that high average raw returns during the three years after going public were earned in Japan (109.6 per cent), Korea (58.0 per cent) and Singapore (22.5 per cent). This finding is supported by Kim *et al.* (1995) who find that in Korea IPOs outperform seasoned firms with similar characteristics. The comparative evidence on long-run IPO performance in different countries is summarised in table 2.5.

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[12]Note that the IPO long-run price performance has been also examined by early studies, such as Stoll and Curley (1970), Ibbotson (1975), and Stern and Bornstein (1985). Their findings generally exhibited evidence on the existence of negative abnormal returns to IPOs in the long-run. However, the sample size, statistical tests and analytic frameworks were limited.

Table 2.5: Evidence on long-run IPO performances in different countries
The table reports abnormal long term returns of IPOs in different countries.
* depending on market reference index used, **if Venture-Backed or not
Source: Ramazzina (2014) and individual authors

Country	Author(s)	Sample Period	Abnormal Returns, %
Australia	Lee et all (1996)	1976-1989	-51
Austria	Aussenegg (1997)	1984-1996	-47,4
Brazil	Aggarwal (1994)	1980-1990	-47
	Leal (1998)	1976-1992	-58,8
Chile	Aggarwal (1993)	1982-1990	-23,7
China	Wong and Xie (1999)	1992-1996	+18,8 A shares and +7,16 B shares
Denmark	Jakobsen and Sorensen (1999)	1984-1992	-21,6
Finland	Keloharju (1993)	1984-1989	-26,4
France	Leleux (1993)	1985-1991	-11,2
Germany	Loughran&Ljungqvist (1994)	1974-1989	-12,8
	Stehle et al (2000)	1960-1992	-5
Hong Kong	McGuiness (1992)	1980-1990	-18,3
Italy	Giudici and Paleari (2001)	1985-1999	-23,01
	Fabrizio and Samà (2001)	1995-1998	From -28.43 to -49.45*
	Rossi (2012)	1998-2005	-88,37%**
Japan	Cai and Wei (1997)	1971-1992	-18,4
Korea	Kim et al (1995)	1985-1988	80,6
Malaysia	Wong and Uddin (2000)	1989-1997	54
Mexico	Aggarwal et al (1993)	1987-1990	-19,6
Netherlands	Van Fredriklust and van der Geest (2000)	1985-1998	-10
Poland	Aussenegg (2000)	1991-1997	11,5
Singapore	Hin and Mahmood (1993)	1976-1984	-9,2
South Africa	Page and Reyneke (1997)	1980-1991	-50,6
Spain	Alvarez Otero and Gonzales (2001)	1987-1997	5,6
Sweden	Loughran, Ritter and Rydqvist (1994)	1980-1990	-1,2
	Besser, Carlman& Mossberg (2001)	1980-2000	No evidence
	Björcke and Menzel (2006)	1992-2005	-26.08
Switzerland	Ogna et al (1999)	1985-1994	-9,3
Taiwan	Chen and Pan (1998)	1992-1994	-7,22
Thailand	Allen et al (1999)	1985-1992	10
Tunisia	Ben Naceur (2000)	1992-1997	5,7
Turkey	Kiymaz (1997)	1990-1995	44,1
UK	Levis (1993)	1980-1988	-8,1
	Khurshed et al. (1999)	1991-1995	-17.8 (over 5yr)
	Espenlaub et al (2000)	1985-1992	-17,6
USA	Loughran& Ritter (1995)	1970-1990	-17,1
	Ritter (1991)	1975-1984	-16,9
	Loughran and Ritter (2000)	1970-1997	-15,9

2.2.2 Previous studies of the UK market

The first scholar who examined IPO performance in the UK market was Dimson in 1979 and found robust evidence of underpricing in the UK market. Levis (1993); Levis (1995) exhibited the persistence of underpricing in the UK on different sub-markets: the main market and the AIM. Levis also showed that, on average, IPOs listed on the AIM tend to be more underpriced than the ones listed on the main market.

Another study by Keasey and McGuinness (1992) also attempts to explain the underpricing in the UK market, in particular on the USM. They propose a signalling model, which employs multi signals. They argue that to be a credible signal, the variable should be observable by investors. They propose five observable actions as signals to the IPO value, they are: (i) the percentage of shares retained by entrepreneurs, (ii) the levels of planned post-flotation capital expenditure, (iii) the quality of the advising agents, (iv) the disclosure/nondisclosure of forecasted earnings, and (v) the level of underpricing. They derive a total of 12 proxies for these signals and test them against the dependent variable, the market capitalisation of issuers at the close of the fifth day of trading. The result confirms previous signalling models. They find that the underpricing serves as a signal to the market value of a firm. Along with that, they also find that the percentage of shares retained, net proceeds, and the auditor quality signal the firm value.

Using a different set of data from the UK Main market and the USM, Byrne and Rees (1994) also find a significant positive return for five days after the IPOs are first traded. Moreover, the result also shows significant relations between the underpricing and the sponsor reputation, equity retained and dividend per share. Consistent with previous studies, they find a negative relation between the underpricing and the equity retained by old shareholders on the flotation day. Contrary to previous studies, IPOs brought to market by a prestigious sponsor tend to be more underpriced than other IPOs. The result of the relation between the underpricing and dividend per share comes as a unique part of this study. The result shows a robust significant negative coefficient on dividends. Based on the signalling argument, it is argued that dividends may play a role as a signal, so that investors require a lower mark-up for IPOs with high dividend payout.

Using a sample of 222 IPOs during 1984-1988, Keasey and Short (1992) investigate the relationship between the underpricing and the ex-ante uncertainty surrounding IPOs. The underpricing is measured by the initial returns on the fifth day of trading. They employ a number of prospectus information as proxies to the ex-ante uncertainty and find that the level of IPO underpricing on the USM is significantly related to a few factors, such as the percentage of equity retained in the firm by the original entrepreneurs, the amount of new money raised on flotation and the presence of an earnings forecast.

Dewenter and Malatesta (1997) examine public offerings of state-owned enterprise and their difference to privately owned ones. According to the government, the UK privatisation policy objectives are to promote efficiency in the business, and to spread share ownership as widely as possible among the UK population. Moreover, it is also emphasised that the concern is with economic efficiency and not the intention of raising money for the UK Exchequer. However, Dewenter and Malatesta (1997) argue that in order to ensure the achievement of the second objective, the privatisation, IPOs are deliberately underpriced. Furthermore, they also attempt to examine the underpricing deliberation with the motive to raise fund for the government. Using a total sample of 38 UK privatisations and 2,100 private company IPOs obtained from Loughran *et al.* (1994), Dewenter and Malatesta (1997) find that privatisations are significantly more underpriced than the IPOs of private company IPOs. This confirms the evidence found by Keasey and McGuinness (1992). However, they do not find support for the hypothesis that the privatisation IPOs are deliberately underpriced.

Coakley *et al.* (2009) analyse the nature and causes of short-term underpricing of IPOs in the UK in relation to bubble years (identified as the period of 1998-2000 on the basis of the US bubble period) and find significant difference in the IPO performance of the bubble years issues and the rest of the sample. They argue that reputable underwriters and venture capitalists, generally playing a certification role, during the bubble years, ceased their traditional function and took advantage of exuberant investor sentiment timing the issues. The combination of venture capitalists and prestigious underwriters in the bubble years is associated with substantially larger levels of underpricing.

A study on IPO long run performance based on the UK data is conducted firstly by Levis (1993). He investigates the UK long-run performance of a sample of 712 UK IPOs floated during 1980-1988. He recognizes the importance of the size effect for the UK stocks and reports long-run abnormal returns based on three alternative benchmarks: the Financial Times Actuaries All Shares (FTA) index, the Hoare Govett Smaller companies (HGSC) index, and a specially constructed all shares equally-weighted index. The result confirms that over three years after the flotation, IPOs suffer from underperformance of between -8% and -23% depending on the market benchmark. Using a similar method, but a longer time period to Levis' study, Khurshed *et al.* (1999) examine the UK IPO long-run performance during 1991-1995. They find an average of -17.8% abnormal returns over five years after the IPOs.

In addition to examining the UK IPO long-run performance, Khurshed *et al.* (1999) also investigate the relationship between some firms' conditions pre-IPO and the long-run performance. They hypothesise that the long-run performance of IPO is a function of the managerial decisions and performance of the firm prior to going public. Similar to other studies, they find a negative and strong relation between the IPO underpricing and the long-run performance for the sample as a whole. However, when the sample is split into small and big firms, the significance disappears in the small firm sample. They also find a negative relationship between the firms' pre-tax profit for the last three years before listing and the long-run performance. This implies that firms, which gained more profits before the listing, tend to underperform the market after three years traded. Moreover, they find some moderate relations between the IPO long-run performance and flotation cost, net asset a year before listing, and the percentage of equity retained at the flotation date. Interestingly, they find that the long-run performance of multinational companies (MNCs) is better than domestic companies. However, in contrast to other studies they do not find significant evidence for the relation between the underwriter reputation, firm size, and the long-run performance.

Espenlaub *et al.* (2000) re-examine the long-run performance of the UK IPOs. Using more up to date data (1985-1995), they compare the IPO long-run abnormal returns based on a number of alternative methods: CAPM, size control portfolio, Value weighted multi-index using HGSC index, Fama-French value weighted three factor model, and Ibbotson’s Returns Across Securities and Times (RAST) approach. In line with other studies, they find that the long-run abnormal returns vary across the benchmarks. The result shows a range of negative and statistically significant abnormal returns over 60 months after the IPO dates for CAPM, size control portfolio, Fama-French factor, and RAST. Slightly negative and statistically insignificant abnormal returns are found when using the HGSC index.

Coakley *et al.* (2007; 2008) investigate hot market and long run performance of venture-backed and non-venture IPOs on the sample of 593 IPOs in the UK over the period from 1985 to 2003. The study shows that hot market IPOs significantly underperform those issued during normal markets and provides empirical evidence of venture capitalists exploiting investor sentiment during hot markets which is confirmed by a significantly negative relationship between underpricing and long-term returns for venture-backed IPOs during hot markets.

Ali (2017) using a data set of 1,926 nonfinancial UK IPOs, launched on the London Stock Exchange during the time period of 1987–2007, tests for the behavioural timing hypothesis. The behavioural timing hypothesis attributes timing of IPOs to a window of opportunity during which firms time their offerings to deliberately exploit stock misvaluations and investor sentiment in the stock markets. One empirical approach proposed to test the behavioural timing is to inspect the (mis)valuation of IPOs and how it affects the post issue stock performance. To misevaluation is examined through investigating how IPOs are priced relative to an intrinsic or fair value estimated using valuation models. Other indicators have been also proposed to proxy for this misvaluation, such as issuance intensity as managers behaviourally timing their offerings are expected to exploit increasing stock misvaluations associated with periods of hot issuance volume periods.

Overall, Ali (2017) found strong evidence in support of the behavioural timing hypothesis. With respect to the stock returns in the short run, his results indicate the average underpricing more than doubles for hot market IPOs compared to cold market IPOs, with being significantly different between the 2 markets. With regard to long-run abnormal returns, he also finds consistent evidence of the behavioural timing hypothesis. Hot market IPOs exhibit highly significant negative returns, whilst cold market IPOs constantly exhibit insignificant abnormal returns.

These findings are in line with prior evidence shown for U.S. IPOs by Helwege and Liang (2004) and Yung *et al.* (2008) and for UK IPOs by Michailides (2000). In addition the findings on the post issue operating performance stand in line with the behavioural explanations of the operating underperformance by hot market IPOs. In specific, the hot market IPOs exhibit significantly weaker performance than cold market IPOs both before and after adjustment for industry effects in every year following the IPO, and the differences are statistically and economically significant between hot and cold IPOs.

Ali (2017) shows that stock price and operating underperformance in the post issue are directly linked to the degree of IPOs' misvaluation. Specifically, the stock price and operating performance are found to be significantly different between hot markets IPOs and cold market IPOs 3 years post issue. Ali (2017) also shows that overvalued IPOs have lower long-run stock returns, but outperforming operating performance, than undervalued IPOs do.

2.3 Theories of IPO Performance

The previous section provides an overview of the research area of the Initial Public Offerings, particularly of the IPO process and the short term underpricing and aftermarket performance anomalies. This section discusses the current state of literature regarding the causes and the explanations scholars have suggested over the past years for such anomalies.

2.3.1 Short-term Underpricing

Several theories have been proposed to explain the IPO underpricing. Baron (1982) argues that underpricing is caused by the information asymmetry between the underwriters and the issuers. Beatty and Ritter (1986) explain the level of underpricing by the level of ex-ante uncertainty that surrounds the value of an IPO. To reduce that uncertainty issuers and underwriters use 'signalling mechanisms' to communicate with investors. According to the behavioural argument, over-enthusiastic investors drive the price of an IPO beyond its true fundamental value on the listing day (Ritter and Welch, 2002). The three sections of this chapter provide the overview of the asymmetric information theories, signalling theories and behavioural theories of underpricing.

Asymmetric information theories and signalling theories are traditional theories of IPO underpricing. They are based on the assumptions of market efficiency (J. Ritter, 2003).

2.3.1.1 Asymmetric information theories of IPO underpricing

According to Daily *et al.* (2003), most studies of pricing of IPO argue that at the root of underpricing is information asymmetry (Rock, 1986; Benveniste and Spindt, 1989; Karlis, 2000; Kiymaz, 2000); Ritter and Welch (2002); (Kennedy *et al.*, 2006). Information asymmetry manifests in two primary forms with regard to IPOs. The first one is between the issuer and the underwriter and the second one is between the underwriter and the investors or various classes of investors (market).

Potential investors that face higher levels of uncertainty regarding the firm’s performance potential will submit purchase orders only at a discount to the expected value of the share price. This results in a situation where informed investors contract to purchase available shares of high-quality firms, leaving uninformed investors with the opportunity to purchase only shares in firms with greater uncertainty regarding the firm’s performance prospects. Uninformed investors realize that, on average, they will earn below-average returns. Underwriters, therefore, must discount (underprice) new issues to attract uniformed investors to the overall pool of potential investors (Rock, 1986; Daily *et al.*, 2003).

Asymmetric information theories include two types of information asymmetry: (i) information asymmetry between issuers and investors (Adverse Selection theory), and (ii) information asymmetry between issuers and underwriters (Agency-based theory).

One of the first theories of underpricing, the Adverse Selection Theory, was introduced by Rock (1986). According to the theory, investors are divided into a group of informed and uninformed investors. The informed investors know the true value of the stock and the uninformed investors invest randomly without much knowledge of the firm. The theory assumes that the prices fluctuate according to the changes in the demand for stock (Rock, 1986). It is argued, therefore, that companies intentionally underprice IPOs as a rational behaviour in order to increase the demand for the issue and induce the uninformed investors to participate in the market. Companies of high value underprice less as the demand for their shares is already large (Karlis, 2000). Hence, pricing mechanism suggested by Rock implies that IPO underpricing varies directly with uncertainty about the firm and indirectly with the true value of the issuing firm. Therefore, it can be assumed that the level of underpricing depends on the firm size: larger companies have lesser underpricing and smaller companies have higher underpricing.

According to Baron (1982), underpricing can be explained through the agency-based theory that assumes the agency-principal relationship between issuers and underwriters. The theory states that the issuing firm does not know its own true value and must rely on the auditing of outside companies and the underwriters to report accurate information. The issuing firm leaves some money for the underwriter acting as an agent to make sure they act in the firm's best interest, disclose all the information accurately, and put in the necessary effort to market the shares.

However, Ritter and Welch (2002) argue that Baron's (1982) hypothesis is neither proved nor discredited as underwriters may be induced to underprice their own offerings to support their argument for it as a necessary cost of going public.

Hence, initial first-day returns of the IPO reflect the uncertainty with respect to the underwriter's information that the issuer faces. However, Baron's model does not take into account competition in the investment banking business which would automatically ensure a certain amount of agent loyalty. The theory also does not take into consideration the fact that the underwriters are concerned with supporting their own reputation and, therefore, have additional incentive to produce truthful information about the firm's value (Ritter and Welch, 2002).

Therefore, as the size and reputation of the underwriter increases, the incentive to protect its reputation also increases and the underwriter is more motivated to produce truthful information. Consequently, higher underwriter's reputation decreases the uncertainty of the information provided and leads to lower IPO underpricing (Kiymaz, 2000; Ritter and Welch, 2002).

2.3.1.2 Signalling theories of IPO underpricing

Signalling theory has received widespread application but is especially relevant to the IPO context. This theory is largely premised on the need to resolve the aforementioned information asymmetry problems and suggests that certain variables or indicators send signals to potential investors about the capabilities and thus, future value of firms. Investors' assessments about this future value will impact the price at which they are willing to purchase IPO shares.

There are two central premises of signalling theory. The first is that the intended signal must be observable and known in advance (e.g., prior to the IPO). The second is that the signal must be costly or difficult to imitate. A primary mechanism for managers to send signals regarding firm quality is the prospectus. The prospectus is one of several documents the SEC requires of firms undertaking an IPO (Deeds *et al.*, 1997; Welbourne and Andrews, 1996). The prospectus provides considerable detail regarding the firm, its operations, and its management that may yield insights into the firm's performance potential. Firms are legally liable for any misleading or inaccurate information; therefore, these documents are highly accurate and typically quite consistent in format across firms (Daily *et al.,* 2003; Tinic, 1988).

Signalling theory includes a number of models that are based on the assumption that the IPO firm has perfect information about its own value and investors are the uninformed entities. The investors then value the firm based on several different signalling mechanisms used by issuers, such as for example, number of shares issued for the IPO or the reputation of the underwriter (Karlis, 2000).

Willenborg (1999) presents a theory that explains demand for IPO shares as a function of several signalling mechanisms which relate to the size and status of the issuing firm and the size and status of the auditing firm and/or the underwriter. The theory distinguishes *informational signalling* and *insurance signalling* effects.

For example, if a firm hires a more reputable underwriter, the signal to the investors is that the firm will stand to benefit from having its financial statements more accurately analysed. This is the informational signalling effect. The reputation of underwriter also acts as an insurance signalling against possible overpricing of an IPO and future securities litigations. Also, size of the firm and the years of operation are often used as indicators or informational signals of the quality of the IPO. Both informational signalling and insurance signalling increase the demand for the IPO (Willenborg, 1999; Karlis, 2000). Table 2.6 summarises the models of the signalling theory.

Table 2.6: The models of the signalling theory of underpricing
The table presents an overview of the signalling theories of IPO underpricing.

Model	Description
Information momentum model	Underpricing the issue attracts attention of more investors through enhanced coverage generated by research analysts and media and increases the demand for the stock (Aggarwal *et al.*, 2002; Bradley *et al.*, 2003; Kennedy *et al.*, 2006)
Entrepreneurial losses model	When engaging in an IPO managers face a trade-off between underpricing the shares and marketing the IPO through expensive mechanisms. The extent to which issuers are concerned about underpricing depends on the amount of shares they sell at IPO, therefore, underpricing decreases with increased promotion costs and increases with higher insider retention (Habib and Ljungqvist, 2001).
Market feedback model	Issuers choose the value of IPO and the offer price to generate higher coverage by informed investors (such as analysts). This increased coverage is then subsequently used to conduct a seasoned equity offering (SEO) (Van Bommel, 2002). The model predicts positive relationship between initial underpricing and intended SEO (Kennedy *et al.*, 2006).
Legal liabilities model	Threat of legal actions by investors in case of an overly inflated price of an issue is sometimes used as an argument for underpricing. As lawsuits are time-consuming, very costly, and have a negative impact on reputation, issuers may choose to underprice in order to reduce their legal liability (Hughes and Thakor, 1992).
Tax model	Investors are compensated for paying taxes via a reduced offer price. Level of IPO underpricing depends on short-term capital tax regime. IPO underpricing and long-term capital gains tax rate exhibit a negative relationship (Hughes and Thakor, 1992).

In general, signalling theory assumes that the underwriters take the signalling effects into account when agreeing to an IPO contract. The underwriters lower the share price to reduce downside risk of either damaging their reputation by having an undersubscribed and overpriced offering or by drawing securities litigation from investors in a high-risk firm. The uncertainty about the firm making the issue and the motive to maintain and improve the firm’s credibility is the catalyst behind the underwriters’ incentive to reduce the price of the offering(Kennedy *et al.*, 2006). The most important determinants of the uncertainty according to signalling theory are the size and status of the firm and the size and status of the underwriter. Therefore, signalling theory predicts that as the size and status of the firm (and/or the underwriter) increases, the degree of underpricing will decrease (Kiymaz, 2000).

Signalling theory is consistent with the perspective that IPO issuers are more informed than investors. Specifically, IPO firm managers will typically have detailed knowledge about the firm's quality that is generally unavailable to outsiders (Anderson *et al.*, 1995; Keasey and Short, 1992; Lawless *et al.*, 1998; Marshall, 1998). As a result, these managers must find a mechanism for communicating their firms' quality - reducing the level of *ex ante* uncertainty - to potential investors in order to reduce the need to discount the stock price in order to attract investors, especially less-informed investors (Beatty, 1989; Daily *et al.*, 2003; Carter and Manaster, 1990).

The vast majority of the available IPO underpricing research relies on information available from the prospectus. This information sends signals, intentionally or otherwise, to potential investors. Investors will utilize this information (i.e., signals) in determining the price at which they are willing to buy IPO shares on the first day of trading. Research has identified a number of indicators that are investigated as potential signals of IPO firm quality. These included retained equity, underwriter reputation, auditor reputation, the number of risk factors, firm size, firm age, the number of uses for the proceeds generated from the IPO, venture capital equity, the offer price, and IPO gross proceeds. Each of these indicators serves as information that issuers present, via the prospectus, such that potential investors gain insight into the firm and its management. Importantly, this information helps reduce the level of uncertainty surrounding the stock offering (Daily *et al.*, 2003). Appendix A presents an overview of these indicators.

It should be reiterated that these indicators reflect the measures empirically examined in the published research. There are undoubtedly alternative measures that could serve as signals of IPO firm quality, thereby reducing uncertainty.

2.3.1.3 Behavioural theories of IPO underpricing

However, many researchers argue that traditional theories of underpricing are not powerful enough to explain existing inefficiencies. An emergent view on IPO underpricing is based on the behavioural finance theories of decision-making and irrationality of market players

(Lowry and Schwert, 2002; Ritter and Welch, 2002; Amihud *et al.*, 2003; Ljungqvist and Wilhelm, 2005; Cornelli *et al.*, 2006; Hirshleifer and Teoh, 2009).

The three principal behavioural explanations of IPO underpricing include: (i) cascades or herding model, (ii) investor sentiment model, and (iii) prospect theory and mental accounting model. The brief overview of the theories is presented in the Table 2.7.

Table 2.7: Behavioural theories of IPO underpricing
The table presents and overview of the three principal behavioural explanations of IPO underpricing.

Model	Description
Cascades/ Herding model	Informational cascades are formed as later investors monitor the performance of an IPO and gather information from earlier investors. If a successful initial sales effort of an earlier investor is perceived to be due to favourable information that the investor had about the IPO, later investors will be more inclined to participate in the IPO. Herding occurs for two reasons: as a result of information shortages and out of fear on behalf of investors to adopt a different strategy. These investors often ignore private information out of conformity to the general tendency (Anderson and Holt, 1997; Ritter and Welch, 2002; Hirshleifer and Teoh, 2009).
Investor sentiment model	The model states that many firms with poorer performance time their initial float on the stock market to coincide with periods of high investor sentiment (Lowry and Schwert, 2002) or when irrational investors are highly confident. The level of investor sentiment can be deduced from the grey market prices[13]. High demand for the newly issued shares indicates investor confidence in the future performance of the issuing firm and is often associated with market participants being over-optimistic (Ljungqvist and Wilhelm, 2005).
Prospect Theory/ Mental Accounting model	Issuers treat the opportunity cost of leaving money on the table as less important than the direct fees. They don't get upset about the severe underpricing because of their loss-averse preferences: they gain a lot on their shares. Such 'irrational' behaviour of CEOs benefits the underwriter that is rehired to manage future equity issues for higher fees. Switching of underwriters occurs when issuers are dissatisfied with the underwriter's performance during the IPO (Loughran and Ritter, 2002).

From the point of view of informational cascades and herding model, issuing firms use underpricing to prevent development of a negative informational cascade (Ritter and Welch, 2002). This theoretical model has been tested by Amihud *et al.* (2003) who argue that underwriters have an underlying motivation to form a positive cascade as the responsibility for unsold shares lies with them. As demand is boosted through the cascades the chance of leftover unwanted stock is greatly reduced. Therefore, underwriters

[13]Grey market is the market just before the IPO takes place. It consists of small investors who sell stock on a forward basis i.e. the buyer receives the stock when the IPO is complete.

underprice to form a positive cascade, and as better informed investors enter the market or new information becomes available, the IPO underpricing decreases (leading to perceiving IPOs as underperforming in the long run).

Investor sentiment model, based on overconfidence and overreaction heuristics, argues that the presence of sentiment investors increases the chances of poorly informed rational investor receiving shares at a discounted price. Therefore, it can be argued that attracting sentiment investors through underpricing of a new issue can protect uninformed investors from making losses and exiting the market (Leite, 2005). Therefore, firms involved in IPO can (and often do) exploit investor sentiment through carefully selecting the timing of the IPO issue (it coincides with the times of high investor confidence/over-optimism) and the level of underpricing (to generate higher demand that boosts investor confidence levels) (Cornelli *et al.,* 2006).

Prospect theory and mental accounting model looks at the behavioural measure of the issuer’s satisfaction with the underwriter’s performance. It states that IPO firms are less likely to switch underwriters when they are highly satisfied with the underwriter's performance. Underwriters also extract higher fees for subsequent transactions involving satisfied decision-makers (Ljungqvist and Wilhelm, 2005).

2.3.1.4 Specific factors

The firm specific characteristics such as age, size, industry, ownership structure, brand loyalty, competitive advantage of a firm, evolution of firm, management quality and its reputation etc. are critical in determining the degree of IPO underpricing. These characteristics communicate certain implicit as well as explicit information regarding the firm and its prospects. Some industries are highly regulated and require greater amount of disclosure (for example financial services). Public going firms belonging to such industry are likely to have lower degree of informational asymmetry due to the requirement of additional regulatory disclosures. Similarly, ownership stake of insiders, managers and other stakeholders have an impact on the agency costs and have a bearing on the pricing. Such endogenous factors combined with their externalities affect the transparency of meaningful information useful for the purpose of valuation. Therefore, these firm specific factors have an impact on reducing or accentuating the degree of informational asymmetry.

The firm specific factors are endogenous in nature and can be addressed by the firm once they are identified. Some of these important factors are identified in literature as business group affiliation and ownership structure.

When the process of IPO issuance is carried out, the external environmental factors have significant impact on the information flow, price perception, probability of success of the issue, and its impact on the security prices. Such exogenous factors also influence the decision of going public. Therefore, macroeconomic environmental factors are critical in influencing the degree of informational asymmetry and consequently, the degree of IPO underpricing. Some of these factors identified through literature are timing of IPO issuance, signalling by the firm and waves or IPO cycles. The role of both the firm specific (endogenous) factors and the economy specific (exogenous) factors in determining the degree of underpricing is explained in this section.

2.3.1.4.1 Business group Affiliation

Business group affiliation is an important characteristic that influences the performance of member firms. These studies clearly indicate that business group affiliation and diversification have significant impact on the performance of member firms that influences the valuation of an IPO. When business group affiliated firms decide to go public, the influence of business group is twofold. Firstly, business group helps in controlling the opaqueness of available information and secondly, it provides certification effect due to its existing reputation. Fisman and Khanna (2004)find that most often business group affiliated firms share the common pool of labour and its reputation.

Therefore, IPO issuance by group affiliated firm gets advantage of its established network of other member firms and reduce degree of informational asymmetry. Khanna and Rivkin (2000) observe that the performances of member firms belonging to the same business group co-vary. Based on this established relationship, the investors can assess the performance of public going firm with the help of additional information associated with the business group and other firms associated with it. Gopalan *et al.* (2007) support the argument mentioned above stating that business group also helps in providing financial stability due to the availability of internal credit. Firm characteristic of a group affiliation is linked with the degree of IPO underpricing.

Friedman *et al.* (2003) support the phenomenon of propping where entrepreneurs' use their personal money to support the firm when it is in trouble and benefit the minority shareholders. Therefore, tunneling and propping shows a reverse process and have distinct influence on the performance of firms that are affiliated to business group. Kim and Sung (2005) have identified the reasons for firms to go public. They observed that business group affiliated firms are more likely to go public a) if the ownership stake is concentrated with the family members that control the group; b) if there is low disparity between ownership and controlling stake by the group members; c) if the contribution by the firm to family's control is low; and d) if the firm has not benefited enough through its internal capital market.

Another important aspect associated with the business group is the degree of diversification of its operations. Khanna and Palepu (2000) find that the degree of diversification has significant positive impact on firm performance up to a particular threshold of diversification. The degree of diversification brings in economies of scale and scope of operations which enables the firm to reduce the overall cost. It also helps the firm to explore new opportunity through synergy (Gomes and Livdan, 2004). The linkage between the firm performance and degree of diversification is extrapolated to the shareholders' wealth and pricing of initial equity offerings. Boulton *et al.* (2013) argue that diversified firms are relatively less underpriced as compared to focused firms since degree of diversification helps in reducing informational asymmetry.

Marisetty and Subrahmanyam (2010) empirically prove that IPOs belonging to business group affiliated firms show greater degree of underpricing than the standalone firms. They attribute higher degree of underpricing due to tunnelling[14] effect that outweighs the certification effect associated with the business group affiliated firms. The study by Ghosh (2005) finds that large equity issues of business group affiliated firms are more underpriced during hot market condition compared to stand alone firm. Further, they find the support

[14]Intra-group loans that the member firm offers to weaker firm to avoid the bankruptcy of the weaker member firms. Internal capital market is used to finance the firm that is in financial distress at free of cost. This is done to avoid the negative spillover effect that will be created if the member firm goes bankrupt.

for signalling theory where highly underpriced business group affiliated firms are likely to revisit the market to raise capital in future.

Therefore, this study supports underpricing as a signalling strategy by group affiliated firms to leave good taste in investors' mouth to ensure the success of further equity offerings. On the other hand, Beckman *et al.* (2001) observed that business group affiliated firms of Japan have shown lesser degree of underpricing than that of others since they are expected to produce stable earnings in the future. Lower degree of underpricing of keiretsu firms is also attributed to their relationship with the main bank. The close linkage with the financial institutions reduces the degree of informational asymmetry where the earnings and other financial statements are disclosed. The choice of a firm between profit maximization and profit stabilization impacts the valuation of the firm. Therefore, the country specific environment in which business groups are operating is one of important determinants of its performance.

Based on the literature, it is concluded that the performance of business group affiliated firms significantly differs as that of standalone firms. Tunnelling, propping and network effect influence the performance and valuation of the group affiliated firm. Similarly, degree of diversification of a business group and the firm has significant role in obtaining economies of scale and scope. The IPOs issued by group affiliated firms show mixed results in terms of its effect on the degree of IPO underpricing. The empirical results are based on country specific environment and specific features of a business group.

2.3.1.4.2 Ownership structure

Ownership stake of promoters, managers and other institutional investors helps in signalling the agency related matters. Since, pre-IPO ownership is concentrated with few promoters/entrepreneurs there is less monitoring cost and low liquidity to promoters' wealth. Ownership structure of a public going firm is closely linked with liquidity and monitoring. Issuance of IPO brings liquidity to owners' fund and provides dispersed ownership that increases the monitoring cost. Pagano and Roell (1998) find that ownership held by the promoters' act as a signal of firm quality to the investors. The owners have superior information. The process of liquidating the promoters' stake through IPO provides signals and investors get information about the companies' prospects. In case of IPO, the regulators enforce the lockup period where insiders cannot trade for fixed duration and insider information is secured and does not influence the price of the security.

The duration of lockup period is determined by the regulator and differs for each country. The restriction through lockup is required to control the participation of insiders who are at informational advantage (including promoters, employees, and venture capital investors) in selling their stock holdings in the secondary market. Other investors can interpret the action of insider and it influences the trading volume and price in the secondary market. Brav and Gompers (2003) propose three possible explanations for the existence of lockup period.

The first possible explanation supports signalling hypothesis. The promoters of high quality firm would like to retain the larger ownership stake for longer time period. Hence it signals the firm quality. Second possible explanation is based on the commitment hypothesis where lockup period serves as a commitment device where the volume, volatility and price reaction is controlled during the initial trading period. The reputed underwriters are less likely to release the lockup provision early than the actual expiration period. This is possible if the country specific regulatory norms offer the discretionary power of early release of expiration period with the underwriter. And the third possible explanation is linked with the discretionary power of underwriter to release the early lockup. Underwriters are likely to demand additional compensation to execute the trade prior to lockup expiration. Their empirical results support the price decline after lockup expiration period due to downward sloping demand curve supporting similar findings by Field and Hanka (2001). Therefore, lockup period is used to overcome informational asymmetry. Their empirical findings support that the firms who are likely to be subject to greater informational asymmetry have longer lockup period.

Based on the above explanation associated with lockup period, Katti and Phani (2016) interpret that the ownership structure and the proportion of ownership held by various stakeholders, that are subject to the trading restriction under the lockup period, are likely to influence the IPO returns.

Booth and Chua (1996) develop a model and empirically prove that the degree of underpricing is necessary to obtain the initial dispersion of ownership through higher oversubscription because it has greater influence on the liquidity in the secondary market. Stoughton and Zechner (1998) explain the degree of underpricing as one of the tools to attract block holders who actively take part in monitoring activities.

The ownership stake of managers' is an important determinant of IPO underpricing. Aggarwal *et al.* (2002) prove that managers induce degree of underpricing to maximize their wealth. Therefore, the degree of underpricing is positively influenced by percentage ownership held by the managers. The increased first day return shifts the demand curve upwards and the managers strategically diversify the fund invested after the lockup expiration period at higher price. As managers would like to maximize their wealth by underpricing the IPO, their motivation to bargain for higher offer price with underwriter is very low (Loughran and Ritter, 2002) resulting in higher degree of underpricing.

Given the above, it is inferred that pre-IPO ownership structure has greater influence on the degree of underpricing. Involvement of institutional investors provides active monitoring and helps in reducing the degree of informational asymmetry. The ownership stake of promoters, other institutional investors and managers influence the degree of IPO underpricing. Therefore, pre-IPO ownership structure of a firm plays pivotal role in determining the degree of IPO underpricing.

2.3.1.4.3 Economy specific factors

The decision of "when to issue initial equity offering?" is quite critical for the issuer. Market timing theory justify the decision of issuer based on market timing by considering different market parameters such as volatility, number of IPOs belonging to the same industry and IPO volume in the market. Market timing of IPO is differentiated into 'hot' and 'cold' market period. In hot market period large number of firms issue IPOs (Ritter, 1984). Lucas and McDonald (1990) find that adverse macroeconomic or industry related conditions can lead to undervaluation of firm. In such cases, the issuer will hold the decision of going public because it will not fetch appropriate price in comparison with the market return and influence the probability of success of an IPO.

Benveniste *et al.* (2003) observe that public going firms get advantage of issues offered by their industry peers. The public going firms gets benefited through the information spillover enabling indirect learning for an issuing firm that is exhibited through price revision. As a result, this indirect learning helps the firm to take advantage and anticipate issue related uncertainties instead of relying on direct learning that takes place through the process of book building. This situation allows large underwriters to spread the cost of information that leads to degree of underpricing over multiple issues. Bouis (2009) studies 4524 IPOs between 1986 and 2007. The study examines the time period between filing of registration statement and the actual issuance date and found that the firms opt to go public when the market returns are higher, and the volatility is relatively low. This way the issuer tries to formulate short term market timing strategy to fetch high price for the IPO.

Schultz (2003) proposes the theory of pseudo market timing. According to this theory, the managers take a decision of going public when they anticipate maximum likelihood of obtaining higher price for the IPO so that it can maximize the issue proceeds. Based on their anticipation, IPOs are launched when their valuation normally reaches the peak. However, most often issuers (managers) do not come to know about this peak and therefore, the offer prices of other IPO issues keep increasing till the market reaches its peak and starts shows decelerating trend.

Literature indicates that market timing of IPO has significant impact on valuation, information production and dissemination and success of an IPO. Therefore, decision of when to issue new equity has significant impact on the degree of IPO underpricing. With the above given explanation associated with various factors influencing the degree of IPO underpricing, they are categorized in the form of endogenous (firm specific) factors and exogenous (economy specific) factors. In addition to these endogenous and exogenous factors, issuers have discretionary decision making capacity associated with most of the issue specific factors. Table 2.8 provides the summary of these factors.

Even though IPO underpricing has enormous amount of literature, it still leaves few open ended questions. Market timing theory elaborates on various capital market related cycles. However, the optimal time of IPO issuance during the organizational life cycle of a firm is not yet clear. The literature is silent on identifying any optimal point for a firm to issue an IPO based on its operational conditions that can maximize the issue proceeds by minimizing the degree of IPO underpricing.

Table 2.8: Reasons of Underpricing
The table presents an overview of the issue specific factors relating to the reasons for IPO underpricing.

Reasons of Underpricing	Theory/ Category	Author
Discount offered to attract investors	Mystery	Ibbotson & Jaffe (1975)
Information asymmetry	Information asymmetry	Kevin Rock (1986)
Insider holding and ability to convey intrinsic value	Signalling	Grinblatt& Hwang (1989)
Signalling for the success of future issues	Signalling	Welch (1989)
Herd behaviour by investors	Cascading	Welch (1992)
Information production and insider ownership	Agency	Chemmanur (1993)
Reputation of underwriter influence the price	Certification Hypothesis	Chemmanur&Fulghieri (1994)
Analyst coverage-investors optimism	After market activity	Rajan&Servaes (1997)
VC backed IPOs outperform	Certification Hypothesis	Brav& Gompers (1997)
Reputed underwriter less Underpricing	Certification Hypothesis	Carter *et al.* (1998)
Underperformance after Lockup expiration	After market activity	Field &Hanka (2001)
Role of underwriter in price stabilization; executing overallotment option	Role of Intermediary	Aggarwal (2000)
Money left on the table by underwriter	Role of Intermediary	Loughran& Ritter (2002)
Allocation bias	Role of Intermediary	Aggarwal *et al*. (2002)
Book building less risky	Issue mechanism	Sherman (2005)
Pseudo Market timing	Market timing	Schultz (2003)
Managerial ownership and lockup expiration period	Agency	Aggarwal *et al.* (2002)
Flipping activity by institutional investors	After market activity	Aggarwal (2003)
Auction less underpriced as compared to book building	Issue mechanism	Derrien& Womack (2003)
Underwriter and publicly available information	Role of Intermediary	Lowry &Schwert (2004)
IPO features and syndicate structure of underwriter	Role of Intermediary	Corwin & Schultz (2005)
Survey of CFOs for reasons to go public and reasons for underpricing	Theory and practices	Brau& Fawcett (2006)
Linkage between past IPO returns, investors sentiment and future oversubscription	Macroeconomic	Kaustia&Knupfer (2008)
Influence of credit rating on IPO underpricing	Firm specific	An & Chan (2008)
Learning from industry peers	Macroeconomic	Colaco*et al.* (2009)

2.3.2 Aftermarket performance

This section lays out the literature regarding the second anomaly which is the long-run IPO underperformance. The first academic study to spot such anomaly was published by Aggarwal and Rivoli in 1990.The authors found evidence of substantial negative abnormal returns. Aggarwal and Rivoli (1990) referred to the phenomenon as a fad: IPOs, which were systematically overvalued in early trading, underperformed the market index. The first study focusing formally on why IPO underperformed is by Ritter (1991), who points out several reasons why the long-run performance of IPO is of interest.

Firstly, from an investor's viewpoint, the existence of price patterns may present opportunities for active trading strategies to produce superior return. Secondly, a finding of non-zero after-market performance calls into question the informational efficiency of the IPO market. Thirdly, the volume of IPOs displays large variations over time. Finally, the cost of external equity capital for companies going public depends not only upon the transaction costs incurred in going public, but also upon the returns earned in the aftermarket. Ritter's (1991) study suggests that at some point after going public the abnormal return on IPO may be negative.

2.3.2.1 Fad Theory

This hypothesis is proposed firstly by Aggarwal and Rivoli (1990). As mentioned above, they find evidence of IPO shares underperforming the market over longer time horizons. However, they could not find any rational explanation to this phenomenon and referred to this situation as a fad in the IPO market.

Ritter (1991) drawing on a sample of 1,526 firms that went public in the US during 1975-1984, examines their performance after three years trading, and compares them to the performance of matching firms by industry and market capitalisation. He finds evidence that is consistent with the notion that many firms go public near the peak of industry-specific fads. Further, he also finds that a strategy of investing in IPOs at the end of the first day of public trading and holding them for three years would have left the investors with only 83 cents relative to each dollar from investing in a group of matching firms listed on the US markets. Moreover, younger firms and firm that went public in heavy volume years did even worse than average. Thus, it can be argued that while new issues are a profitable investment opportunity if bought at flotation, they should not be held long beyond the first few weeks or months of trading.

Ritter (1991) suggests three possible explanations for the long-run underperformance: risk mismeasurement, bad luck, and fads. However, the empirical evidence does not support the first two explanations. It shows that there is a robust tendency that firms go public when investors are overoptimistic about firms' prospects so that investors overpay initially. Then, share prices are corrected, as more information becomes available. Therefore, expected long-run returns decrease in initial investors' sentiment. This result is consistent with the result of Aggarwal and Rivoli (1990) study.

Later, Loughran and Ritter (1995) extend Ritter's (1991) study. They argue that firms tend to make IPOs when they see firms in the same industry trading at high earnings and market-value to book-value multiplies. This effect is reinforced by the positively biased marketing campaign, which accompanies the share offering. Investors appear to value issuing firms as if the rapid earning growth, which they experience in the period before the offering, will continue forever. However, in fact this rapid growth often ends shortly after the offering. They also suggest that it is difficult for more rational investors to exploit other investors' overvaluation of IPO stocks. Other explanations are firstly, that when the price support provided by the underwriters are withdrawn, the market will make an adjustment and this results in underperformance of IPO; and secondly, it is difficult at the best of times to control correctly for risk over long time horizons.

Replicating Ritter's (1991) study, Levis (1993) finds that the pattern of returns on the UK IPOs is remarkably similar to that of the US issues. This phenomenon is also found in some other countries, such as Finland, Australia, Brazil, and Canada (Jenkinson, 1993; Lee *et al.*, 1996). In sum, the finding that IPOs underperform implies that the costs of raising external equity capital are not inordinately high for these firms. The high transaction costs of raising external equity capital are partly offset by the low realised long-run returns, at least for those firms going public at times when investor sentiment is optimistic. Consequently, the small growth companies that predominate among firms going public do not necessarily face a higher cost of equity capital than that faced by the more established firms.

2.3.2.2 Heterogeneous Expectations Theory

Heterogeneous and time-varying expectations of investors are shown by behavioural economists to violate Bayes' Rule as well as rational choices (Kahneman and Tversky (1982). "Heterogeneous expectation hypothesis" was firstly proposed by Miller (1977). He argues that in markets with restricted short selling, such as IPOs, share prices were determined by overoptimistic investors. Over time, as the restriction weakens and more information becomes available, share prices are corrected. Short run overvaluation and greater long run underperformance are therefore, generated by the divergence of opinion. By using three proxies of divergence of opinions (the percentage opening bid-ask spread, the time of the first trade, and the flipping ratio), Houge *et al.* (2001), on a sample of 2,025 US IPOs during the 1993-1996 period, find that IPOs with a high proportion of flipping activity, wider opening spreads, or long opening delays, significantly underperform the market for up to three years after the offering. Therefore, Houge *et al.* (2001) conclude that IPOs with greater uncertainty, will exhibit poor long run return.

In accordance with the above, Rajan and Servaes (2002) suggest that two market conditions might help explaining IPO anomalies: investor sentiment (or price-insensitive demand) and feedback trader risk of propensity of investors to chase trends. According to their model, over-optimism drives price above fundamentals and since prices are supposed to be reverting to fundamentals in the long run, returns are more negative for listings or issues that came to market during periods when sentiment was high.

2.3.2.3 Agency Theory

Carter *et al.* (1998) conduct a study on several proxies used to measure underwriter reputation, using data from a sample of IPOs in the US market during 1979-1991. Only firm commitment offerings with domestic offerings of at least $2,000,000 are considered. The primary method used to examine the explanatory power of the underwriter reputation measures is the OLS regression with initial return as dependent variable in model one and long-run performance as dependent variable in model two. In each model, they run a number of underwriter reputation measures (Carter and Manaster, 1990; Johnson and Miller, 1988; Megginson and Weiss, 1991)[15] individually as well as simultaneously.

Results of model one show that each reputation measure is significantly related to the initial return. However, only the Carter and Manaster (1990) measure remains significant when evaluated simultaneously. From the analysis of model two, they also find that on average, the long-run performances of IPOs are less negative for the IPOs that are brought to market by more prestigious underwriters. In other words, they find that the underperformance of IPO stocks relative to the market over a three-year holding period is less severe for IPOs handled by the more prestigious underwriters.

The role of another agent regarding the IPO long-run performance has been examined by Brav and Gompers (1997). They investigate the long-run underperformance of the US IPO firms in a sample of 934 venture-backed IPOs during 1972-1992 and 3,407 non venture-backed IPOs from 1975-1992. It is found that venture-backed IPOs outperform non venture-backed IPOs using equal weighted returns. Value weighting significantly reduces performance differences and substantially reduces underperformance for the non venture-backed IPOs. They conduct further tests using several comparable benchmarks and the Fama-French three factor asset pricing model and find that venture-backed companies do not significantly underperform, while the smallest non venture-backed firms do. However, the long-run underperformance is not an IPO effect as the matching firms with similar size and the book-to-market that have not issued equity, perform as poorly as the IPO firms.

In sum, the agents seemingly have an important role in affecting the IPO valuation process by investors. Previous studies show that prestigious investment bankers and venture capital backing of IPOs have affected the IPO valuation in the long-term.

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[15]Johnson and Miller measure the underwriter reputation based on their descriptions, such asthe IPO size, the number of IPOs that have been underwritten since Securities Act 1933. Theycategorise the investment bankers into four groups. Megginson and Weiss use theunderwriter's relative market share as a proxy for underwriter reputation. Carter and Manasterdevelop ten-tier reputation measure based on the rank of the underwriters in the syndicate,which is presented in the tombstone advertisement.

2.3.2.4 Signalling Theory

As mentioned above, the signalling hypothesis demonstrates that in order to reveal their true values, firms need to employ some signals to the investors prior to flotation. Although it is meant to explain the IPO puzzle in the early days of trading, there are some implications to the longer time horizons.

As the signalling models assume that the IPOs are followed by seasoned equity offerings, Jegadeesh *et al.* (1993) argue firstly, that firms raising further equity financing after their IPO are high value and hence outperform non-issuing firms in the long-term. Secondly, firms that underprice exhibit superior post listing returns relative to those that do not, and finally, the greater their quality, the more capital firms retain initially, and the better they perform in the long-term.

Therefore, it implies that there are at least three testable implications. The first is that there is a positive association between the underpricing and the long-run performance. Secondly, a positive relation is expected between the quality of the firm and its long-run performance. Finally, there is an expectation of a negative relation between the percentage of equity retained on the flotation and the long-run performance.

The empirical evidence shows mixed results. Using the US data, Welch (1989) finds that firms that underprice the IPO are more likely to return to the market for further issues. Furthermore, he finds that those IPOs outperform the non-issuing firms. However, some studies show that firms that underprice do not exhibit superior post-listing returns relative to those that do not. (Ritter, 1991; Jain and Kini, 1994). Using Singaporean data, Lam *et al.* (1993) demonstrate that the more equity retained by the old shareholders on the flotation, the better the IPO long-run performance. However, based on the German data, Ljungqvist (1997) fails to find support for this proposition.

2.4 Chapter Summary

Chapter two provides a description of the Initial Public Offering and reviews the theoretical background and empirical evidence of IPO performance. It commences with the overview of the IPO process and the reasons to IPO. The IPO process, the new issues regulations and the IPO flotations methods in the UK are presented in detail.

The chapter also looks at the pricing of IPOs. It compares the offer price setting in different markets and introduces the IPO underpricing concept. The final price must attract sufficient investor base, ensure the provision of the required capital and at the same time guarantee the full subscription.

The tendency of IPOs to clusters in time and to go through so-called ‘hot’ and ‘cold’ periods is also examined. It is related to the cycles in IPO issuance activity. There are few issues that emanate from this anomaly. Benveniste *et al.* (2002) argue underwriters bundle IPOs together to profit from the occurring cycle. Jain and Kini (2006) identify high-growth and fragmented industries characterised by strong investment opportunities, favourable investor sentiment, and higher requirements of investment in R&D as industry conditions that influence IPO clustering. It is this initial stock price that forms the basis for underpricing.

Section 2.2 reviews the international evidence of IPO performance in relation to the short-term underpricing and the long-term aftermarket performance. Section 2.3 reviews the theoretical explanations for these anomalies. Theoretical explanations of the short term underpricing include asymmetric information, signalling, and behavioural theories. Aftermarket performance is looked through fad, heterogeneous expectations, agency, and signalling theories.

Chapter 3

INITIAL PUBLIC OFFERING CLUSTERS

“When people are free to do as they please, they usually imitate each other.”

Eric Hoffer.

CHAPTER THREE – INITIAL PUBLIC OFFERING CLUSTERS

The chapter explains herding and informational cascades in financial markets. It offers a general overview of the model of observational learning and its application to IPO markets, followed by an overview of the existing empirical research on herding and informational cascades.

3.1 Herd behaviour and informational cascades in capital markets

The next step in achieving the overall objective of the research is to understand the behaviour of market participants and to analyse the formation and characteristics of informational cascades in financial markets and in IPO markets in particular.

3.1.1 Herding and informational cascades overview

Much of our behaviour is grounded and organised by complicated social systems that we live and function in. This social behaviour, termed herding[16], acts as a bridge that connects agents and the social structures in which they are embedded. It is a powerful and widely-recorded characteristic of human behaviour that is prevalent in many domains (Raafat *et al.*, 2009). Recent economic events have exposed the depth of herding amongst financial institutions in general, and their decision-making agents and individual investors in particular (Raafat *et al.*, 2009).

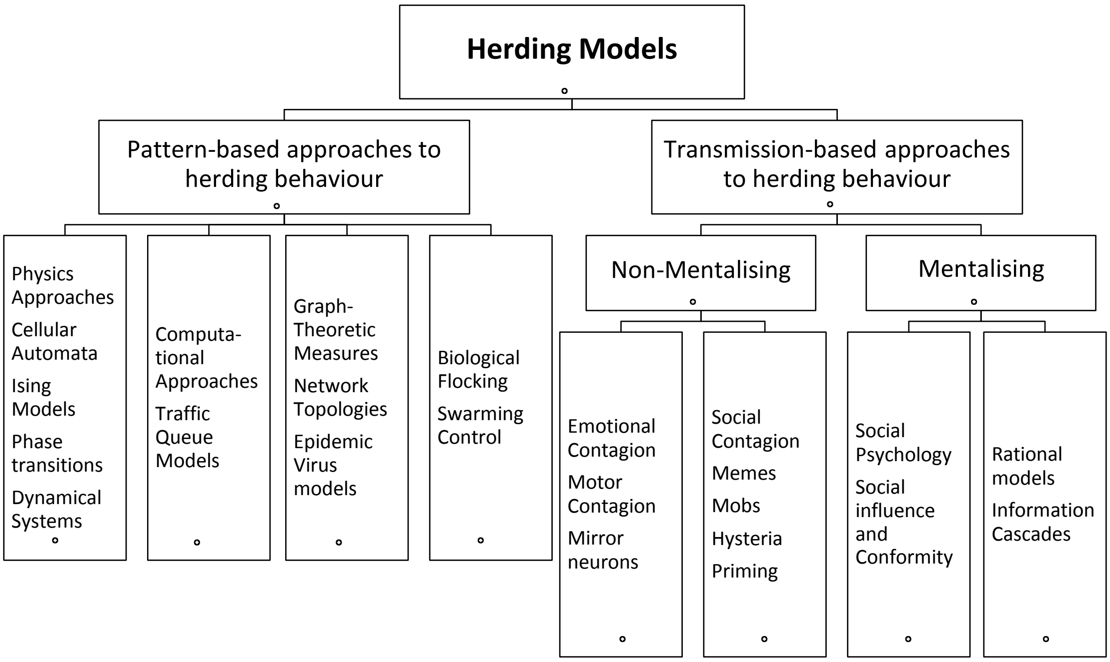
The concept of herding among individuals has been studied within a number of different disciplines, and events that involve herd behaviour are numerous. They range from speculations on financial markets and price bubbles to zealotry, consumer preference and political choice and are often described by terms such as fad, fashion, mass hysteria, bandwagon effect, groupthink and herd instinct (Raafat *et al.*, 2009).

Cognitive psychology differentiates between two approaches of studying herding. The pattern-based approach focuses on relationships within a static system and treats people as

[16] Herding is a form of convergent social behaviour that can be broadly defined as the alignment of the thoughts or behaviours of individuals in a group (herd) through local interaction and without centralised coordination (Raafat*et al*., 2009: 420).

units with certain characteristics that yield herding. The transmission mechanisms approach investigates information transfer in herding by focusing on the role of mentalising[17] (Raafat *et al.*, 2009). Figure 3.1 summarises the two approaches.

Figure 3.1: Approaches to Herding behaviour in Cognitive Science.
The figure presents two approaches of herding models in cognitive psychology: the pattern-based and the transmission-based approaches. *Source: Raafat et al. (2009)*



Convergence happens when individuals model their behaviour and beliefs in accordance with the larger social group that they are ingrained in. To arbitrate their own views, individuals often expressly try to infer beliefs, preferences and attitudes of others (Raafat *et al.*, 2009). Many economic models assume the ability of a single individual to observe the standpoint of another. Economists have witnessed how individually rational agents drawing on inferences they make about choice and information held by others can end up in a collectively irrational 'informational cascade' that does not accurately reflect individual and group preferences (Anderson and Holt, 1996; 1997; Holt and Anderson,

[17]Mentalising is the ability to explain and predict behaviour of others by attributing to them independent mental states (Raafat*et al.*, 2009: 423).

1996; Welch, 1992; Bikhchandani *et al.*, 1992; 1998; Alevy *et al.*, 2007). The development of herding theory in economics is shown in Table 3.1.

Table 3.1: Herding theory in economics

The table presents the development of the herding theory over the years and identifies the seminal works that influenced its formation. *Adopted from Raafat et al. (2009)*

Author	Description	Mechanism
Adam Smith (1759) The theory of moral sentiments.	As people imagine themselves in another's situation, they display motor mimicry.	Motor mimicry.
Charles Mackay (1841) Extraordinary Popular Delusions and the Madness of Crowds.	Crowd psychology creates an emotional feedback loop where dissent may be stifled as the crowd, not wanting to miss out, hears only what they want to hear.	Crowd behaviour is heavily influenced by the loss of responsibility of the individual and the impression of universality of behaviour.
Thorstein Veblen (1899) The theory of the leisure class and economic study of institutions.	Make comparisons with similar people who are slightly better.	An instinct for emulation.
John Maynard Keynes (1936) The general theory of employment, interest and money.	Contagious ''animal spirits'' moving the market. "Worldly wisdom teaches that it is better for reputation to fail conventionally than to succeed unconventionally".	Individuals do not process new information efficiently as they do not know which information is relevant. Conventional behaviour easily turns into herd behaviour.
Sushil Bikhchandani, David Hirshleifer, and Ivo Welch (1992) A Theory of Fads, Fashion, Custom, and Cultural-Change as Informational Cascades.	By modelling, showed that people could follow others even if private information and motivations suggested doing otherwise.	Assumed incomplete information and rationality. The number of others performing the action taken as evidence that the others possessed better information, yielding conformity and ''informational cascades'' based on imperfect information.
James Surowiecki (2004) The Wisdom of Crowds.	Under certain circumstances, crowds or groups may have better information and make better decisions than even the best informed individual.	Diverse collection of independently deciding individuals that can yield better predictions and decisions than even experts. Three types of advantages of disorganised decisions: cognition, coordination, and cooperation.

Theoretical developments in the area of social learning and behavioural convergence reveal that what often seems irrational is actually a natural reaction in a certain context. For example, when little or no information is available firms and individuals often converge upon mistaken actions and the resulting social outcomes can be fragile and very sensitive to small shocks. Another example is the delay in decision making both by firms and individuals for lengthy periods of time resulting in sudden simultaneous surge in activity without any evident external trigger. Also, the recent theoretical framework on reputation-building incentives by managers, while focusing on convergence upon mistaken action, provides justification for deviation from the herd exhibited by some managers (Hirshleifer and Hong, 2003).

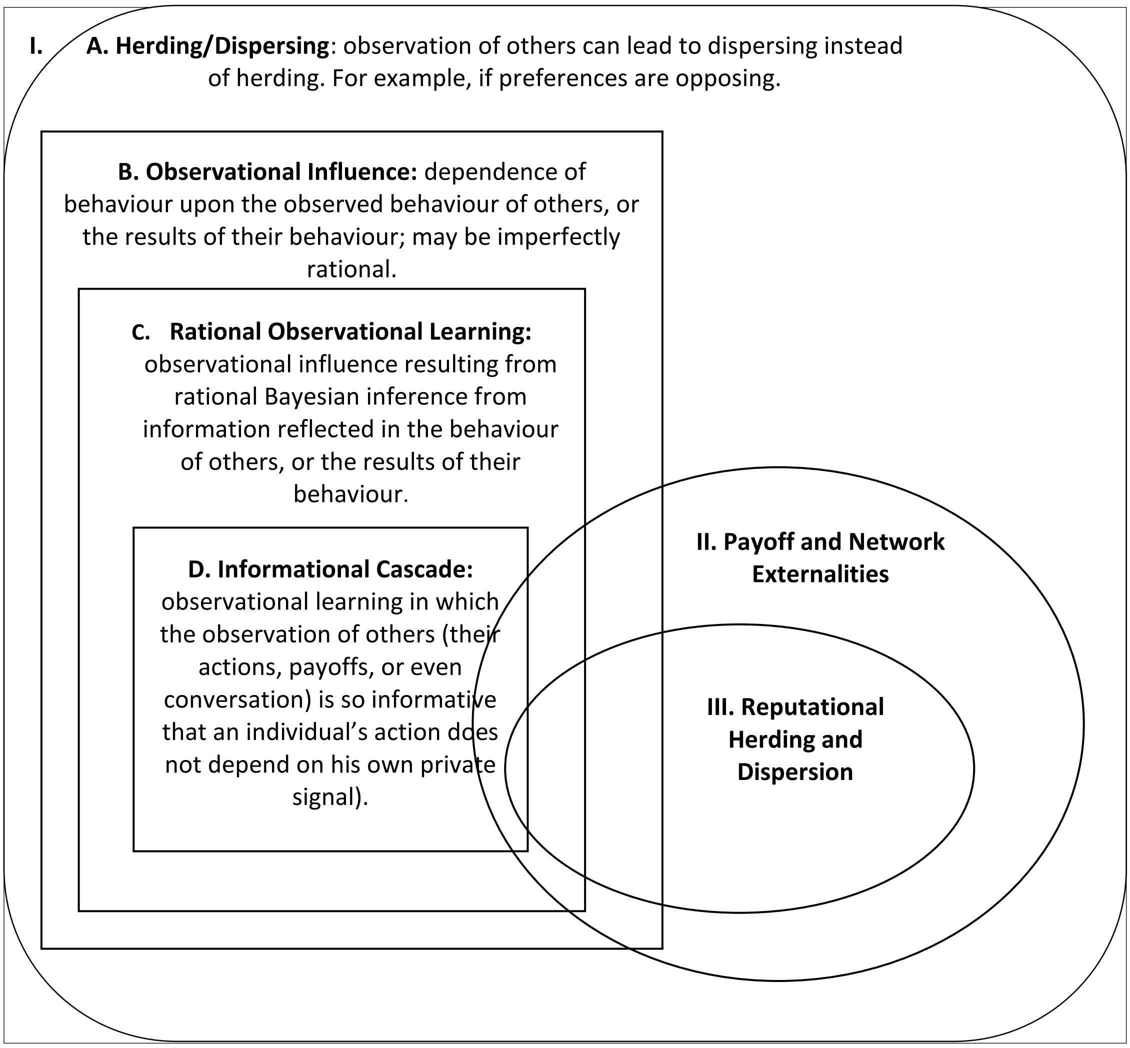
Examples of 'herding' (behavioural convergence) or 'cascading' (disregarding private information) amongst market participants are numerous. Investors may herd in their decisions to participate or not in the market, in their choices of securities to trade, and in their buy and sell decisions. Market analysts herd in the choice of securities that they cover and in their offered forecasts. Firms herd in their finance and investment decisions, timing of new issues, implementation of new projects, and reporting formats of their earnings. Very often firms make decisions that protect against or help to profit from herding and cascading tendencies and behaviours of investors and analysts (Hirshleifer and Hong, 2003).

According to Bikhchandani *et al.* (1998), there are a few reasons for behavioural conformity: positive payoff externalities, preference interactions, sanction upon deviants, and social or observational learning.

Even the simplest form of interaction within society provides essential benefit to individuals because it allows them to take advantage of the vital information possessed by others about the environment they live in. When a friend is fleeing rapidly, it may be beneficial to start running before finding out the cause of his fear.

There are several means by which the thoughts, feelings and actions of an individual can be influenced by others. These influences occur through words, observing decisions and consequences of these decisions, and include different learning processes, rational, quasi-rational, or even an updating of beliefs that does not improve decision-making at all. This social influence leads to behavioural convergence or divergence (Hirshleifer and Hong, 2003). Figure 3.2 describes different sources of convergence. The most inclusive category is herding/dispersing, defined as similarities/dissimilarities in behaviour caused by social interactions between individuals. The last category, informational cascades, depicts a situation in which imitation is inevitable (Hirshleifer and Hong, 2003).

Figure 3.2: The hierarchy of means of convergence
The figure shows that source of convergence of human behaviour and means by which thoughts and actions of individuals can be influenced. *Source: Hirshleifer and Hong (2003)*



Cascades form in multiple contexts: adoption of new technology, medical treatments and developments, response to environmental factors or hazards. Researchers argue, however, that the most infamous herds or cascades happen in financial markets, where bubbles and crashes are often cited as examples of such behaviour (Alevy *et al.*, 2007). The main theories of herding are summarised in Table 3.2.

Table 3.2: Theories of Herding
The table summarises the main theories of herding. *Source: Welch (2000)*

Herding Theory	Theory explanation	Researchers
Utility interactions	Externalities by which an agent's action affects the utility or the production possibilities of other agents.	Becker (1991), Jones (1984)
Sanction on deviants	Religious attire, political regimes, etc.	Akerlof (1980)
Direct payoff externalities	Herding of analysts or fund managers in models of reputational herding or herd behaviour of depositors in bank runs.	Diamond and Dybvig (1983), Arthur (1989)
Principal-agent payoff externalities	The incentives provided by the compensation scheme and terms of employment are such that imitation is rewarded.	Zwiebel (1995), Brennan (1990), Froot et al. (1992), Hirshleifer *et al.* (1994), Scharfstein and Stein (1990), Trueman (1994)
Irrational agent behaviour	Herding behaviour that is irrational and driven by emotion, e.g. greed in the bubbles or fear in the crashes.	DeLong *et al*. (1991)
Informational externalities	Herding behaviour is based on the information received from observing actions of the others, when investors abandon their own information in favour of inferences based on earlier people's actions.	Banerjee (1992), Bikhchandani *et al.* (1992), Rogers (1983), Shiller (1995), Welch (1992) Bikhchandani *et al.* (1998)

Price patterns were the focus of most of the early empirical studies. Evidence of herd behaviour is found to be weak with a stronger effect in small stocks (Grinblatt *et al.*, 1995; Wermers, 1999). In a more recent study Uchida and Nakagawa (2007) find evidence indicative of herding in Japanese banking, while Lin and Swanson (2008) report little evidence of herding by foreigners in the US market. Another string of empirical research is focused on individual stock returns clustering around market returns during periods of large price movements (Christie and Huang, 1995; Chang *et al.*, 2000; Hwang and Salmon, 2004); Gleason *et al.* (2004); Demirer *et al.* (2010); Chiang and Zheng (2010).

A more recent study by Cipriani and Guarino (2012) develops a model of herding in financial markets that can be estimated with financial markets transaction data. Their work builds on Avery and Zemsky (1998) and studies how traders' beliefs change each trading day in order to identify periods in which herding occurs. Their findings indicate that herding behaviour is quite frequent and can last for some time generating informational inefficiencies.

Despite the extended theoretical work on herding and informational cascades in particular, the questions of whether herding occurs in financial markets remains difficult to resolve with empirical data. As argued by Drehmann *et al.* (2005), investors who seem to take similar actions may do so due to herding. However, their actions may be due to following the same information or it may simply be incidental resulting in 'spurious herding'. Such spurious herding is an efficient outcome whereas 'intentional' herding, as explained earlier, need not be efficient. These explanations offered by empirical studies are often difficult to separate because investors' private information is not easily observed (Bikhchandani and Sharma, 2001).

Several laboratory and controlled experiments have been conducted with a view to offering more decisive evidence on the validity of the rational view of informational cascades (Holt and Anderson, 1996; Anderson and Holt, 1996; 1997; Drehmann *et al.*, 2005; Alevy *et al.*, 2007)[18].

3.1.2 Basic characteristics of informational cascades

Hirshleifer and Hong (2003) summarise the general implications of cascades and other rational learning models. They identify idiosyncrasy (poor information aggregation), fragility (fads), simultaneity (delay followed by sudden joint action), paradoxicality (greater public information or higher observability of actions does not improve decisions), and path dependence (the effect of the order of moves and information arrival on the outcomes) as their main characteristics.

Information and the aggregation of information play vital roles in the formation and dislodgement of a cascade. In reality, the informativeness of past actions is often reduced to the summary statistics of the predecessors' actions and information keeps accumulating

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[18] See also e.g. Goidel and Shields (1994), Bounmy*et al.* (1998), Willinger and Ziegelmeyer (1998), Allsopp and Hey (2000), Sadiraj *et al.* (1999), Huck and Oechssler (2000), Ashiya and Doi (2001), Hung and Plott (2001), Noth *et al.* (1999), Oberhammer and Stiehler (2001), Noth and Weber (2003), Plott *et al.* (2003), Kubler and Weizsacker (2004), Kramer *et al*. (2005).

until it is significant enough to outweigh one individual's private signal. At this stage, privately-held information is disregarded and a cascade forms (Bikhchandani *et al.*, 1998).

Similar development occurs when individuals do not have the opportunity to observe the whole chain but only a few predecessors, such as neighbours, or when only two action alternatives are possible. According to Lee (1993), as the set of alternatives becomes larger and richer, cascades take longer to form. With a continuous set of action alternatives individual followers, even late in the chain, adjust their actions based on the private signals, and cascades do not form.

This suggests that cascades pertain to the situations with choices that are characterised by the elements of discreteness or finiteness. However, individuals tend to divide up actions into discrete choices even when actions have a continuous character, and much of the information is transmitted and received through a discrete filter. Learning is not completely blocked if actions are continuous; however, information aggregation is inefficient and wrong choices persist. Informational cascades do not require discreteness in informational signals received by individuals. For a cascade to arise signals must be inconclusive. If an individual receives a signal that is perfectly informative about the true value, the individual follows it disregarding the actions of his predecessors. If such signals are always possible, individuals make perfectly informed decisions and take the correct action (Bikhchandani *et al.*, 1998).

Social psychologists report that people imitate the actions of those who appear to have expertise. It is argued that these behavioural patterns underlie the success of product endorsements and ensure more informed decisions in simultaneous balloting. In financial markets, investors follow the same principle; they imitate the investment decisions of market 'celebrities', individuals or firms, who are perceived to be better informed. Individuals differ in many dimensions, including the precision of the received information, preferences and payoffs. Such differences can either exaggerate or moderate cascading behaviour (Bikhchandani *et al.*, 1998).

According to their preferences, individuals value adoption and payoffs differently, in extreme cases individuals may prefer opposite behaviours. When each individual's type is observable, his action together with his type communicates information about the signal he has used to decide his action to his follower. If the type of each individual is only privately known and the preferences are downright opposing, followers may have difficulties in inferring the information they receive from the signals of their predecessors. Even when preferences and payoffs are not completely opposing, uncertainty about the characteristics of predecessors can slow down or confine the rate of learning. Therefore, even when the actions of individuals are noisy, as long as they are not continuous and unbounded, cascades still form when public information outweighs an individual's private signal in determining his choice (Bikhchandani *et al.*, 1998).

Sometimes the payoff value may change each time period. Cascades still occur in such situations; however, since information aggregation in a cascade is very limited, some sudden shifts in behaviour may occur without an obvious reason. These changes are caused by the expectation of a change in the payoff value and often lead to fads. The sudden onset of cascades can be triggered by giving people the choice of when to act, in situations when obtaining private signals has a fixed cost or due to network externalities (Bikhchandani *et al.*, 1998).

Often, when making a decision can be delayed, there is a cost per unit of time of postponing the decision. Experts or higher precision individuals gain less from waiting to see the actions of lesser-informed individuals and tend to act fast. When signal accuracy is not public knowledge the followers learn about the accuracy of their predecessors' signals from the delay before action. Their own noisier signals are disregarded, and the first individual's decision is copied immediately. Thus, all actions are delayed until one individual triggers an explosion of simultaneous cascading activity. Since the best informed individual acts first, extreme idiosyncrasy occurs where all actions are based on a single individual's information.

The delay before action can act as a signal about the quality of an issue on its own (Bikhchandani *et al.*, 1998). In the context of IPOs, from the issuers'/underwriters' point of view the shorter this delay is the better. There is a higher chance of inducing a cascade if an 'expert' investor acts fast.

Cascades form instantly when individuals have to pay a fixed cost to obtain private information because followers may find it optimal to rely on their predecessors rather than incur the investigation costs. It is argued that additional information sources can prevent cascades by improving information aggregation. Even when all past actions and outcomes are observable, cascades can still form. A cascade upon a choice with payoffs visible to all may be formed by a number of early joiners, yet an alternative choice may be superior but have hidden payoffs (Bikhchandani *et al.*, 1998). However, according to Fudenberg and Banerjee (2004), the ability to observe a random sample of predecessors' choices and outcomes leads to convergence upon correct actions.

In many realistic settings uniformity is likely in the presence of positive network externalities (in the form of positive consumption or production externalities) because joining a network benefits both the joiner and those who have already joined. According to Choi (1997), in a situation with positive network externalities and imperfect information about outcomes, observational learning determines fixed behaviours and strengthens the path dependence of the outcome.

The formation of a cascade is very likely when only the actions of predecessors are visible. In that situation privately held information of the predecessor is not observed, and outcomes are relatively inefficient. These informational inefficiencies are due to the limited nature of possible actions and discrete filters of information transmission between individuals. These inefficiencies could be potentially solved through trade in information. However, the costs of obtaining private information from predecessors and their credibility could be discouraging and lead to imperfect markets for information (Bikhchandani *et al.*, 1998).

The gathering and dissemination of information could possibly be organised through the intervention of an independent third party, such as government, rating agency, or through improvements in the institutions and technologies used for communication by individuals facing similar choices. However, improved communication can also help individuals to observe the actions of others and thus reduce incentives to collect information. This could trigger cascades sooner and extend them further (Bikhchandani *et al.*, 1998).

3.1.3 Informational cascades in IPO

The clustering of IPOs has attracted much attention. Studies show that IPOs tend to cluster because of prior underpricing (Lowry and Schwert, 2002) and underwriters' ability to bundle IPOs (Benveniste *et al.*, 2002). Benveniste *et al.* (2003) find evidence that indirect learning from a prior IPO influences a firm's decision to complete or withdraw its own IPO and determines how the offer is priced relative to prior expectations.

The clustering of IPOs and the pricing of new offers during the cluster remains an area where much is still to be explained. The pricing of new offers is the point of contact between investors and issuers that can provide an insight into the behaviour of market participants and explain existing anomalies. In the context of IPOs two types of cascade are possible; firms cascading in their decisions to go public (or remain private) and investors cascading in their decisions to invest into a new issue (or abstain).

An informational cascade is viewed as a consequence of informational externalities. Each potential issuer holds private information on the expected value of the IPO. However, due to the information spillovers, issuers update their expectation and re-evaluate the IPO decision. Informational cascades are formed when this spillover information dominates the private information, i.e. after observing a few successful IPOs potential issuers believe that IPOs produce positive value and go public themselves, irrespective of their initial expectations. When this happens IPO clusters form and with the start of an informational cascade consecutive issuers blindly follow the herd and no new learning occurs in the market (Draho, 2000).

Welch (1992) discusses the role of information through the role of underwriters in an IPO. The information about the value of this IPO may be undetermined by individual investors; however, in combination investors hold very accurate information about the value of the stock. This scenario predicts success for underpriced IPOs and failure for the overpriced IPOs as potential investors are numerous and a few of them jointly via deliberation can easily determine the correct value of an IPO.

However, according to Welch (1992), when underwriters have limited distribution channels the situation is reversed, i.e. underpriced stocks fail and overpriced stocks succeed. This is due to the fact that with limited distribution underwriters require time to approach interested parties. Due to this time gap, later investors can observe the success of an IPO up to some date and/or its progress relative to the previous offerings of the same underwriter(s). Consequently, investors can infer information from earlier investors. The initial success of an IPO can indicate that early investors had private information favouring the offering and, thus, provide additional incentives for others to invest. On the other hand, slow initial investment can reduce the demand for shares and result in IPO failure. The decisions of later investors are conditioned upon positive informational externalities, i.e. they are dependent on the decisions of earlier investors.

Therefore, the proceeds of an IPO are conditional on the order in which investors make decisions and receive information. Holding combined information unchanged, an issuer will generally receive higher proceeds if initial investors favour the IPO. The value of an IPO inferred by a relatively late investor does not often reflect the true or aftermarket value of the stock.

The inferred value would reflect the true value if later investors could observe signals held by their predecessors. In reality, however, investors can seldom observe these signals and are forced to infer information based only on the actions of earlier investors. In that situation, investors base their investment decisions on previously high or low demand. As a result, early investors' beliefs about the value of an IPO can doom the offering to fail or generate an unlimited demand for the shares. Welch (1992) refers to this effect as a 'cascade'.

Cascades can be quite beneficial for an issuer. When later investors disregard their private information and act as their predecessors, their decisions provide no further information to later investors, thereby reducing information accumulation amongst investors. This leaves the issuer at a greater informational advantage and increases the issuer's expected wealth. According to Welch (1992), issuers deliberately prevent communication among investors and hire underwriters to act "as an institution that distributes an offering widely, i.e., to investors who find it more difficult to communicate among themselves".

When subscriptions to an IPO are not pro-rata based but are served in a sequential order, IPO underpricing can be explained through path dependence and cascades, without a winner's curse. According to the demand curve of the cascade model, the success or failure of an IPO is determined by the time the first investor who could be rationed is approached, and, as a result, the pricing of an IPO is aimed at convincing earlier investors, and not the later ones. When private signals about a firm's aftermarket value distribution are observed by both the issuer and investors, internal and external information is correlated. Under these circumstances, an issuer can set a high price if high future cash flows are expected. This pricing is risky because when many outsiders have negative information, a high price increases the probability of IPO failure. This marginal cost of higher pricing is especially high for a lower quality issuer(Welch, 1992: 697).

3.2 Cascade model (Model of Observational Learning, MOL)

In order to analyse the clusterings and waves in financial markets it is important to understand the conditions for a formation of a cascade and the stages of its formation. The seminal papers by Banerjee (1992) and Bikhchandani *et al.* (1992) formalised the concepts of herd behaviour and informational cascades. Their models assume decision-making through social learning in a situation with imperfect information.

By the argument of the law of large numbers, the accurate reporting of information held by each individual is a sufficient natural condition for information aggregation. A number of papers, most notably Welch (1992) and Bikhchandani *et al.* (1992); (1998) explain how the information fails to aggregate under the conditions of perfect Bayesian learning.

Bikhchandani *et al.* (1992) propose a model, based on informational cascades, that explains conformity in social behaviour and also rapid and short-lived fluctuations, such as fads, fashion, booms and crashes. The four mechanisms of conformity discussed in section 3.1.1 imply that shifts in mass behaviour triggered by small shocks happen when social groups border the alternatives. According to the theory of informational cascades, even when little information is available social groups tend to near the borderline causing fragility.

The model proposed by Bikhchandani *et al.* (1992) applies the dynamics of imitative behaviour to informational cascades. They examine how likely cascades are to happen, how likely incorrect cascades are to occur, how fashions change and how effective are public information releases.

Under the Model of Observational Learning (MOL) two scenarios are distinguished: the observable actions scenario and the observable signals (and actions) scenario.

Bikhchandani *et al.* (1992) concentrate their analysis on the least informative case: the observable actions only scenario, in which individuals can observe the actions of predecessors but not the signals.

3.2.1 Model settings

The model assumes a number of decision makers facing a choice of the adoption or rejection of certain behaviour. The actions of all predecessors are visible to all and decisions are made in sequence. The cost of adoption, C, is set at 1/2 and is the same for all, as well as the gain from adoption, V, that is either 1 or 0 (with equal prior probability of 1/2). Each decision-maker observes a private signal, X, indicating the value. Signal X_i (for an individual i) is H or L, probability of H is $p_i > 1/2$ if $V = 1$, and $1 - p_i$ if $V = 0$. The signals are distributed identically ($p_i = p$ for all i).

A H signal induces an individual to adopt and an L signal to reject. His follower can make inferences about the value of the signal according to his decision. Adoption by the first individual causes the second individual to adopt if his signal is H. An L signal, however, results in inferred HL signal ordering and reduces the expected value of adoption for the second individual to 1/2. He becomes indifferent between choices and with probability 1/2 he adopts. The reasoning is similar when the first individual rejects. In the case of the third individual three scenarios are possible: (1) adoption by both first and second individual (causing him to disregard his own signal and adopt creating and UP cascade); (2) rejection by both predecessors (inducing further rejection and causing a DOWN cascade even if his signal was H); or (3) one adoption and one rejection, in which case his situation is similar to that of the first. In that case, the fourth individual faces the same choices as the second, the fifth as the third, etc.

An unconditional ex-ante probability of an UP, DOWN, or no cascade can be determined after the first two individuals. The actions of the first two individuals do not lead to a cascade if one H and one L signal have been observed. Since the occurrence of HL or LH leads to indifference in choice, the total probability is $½\, p\, (1 - p) + ½\, p\, (1 - p) = p – p^2$. Probabilities of an UP or a DOWN cascade are not conditional on the gain, V; therefore, the probability of an UP cascade equals the probability of a DOWN cascade ($Pr_{UP} = Pr_{DOWN} = ½\, [1 – Pr_{no\ cascade}]$):

$$\mathrm{PrUP} = \mathrm{PrDOWN} = \frac{1-p+p^2}{2} \tag{1}$$

$$\text{Pr no cascade} = p - p^2 \tag{2}$$

After an even number of individuals, the probabilities of an UP, a DOWN or no cascade are calculated as follows:

$$\mathrm{PrUP} = \mathrm{PrDOWN} = \frac{1-(p-p^2)^{n/2}}{2} \tag{3}$$

$$\text{Pr no cascade} = (p - p^2)^{n/2} \tag{4}$$

The equations show that the reduction in p towards ½ delays the formation of a cascade and is equivalent to adding noise to the signal. Cascades start sooner when signals are more precise, and the chances of cascade formation increase with the number of decision makers.

When only the actions of the predecessors are observed, outcomes are more uniform and, once a cascade starts, information stops accumulating. The actions of individuals do not improve later decisions and cascades are not reversed. However, in a situation where signals of predecessors are also visible, even if a signal is disregarded by an individual, the information is still gathered in the common pool of knowledge and it can improve later decisions.

According to Bikhchandani *et al.* (1998), individuals learn from the actions of their predecessors and base their own decisions on that learning. Moreover, this learning process can often be manipulated to influence or produce the (desirable) outcome. As argued by the authors, this learning by observing the past decisions of others (Observational Learning) can explain behavioural convergence, herding and informational cascades in financial markets.

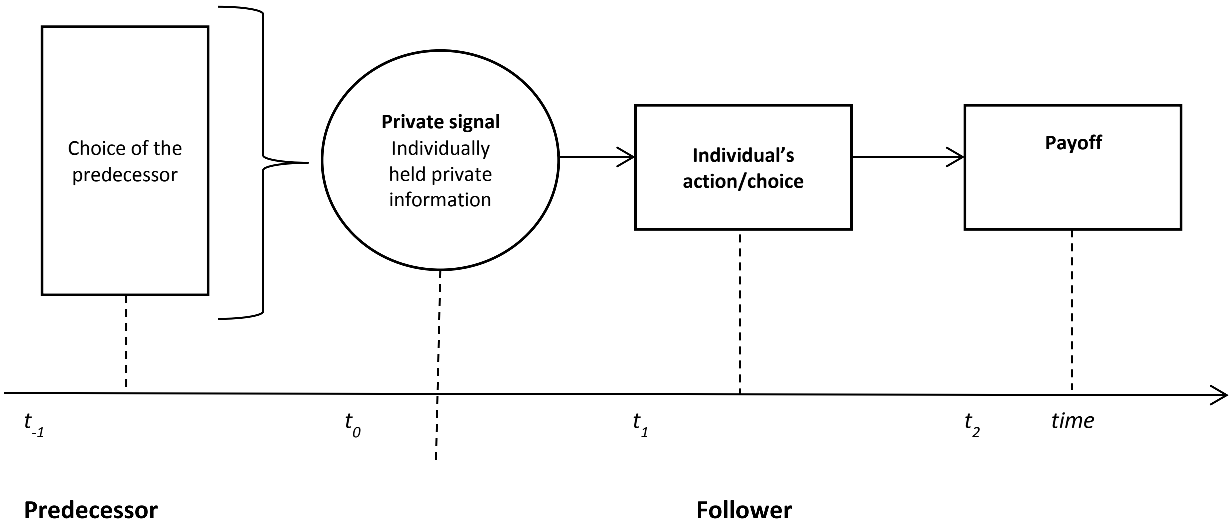
3.2.2 Model scenarios

Behavioural convergence through social (observational) learning arises when individuals find themselves in situations with similar decision problems and have similar information. They face similar alternatives with similar payoffs, and as a result make similar choices. It may also arise in settings where individuals face similar payoffs but do not hold similar information. In these case individuals learn by communicating with each other or by observing the actions of others or consequences of these actions. Direct analysis of the alternative choices can be costly and time-consuming; therefore, individuals may decide to rely on the information of others (Bikhchandani *et al.*, 1992).

In both scenarios, the observable actions scenario and the observable signals (and actions) scenario, individuals start with some private information, obtain some information from predecessors, and then make a choice between alternative decisions. Figure 3.3 presents the basic model of observational learning.

Risk-neutral individuals decide in sequence whether to adopt or to reject a possible action. The payoff to adopting is 'V' and can be either '1' or '-1'. Probability *(p)* of V=1 is the same as V= -1 (probability of V=1 is *p*=0.5 and probability of V= -1 is *p*=0.5). The payoff to rejecting is V=0. Both alternatives are equally desirable if no further information is received. The order of individuals' decisions is sequential and known to all.

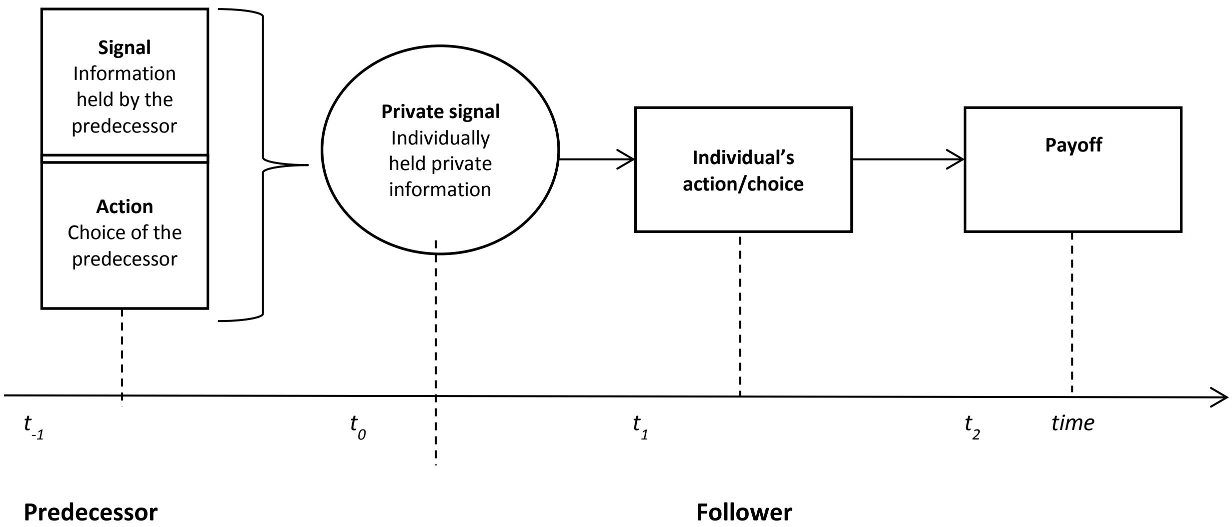
Figure 3.3: Model of Observational Learning (MOL)
The figure presents the basic scenario of the model of observational learning (MOL) introduced by Bikhchandani *et al.* (1998).



Each individual's signal is either *High* or *Low*. The signal is more likely to be *High* when adoption is desirable (V=1), than in situations when V= -1 (adoption is undesirable), i.e. each individual observes *High* with probability $p > 0.5$ if V=1, and *Low* with probability 1 - *p* if V= -1. Therefore, if an individual observes only one *High* his subsequent probability that adoption is desirable (V=1) is *p*, and the probability that adoption is undesirable (V=-1) is 1-*p* if he observes *Low*. Thus, subsequent probability (*p*) determines the correctness of the signal. All private signals are distributed in an identical manner and are independently conditional on the payoff. Each individual's belief about the payoff (V) depends on the information received from predecessors. This belief differs in the two scenarios.

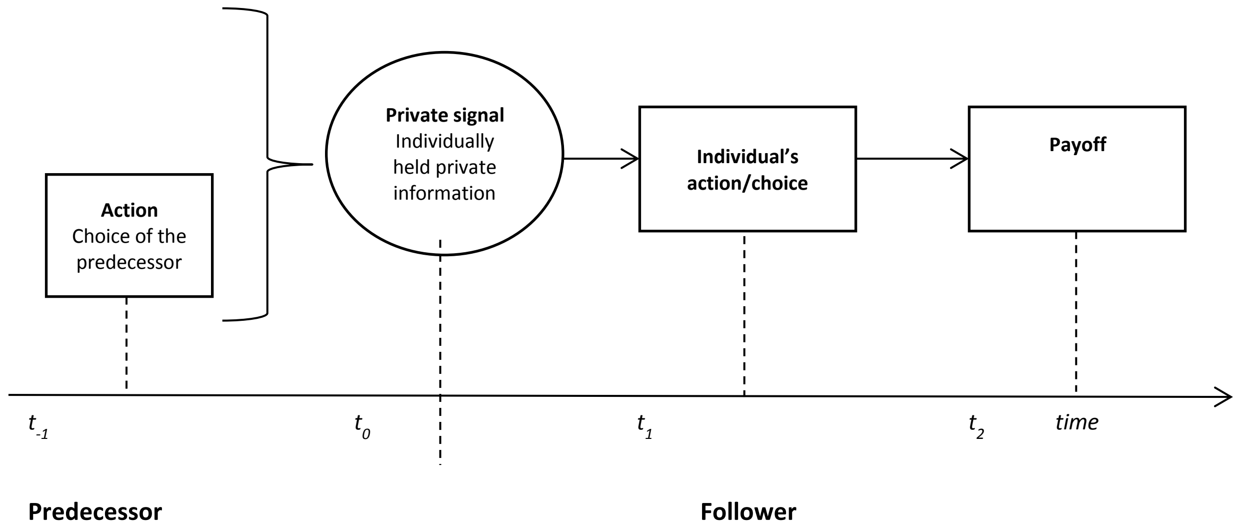
In the observable signals scenario, an individual can observe both the actions and signals of his predecessor. All signals are publicly observed, the pool of public information builds gradually, and individuals eventually settle on the correct choice and act in a similar manner. The scenario is summarised in Figure 3.4.

Figure 3.4: MOL: Observable signals (and actions) scenario
The figure presents the observable signals scenario (both signals and actions of the predecessor(s) are visible)of the model of observational learning (MOL) introduced by Bikhchandani *et al.* (1998).



In the situations when only the actions of predecessors are observed the choices of the first few individuals determine the choices of all followers. The behaviour of individuals becomes idiosyncratic and an UP or DOWN informational cascade is formed. The scenario is presented in Figure 3.5.

Figure 3.5: MOL: Observable actions (only) scenario
The figure presents the observable actions only scenario (only the actions of the predecessor(s) are visible)of the model of observational learning (MOL) introduced by Bikhchandani *et al.* (1998).



As summarised by Bikhchandani *et al.* (1998), the optimal decision for an individual in the observable actions scenario is determined by the difference between the number of predecessors who adopted and the number who rejected.

If there is no difference (d =0), then a follower makes a choice based on his private signals. If the number of predecessors who adopted is higher than those who rejected by just 1 (d=1), then a follower adopts if his private signal is *High* and remains indifferent between choices if his private signal is *Low*. If the number of predecessors who adopted is higher by more than just 1 (d>1), then a follower adopts regardless of his private signal. The decisions for d=-1 and d<-1 are symmetric. Table 3.3 summarises these choices.

Table 3.3: An individual's optimal decision rule.
The table presents the choices and the optimal decision for an individual in the observable actions only scenario. *Based on Bikhchandani et al. (1998)*

Number of predecessors (d)	Follower's choice	
	Private signal: ***High***	Private signal: ***Low***
d=0	Follow private signal	
d=1	Adopt	Indifferent between choice
d=-1	Indifferent between choice	Reject
d>1	Adopt regardless of private signal	
d<-1	Reject regardless of private signal	

The predominance of adoptions over rejections evolves randomly and usually in a short period of time reaches an upper barrier (d = 2) or a low barrier (d = -2) and forms an UP or DOWN cascade in which all individual followers except the first few make the same choice.

The outcome of the scenario with observable actions is fundamentally different from the scenario with observable signals. Once the cascade starts public information stops accumulating and individual followers herd towards the same choice regardless of their private signals that never join the public pool of knowledge.

3.2.2.1 Formation and breaking of a cascade under MOL

Very often the public pool of knowledge does not need to be very informative for individuals to disregard their privately held information. Once the public knowledge becomes even slightly more informative than the private signal of an individual, his successor follows the same choice and a cascade begins. The type of cascade is determined by the number of signals and the order that they arrive in. Table 3.4 summarises the formation of an UP or DOWN cascade.

Table 3.4: Order of signals and the type of cascade

The table presents the formation of an UP or DOWN cascade under the MOL. *Based on Bikhchandani et al. (1998)*- Names as used in Bikhchandani et al. (1998). H – High signal, L – Low signal, p – probability*
**-2[nd] Follower, Clarence, adopts (rejects) even if he sees a Low (High) signal because he believes that there is a better than an even chance that the value to adoption is 1(-1). If Clarence takes into account only Aaron's High (Low) signal and his own Low (High) signal, then he believes that the value to adoption is equally likely to be 1 or - 1. But Clarence also knows that Barbara is more likely to have seen a High (Low) signal than a Low (High) signal. This tilts the decision in favour of adoption (rejection).

Predecessor's		1st Follower's			2nd Follower's		
Signal	Action	Private signal	Visible Signals	Action	Private signal	Visible Signals	Action
*Aaron**		*Barbara**			*Clarence**		
H	*Adopts*	*H*	*'HH'*	Adopts	*H*	*'HHH'*	Adopts and starts an UP cascade
					L	*'HHL'*	Adopts and starts an UP cascade**
		L	*'HL'*	indifferent between choices and with *p=0.5* Adopts or Rejects	*H*	*'HLH'*	Adopts and starts an UP cascade
					L	*'HLL'*	Rejects and starts a DOWN cascade
L	*Rejects*	*H*	*'LH'*	indifferent between choices and with *p=0.5* Rejects or Adopts	*H*	*'LHH'*	Adopts and starts an UP cascade
					L	*'LHL'*	Rejects and starts a DOWN cascade
		L	*'LL'*	Rejects	*L*	*'LLL'*	Rejects and starts a DOWN cascade
					H	*'LLH'*	Rejects and starts a DOWN cascade**

The likelihood of a cascade is very high. In a situation where V=1, private signals are very noisy (the probability of a signal being correct is p=0.51 (*see section 3.2.1 'Model settings'*), an UP cascade forms:

1) HH + H: when first two followers both receive *High* signal, 0.51×0.51=**0.2601** or
2) HL + H: when the first follower receives *High* signal and the second follower receives *Low* signal, the third follower becomes indifferent between adopting and rejecting, and with an even probability chance chooses to adopt, 0.51×0.49×0.5=**0.12495** (Bikhchandani *et al.*, 1998).

A DOWN cascade forms:

1) LL + L: when both followers receive a *Low* signal (with probability p=0.49, *see section 3.2.1 'Model settings'*), 0.49×0.49=**0.2401** or
2) LH + L: when the first follower receives *Low* and the second follower receives *High*, the third follower becomes indifferent between the choices, and with an even probability chance decides to reject, 0.49×0.51×0.5=**0.12495** (Bikhchandani *et al.*, 1998).

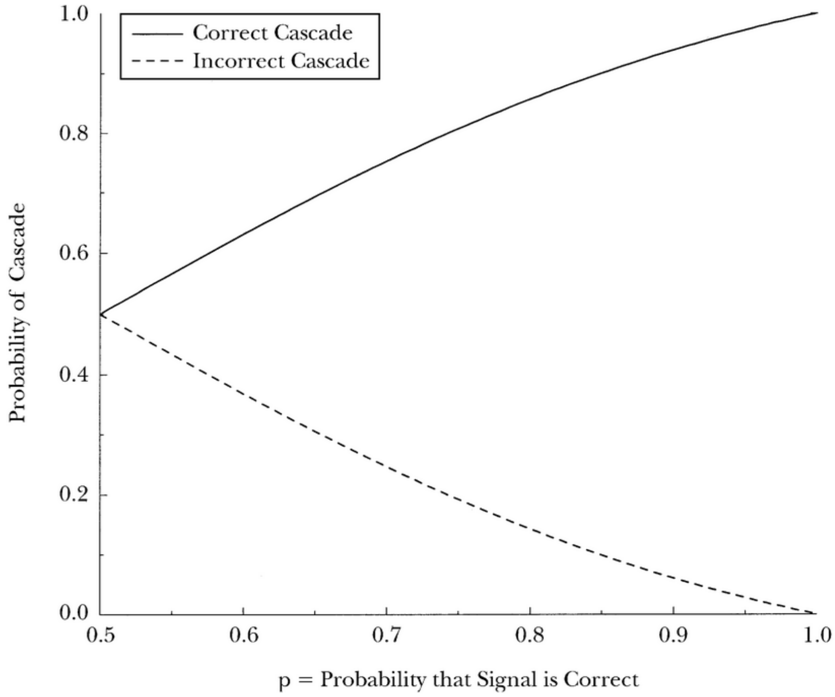
Summing up these probabilities, there is a 75% chance that a cascade will form after the first two players[19]. Calculations for V=-1 are symmetric.

Similarly, if the choices of the first two followers are different, then their signals offset each other, and the game begins with the third follower; if the choices of the third and the forth followers are different the game begins with the fifth follower. "After eight players the probability is only 0.004 that such offsetting has occurred four times, leaving 0.996 probability that individuals are in a cascade" (Bikhchandani *et al.*, 1998: 156).

Bikhchandani *et al.* (1998) argue that the gain from observing the actions of predecessors compared to the situations where no observation occurs is minimal. Considering the above scenario (V=1), the probability of an UP cascade after two followers is 0.2601+0.12495=0.38505, while probability of a DOWN cascade is 0.2401+0.12495=0.36505. The probability of the cascade being a correct UP cascade rather than an incorrect DOWN cascade is 0.38505/[0.38505+0.36505]=**0.5133**. In a situation where no observation occurs, individuals base their choices only on their private signals with a probability of 51 percent of it being correct (*see section 3.2.1 'Model settings'*). Therefore, the observable action only scenario increases gain in accuracy of choices only by 0.3 percent. In contrast, when both actions and signals are observed decisions made by individuals are virtually correct as all the information is publicly available. Figure 3.6 illustrates the probabilities of correct and incorrect cascade.

[19] 0.2601+.012495+0.2401+0.12495=0.7501

Figure 3.6: Cascade probabilities
The figure presents the probabilities of formation of a correct and an incorrect cascade. *Source: Bikhchandani et al. (1998).*



Individuals' actions that are informative to others create positive externalities. This information externality is stronger when past signals are observed. In a cascade it disappears completely. The action of an individual who chooses to follow his private signal instead of obeying the cascade adds to the public pool of knowledge and benefits the followers. In the long run such altruistic actions by a number of individuals would lead to accurate decisions. However, rational individuals imitate their predecessors and follow the uninformative path acting in their own self-interest. According to Bikhchandani *et al.* (1998), the theory of informational cascades suggests that "irrationally overconfident entrepreneurs and social misfits of all sorts are exceptionally useful citizens who may disproportionately benefit society" (Bikhchandani *et al.*, 1998: 157).

Cascades are very fragile. When individuals realise that they are in a cascade, they also realise that information in the cascade has little relevance to the private signals of its participants. Therefore, behaviour in cascades is fragile with respect to small shocks.[20] There are several kinds of shocks that could dislodge a cascade: the arrival of better-informed individuals, the release of new public information, and shifts in the underlying value of adoption versus rejection.

Bikhchandani *et al.* (1998) illustrate this fragility through an example of an UP cascade where a one-in-a-thousand individual instead of receiving one signal, *High* or *Low*, receives two conditionally independent signals. In that case, the observation of two *Low* signals will be sufficient for that individual to go against the cascade and reject. As all of the signals of his predecessors were part of the cascade and thus revealed no information, rejection based on two *Low* signals is logical and the cascade breaks.

According to the model settings, with p=0.51, there is a 0.487 chance that the original Up cascade was incorrect. In this case, the unconditional probability that an individual observes two Low signals and dislodges the Up cascade is 0.24984. If the next person draws a Low signal, then a Down cascade starts; in the case of a High signal several more draws may be required before the cascade reasserts itself. This new cascade may again be overturned by an individual who receives two signals.

3.2.2.2 Model criticism

A substantial number of papers followed the seminal work of Bikhchandani *et al.* (1992), Banerjee (1992) and Welch (1992). For a comprehensive review see Bikhchandani and Sharma (2001) and Hirshleifer and Hong (2003). There is a number of criticisms of the original model of social learning. Bowden (2013) identifies the main four that relate to: the action space; the externally determined sequence of decision makers; Bayesian updating of beliefs and fixed price.

Informational cascades can arise only in a situation where information is discrete, bounded or with gaps. If a signal is continuous, unbounded, and without gaps, then an individual

[20]Kuran (1989) describes models enforced by the threat of sanctions upon deviants in which rare shifts occur when the system crosses a critical value that shifts the outcome from one equilibrium to another.

remains sensitive to his private signal and a cascade does not form (Smith and Sørensen, 2000; Hirshleifer and Hong, 2003; Çelen and Kariv, 2004; Goeree *et al.*, 2006)[21]. The assumption of the exogenously determined sequence of decision makers in the observational learning model can be relaxed. Research shows that if market participants have a choice of postponing their decisions, there can be long periods of inactivity followed by sudden outbursts triggered by project adoption by one firm (Beaudry and González, 2003; Chari and Kehoe, 2004; Chamley, 2004; Banerjee and Fudenberg, 2004)[22].

A number of researchers relax the assumption of sequential decision making through the introduction of the concept of a social network, where market participants observe decisions and payoffs of the investors to which they are connected. Some decisions are inherently social and in such circumstances agents base their decisions on the subset of society; for example the Royal Family, in Bala and Goyal (1998). Information gathering in finite agent societies is generally incomplete and informational cascades within a network can lead to clustering (Gale and Kariv, 2003; Acemoglu *et al.*, 2011).

The assumption of Bayesian updating of beliefs does not hold in more complex decision-making scenarios. Recent research shows that market participants are more likely to deviate from Bayes' rule and follow their own private signal when signals have varying precision or the framework for decision making is more complex than under Bikhchandani *et al.* (1992). Perceptions about the quality of the previous signals, as well as the overconfidence heuristic are found to be the likely cause of the deviant behaviour (Çelen and Kariv, 2005; Guarino *et al.*, 2006; Drehmann *et al.*, 2005; Goree and Rogers, 2007; Spiwoks *et al.*, 2008; Grebe *et al.*, 2008)[23].

Cascade behaviour may emerge even when the fixed price assumption is relaxed. Avery and Zemsky (1998) extend the Bikhchandani *et al.* (1992) model and introduce multiple dimensions of uncertainty. The assumption of 'event uncertainty' – uncertainty over whether the received signal is an informative one – gives additional informational advantage to informed traders over market-makers (who adjust prices sluggishly as a result

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[21] See also Lee (1993) and Vives (1993).
[22] See also Chamley and Gale (1994) and Zhang (1997).
[23] See also Huck and Oechssler (2000), Anderson (2001) and Kubler and Weizsacker (2004).

of ignorance over the signal informativeness). As a result, insiders adjust their expected value quicker than the market maker, while the price adjustment remains slow. In the extreme scenario where event uncertainty is a complete surprise, the market-maker recreates the scenario of Bikhchandani *et al.* (1992) by completely ignoring the event and fixing the price. Hirshleifer and Hong (2003) characterise the behaviour described by Avery and Zemsky (1998) as pseudo-cascading that can, nonetheless, lead to partial information blockages.

3.3 Model of Observational Learning (MOL) in IPO settings

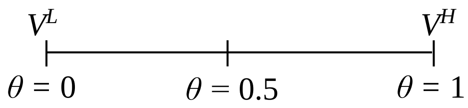
As the overall objective of the research is to investigate clusterings in IPO markets it is important to understand the application of the model of observational learning to the IPO settings. The Model of Observational Learning was applied to the IPO settings by Welch (1992).

3.3.1 Model settings

The Welch's (1992) model assumes n investors, who are rational, risk-neutral, expected wealth-maximisers. V is the efficient aftermarket value of a share of an IPO and it is unknown to both an issuer and investors. A share is purchased by an investor only if the expected aftermarket value is equal to or higher than the offer price. The issuer can offer an investor one share and has a sufficient amount of shares to service each individual investor. The shares are offered to the public once and at a fixed price. Each investor decides to buy or to abstain.

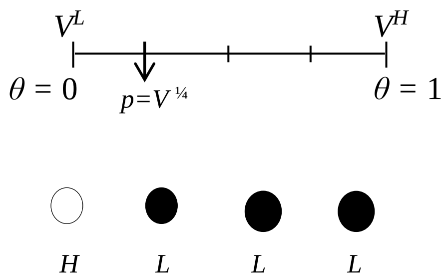
The issuer's reservation value is V^P and the market valuation of a share is between V^L and V^H, where $V^P \leq V^L < V^H$ (if $V^P > V^L$, the set of optimal prices is unconstrained). The aftermarket value has dispersed uniform prior distribution for all investors, $\widetilde{V} \sim U\,[V^L, V^H]$. The capital requirements of the issuer equal V^L - V^P and constitute a loss if the IPO fails. The settings imply constant return to scale, i.e. the public value of each share is independent of total sales.

The issuer type or the issuer's project type, θ, identifies transformed linear values for [V^L, V^H] and is $\theta \in [0, 1]$. The offer price, p can be expressed in terms of underlying value, $p \in [V^L, V^H]$, and as a unique type of issuer (ranging from 0 to 1) $\theta \in [0, 1]$, $p = (1- \theta)\, V^L + \theta\, V^H$.



In that case, the value of type 0 offering, $\theta = 0$, is V^L, the value of type 0.5 offering, $\theta = 0.5$, is $(V^{L\,+}\,V^H)/2$, and value of $\theta = 1$ offering is V^H. Also, θ^P denotes linear transformation for V^P and, as $V^P \leq V^L$, $\theta^P \leq 0$.

Signals, $s \in [H, L]$ are drawn independently and are privately observed by individual market participants. The inferences made from these signals by investors carry information about the aftermarket value of shares and all signals combined together ('investors' belief') represent the *aftermarket value.* The aftermarket value (type) of a project is related to the signal in the way that the probability of an investor observing a *High* (H) signal is θ. If, on average, for every investor with a H signal there are three with an L signal, then the aftermarket value of a project is ¼ into the range of possible values.



According to this specification, the posterior expected value of the project type, θ, with n number of signals of which k number of signals are H type is:

$$\text{prob } (\theta |\ \text{k } H \text{ signals}) = \frac{\text{prob } (k\ H \text{ signals}|\theta)\ \text{prob } (\theta)}{\text{prob } (k\ H \text{ signals})}$$

$$E(\theta |\ k, n) = \frac{k+1}{n+2} \qquad (5)$$

After only one H signal, the expected aftermarket value of a project is 2/3 and after only one L signal it is 1/3.

The Welch's (1992) model assumes that the number of investors approached by the issuer (or his underwriter) is publicly known. The aftermarket value of a firm could be determined arbitrarily precisely if investors could communicate with each other. The model could be interpreted to allow for either endogenous or exogenous aftermarket valuation: the large number of signals among investors, when perfectly aggregated, could *be* the efficient aftermarket value of the offering; or, signals could be informative about an underlying true value that is revealed soon after the IPO.

3.3.2 Model scenarios

Welch (1992) identifies three scenarios of investor communication in the IPO market: Perfect Communication scenario, Simple Path Dependence scenario, and Cascade scenario.

The *Perfect Communication scenario* denotes the case where investors can communicate with each other freely and readily. The total number of signals, *n*, has *k* number of *H* signals. According to Welch's (1992) model the issuer's ex-ante probability of observing *k* number of *H* signals is

$$prob\ (k\ H\ signals \mid n\ investors) = \frac{1}{n+1} \tag{6}$$

and the ex-ante probability of observing *k* or more *H* signals is

$$prob\ (k\ or\ more\ H\ signals \mid n\ investors) = 1 - \frac{k}{n+1} \tag{7}$$

The optimal offering price (highest price at which each investor would buy):

$$P^{max}(k, n) = 1 - \frac{k+1}{n+2} \tag{8}$$

The issuer's goal, expected utility maximisation, can be expressed in terms of price optimisation against the total number of investors with *H* signals (i.e. the investor guesses the number of investors with *H* signals and sets the offering price in accordance with that number). Each proceed-maximising price, *P*, quoted in θ units, relates to one *k* for which all investors decide to invest. If the issuer's price does not require selling either all or no shares, his problem of maximisation over price relates to (and includes) two terms:

a) the issuer's proceeds from pricing the offering so that it succeeds (if *k* investors have positive information and the probability that at least *k* investors observe *H* signal):$\max_k \text{prob}(k \text{ or more } H \text{ signals} \mid n) * P^{max}(k, n)n$

b) probability of failure and his private value of unsold shares:
prob(less than k H signals | n) $* \theta^P n$

Therefore, issuer's problem of maximisation over price is:

$$n \max_{k} \left(1 + \frac{k}{n+1}\right)\left(\frac{k+1}{n+2}\right) + \left(\frac{k}{n+1}\right)\theta^P \quad (9)$$

The solution to the problem is the optimal number of investors k^* that the issuer should attract:

$$k^* = \frac{n}{2} + \left(1 + \frac{n}{2}\right)\theta^P \quad (10)$$

According to equation (8), the optimal price, P^*, is $P^* = (1+\theta^P)/2$. Using the optimal k^*, expected wealth of the issuer is:

$$n \max\left\{\frac{1}{n+2}, \left(\frac{1}{4}\right)\left[\frac{n\,(\theta^P+1)^2+2}{n+1}\right]\right\} \quad (11)$$

and the average underpricing of successful offerings is $\frac{1-\theta^P}{2(1+\theta^P)}$

Through the extensive mathematical calculations Welch (1992) offers proof to his Theorem 1 theoretically supporting the empirical evidence on the strong relationship between IPO underpricing and risk[24].

The *Simple Path Dependence scenario* assumes *Perfect Communication* only from early to late investors and implies that each market participant observes only his signal and the privately-held information of investors approached earlier. There is a θ probability that the information held by the first investor is a type H signal. In this case the issuer's proceeds are P if $P \leq 2/3$, and 0 if otherwise. Similarly, the second investor makes his decision based on his observed signal and on the signal of previous investor. It is important to note that the issuer's proceeds are path-dependent: if signals drawn by the first two investors come in the order H followed by L and the price is 2/5, then issuer's proceeds are $2P = 2(2/5)$, if

[24] Theorem 1: *With perfect investor communication, a risk-neutral uninformed issuer never prices above the value of the average type (θ = 1/2); the average ex-post underpricing (observed initial returns) of successful offerings is not bounded above; no successful offerings are overpriced; offerings are at least as likely to succeed as they are to fail; and, for a large number of investors, the expected utility of the issuer is at most 1/4 per share* (Welch, 1992: 701).

the order of signals is reversed, it is only $P = 2/5$. Figure 3.7 summarises the decisions faced by investors and the proceeds of the issuer according to the path.

For example, an *L* signal observed by the first investor induces him to invest if the price is not higher than 1/3 ($p < 1/3$) and pass if it is. His follower makes a decision based on the price, the information received from the first investors and his own signal. The issuer's equilibrium proceeds conditioned by the price and investors' information are presented in Figure 3.8. As the number of investors increases to infinitely many (identified as 'large market' by Welch, 1992), an issuer's expected outcome becomes the same as in the scenario of perfect communication. This is because information about the aftermarket value of an offer contained in the signals of many earlier investors is accurately transmitted to later investors.

According to Welch's Theorem 3[25], in a large market an issuer prices his offering in the similar manner as when investors have perfect communication. Even for a small number of investors, the issuer is best off pricing as under the perfect communication condition. His proceeds, however, could be higher, because with small *n* the initial few investors, that make the larger portion of the market, are at a higher informational disadvantage against the issuer (Welch, 1992).

[25] Theorem 3: *With simple path dependence (where investors can observe the signals of prior potential investors), for an infinite number of investors, the outcome is identical to the outcome when all investors perfectly communicate* (Welch, 1992: 702)

Figure 3.7: The simple path dependence game tree with two buyers.
The figure presents the decisions faced by investors and the proceeds of the issuer according to the path. Square boxes indicate actions taken; round boxes indicate decisions faced by an investor. *H* and *L* are the signal types, *p* is the price, and *π* is the issuer's proceeds. *Source: Welch (1992)*

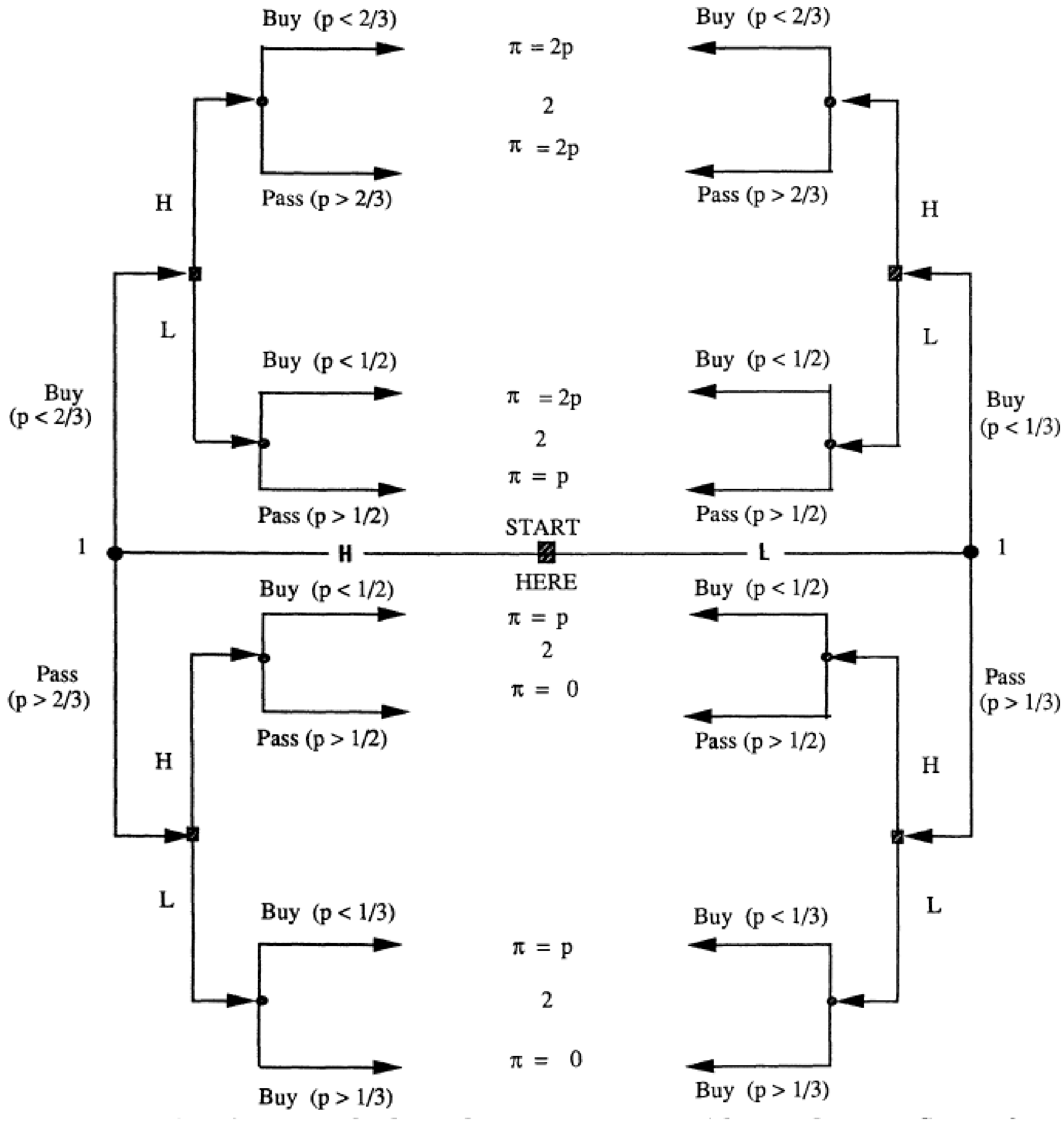
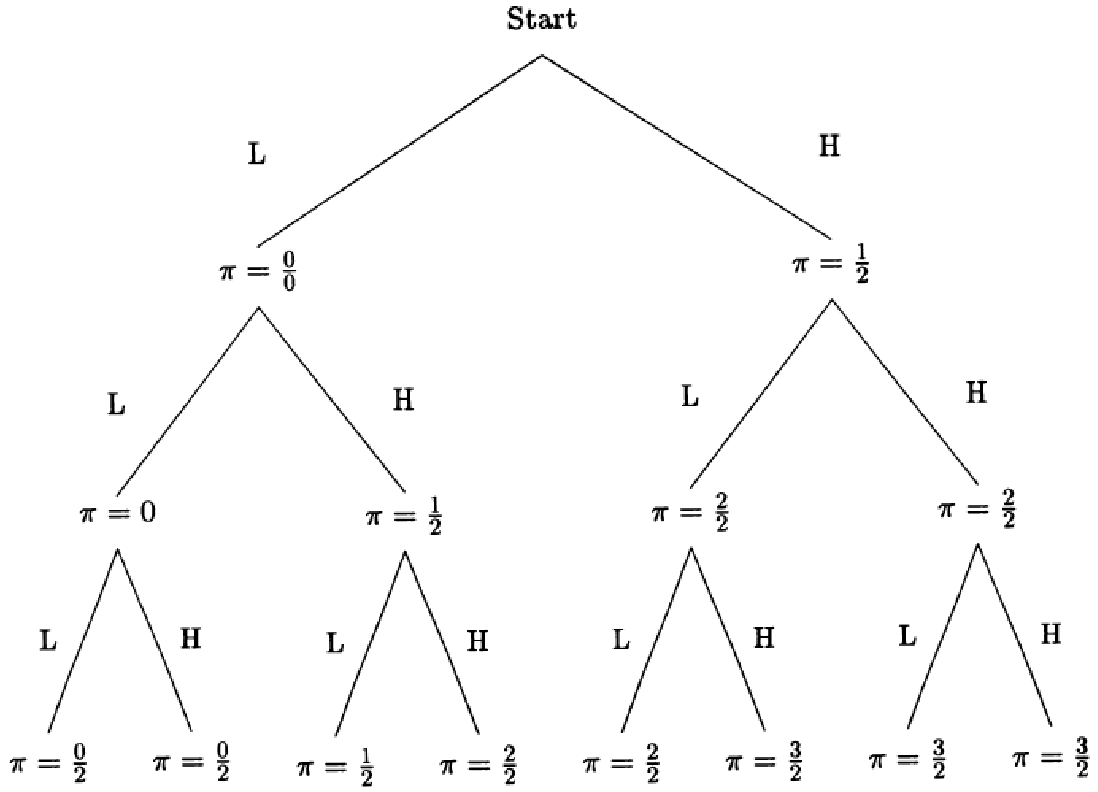


Figure 3.8: The simple path dependence equilibrium outcome when the price is P=1/2.
The figure presents cumulative proceeds of an issuer (π) as a function of the signals (H and L are the signal types).*Source: Welch (1992).*



The figure illustrates the path-dependence of the issuer's proceeds according to the ordering of information among investors. For example, the proceeds are higher when the signals of the first three investors come in order *HLL* than *LLH*.

The Cascade scenario assumes no communication among investors. The scenarios discussed above are unrealistic because predecessors' information cannot be naturally observed; instead, investors can only observe and verify decisions of earlier market participants, which can lead to formation of a cascade. When an investor, *M*, with a*H* signal finds it optimal not to invest, his followers will conform to the same decision. Even though *M*'s decision to abstain, given previous investment choices, should not be directly interpreted as a received *L* signal, investor *M+1* does not learn from his predecessor's action and faces the same decision problem. He will also abstain regardless of his private signal, inducing all the later investors not to invest.

For example, in a situation where issuer's price is $P = ½$ and the order of signals received by the first two investors is *H* followed by *L*, both individuals invest. The first investor receives a *H* signals and infers the value of the offering to be 2/3. Consequently, the second investor who receives an *L* signal infers the value of the project to be ½. He believes that the shares are not overpriced and buys too. The third individual cannot know the second investor's signal and invests regardless of his own private information, thus, forming a positive cascade. Analogously, a negative cascade is formed if the order of signals is *LLH*. The cascade model is illustrated in Figures 3.9 and 3.10. Figure 3.9 describes choices faced by first two investors. Figure 3.10 illustrates the issuer's proceeds as a function of the price and information held by investors.

Figure 3.9: The Cascade game tree with two buyers.

The figure presents the choices faced by the first two investors. The dotted line implies that the second investor cannot observe the signal of the first investor, only his decision, therefore, he does not know at which node he moves. *Source: Welch (1992).*

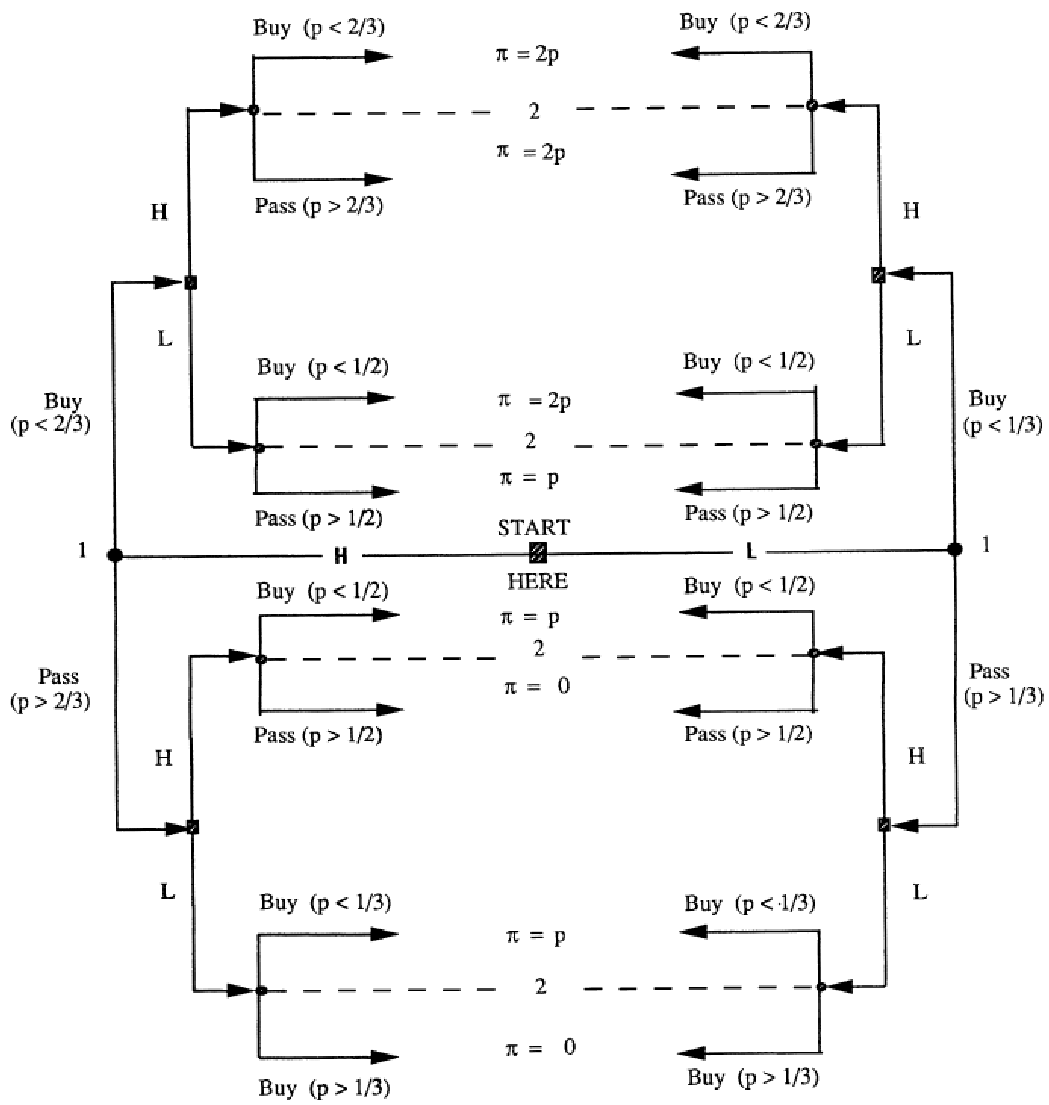
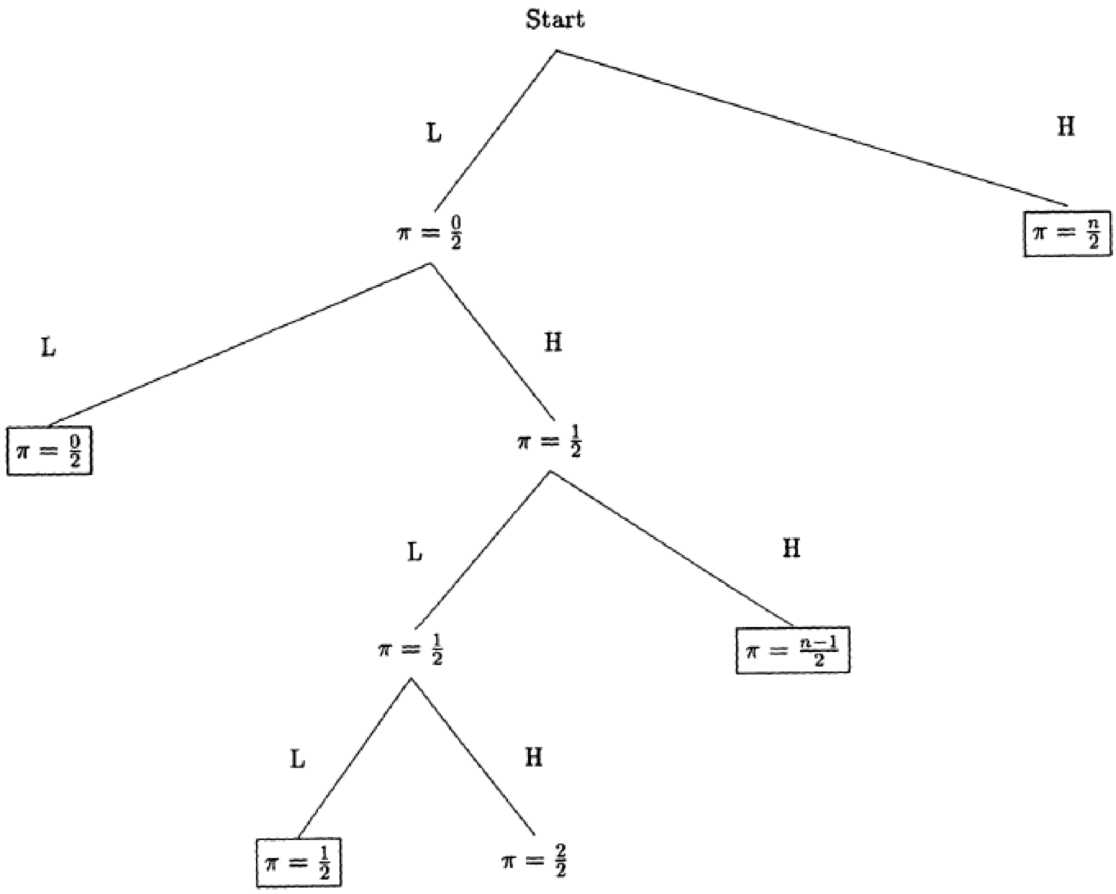


Figure 3.10: The cascade equilibrium outcome tree when the price is P = ½.
The figure shows the issuer's proceeds as a function of the price and information held by investors. Boxed nodes indicate that the tree can end abruptly with all subsequent investors acting alike. *Source: Welch (1992).*



This argument is summarised in Theorem 4[26]. Therefore, a well-informed market does not accumulate information well and market efficiency does not necessarily prevent the failure of underpriced offerings or guarantee failure of overpriced offerings. However, the success of an offering can be ensured through setting price at 1/3 and inducing investors to disregard information. Also, when aftermarket price reflects accumulated information perfectly, both underpriced and overpriced (relative to the aftermarket price) offerings can be successful.

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[26] Theorem 4: *With cascades, for any given price P >1/3, even with an infinite number of investors (and therefore with infinite selling opportunities), the probability that an offering of ultimate value θ< 1 (and in particular an underpriced issue) fails completely (no investor purchases) is strictly positive. For any given price P <2/3, the probability that an offering of ultimate value θ> 0 (and in particular an overpriced issue) succeeds perfectly (all investors purchase) is strictly positive* (Welch, 1992: 706).

This is a distinguishing feature of cascades as overpriced offerings are unsuccessful in other scenarios.

Theorem 5[27] derives the issuer's optimal price (θ= 1/3) and expected underpricing (0% to 50%). The reasoning behind this theorem is that the price reduction in order to convince market participants to invest is secondary to the risk of a complete failure for any price above the full-subscription price. At optimum price cascades ensure demand elasticity. This is especially the case with a risk-averse issuer as full-subscription price assures safe proceeds (compared to the uncertainty of proceeds in the simple path-dependent scenario).

Figure 3.11 illustrates the expected proceeds per investor under the three information scenarios as a function of a price. The figure shows that the optimal price is 1/2 for the perfect communication and the simple path-dependence scenarios. For the cascade scenario it is 1/3 with a sharp decline in proceeds when prices are raised. Expected proceeds in a perfect communication scenario are regular, while a simple path-dependence scenario displays irregular proceeds. Cascade proceeds are chaotic with irregular drops.

A risk-neutral issuer may choose to vary the price in order to induce only investors with *H* signals to buy, and then create a cascade to induce all subsequent investors to purchase the issue at the price arbitrarily close to the aftermarket value. However, issuers are risk-averse and prefer to price an offering low enough (at the full-subscription price) to create a cascade immediately, forgoing the path-dependent pricing. Therefore, according to Welch's (1992) theorem 7, the issuer is best off in a cascade scenario. The cascade model supports the documented positive relationship between IPO underpricing and ex-ante risk.

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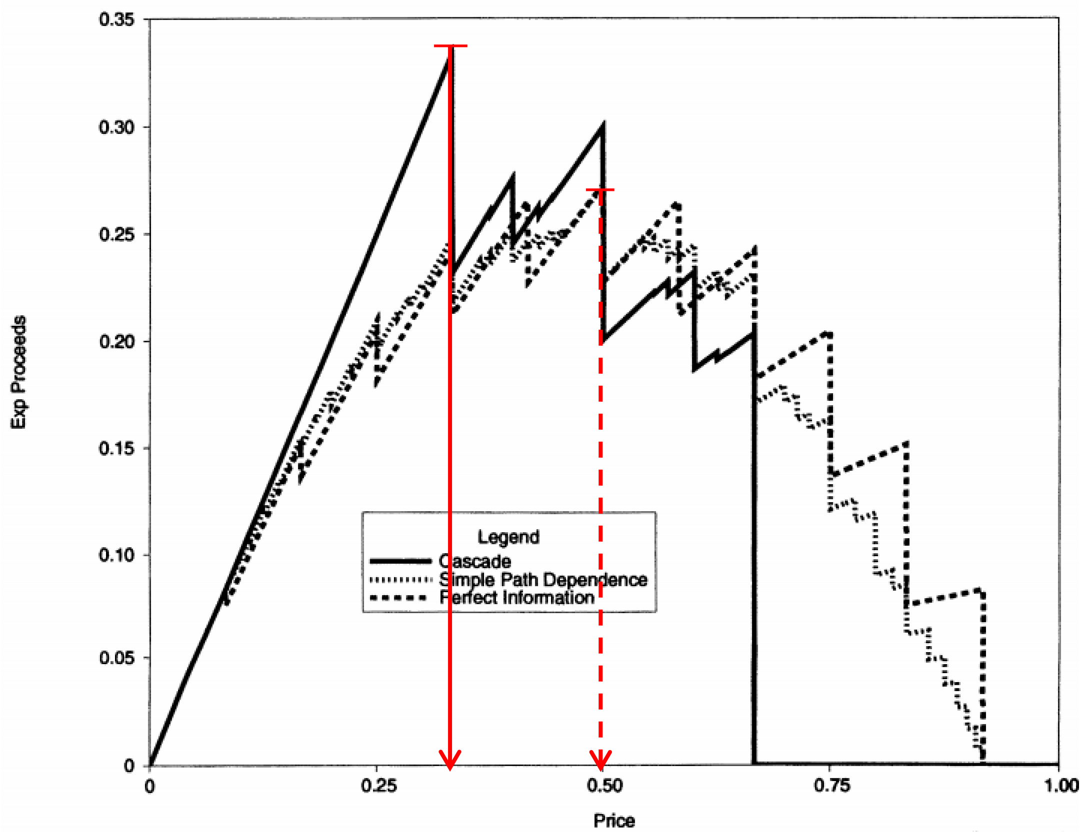
[27] Theorem 5: *An uninformed risk-neutral issuer optimally chooses the full-subscription price (θ = 1/3), and all offerings succeed. Successful offerings can ex-post be either over- or underpriced. The expected IPO underpricing (initial return) is between 0% and 50% (*Welch, 1992: 707).

Figure 3.11: Expected proceeds per investor as a function of the price.
The figure shows the expected proceeds per investor under the three information scenarios as a function of a price: for the perfect communication and the simple path-dependence scenarios the optimal price is 1/2, for the cascade scenario it is 1/3.*Adopted from Welch (1992).*



3.4 Informational cascades in IPO markets

Herding in general has been studied by many researchers, while informational cascades remain an area of predominantly experimental literature.

3.4.1 Empirical evidence

As herding is defined as the most inclusive category of behavioural convergence, with informational cascades as one of the sources of that conformity (Hirshleifer and Hong, 2003), it makes sense to look at the empirical research from the point of view of herding.

Price patterns were the focus of most of the early empirical studies. An influential study by Lakonishok *et al.* (1992) introduced a measure of herding referring to the simultaneous buying/selling of the same stock by money managers leading to a destabilisation of stock prices. Evidence of herd behaviour is found to be weak with a stronger effect in small stocks. Grinblatt *et al.* (1995) also find little evidence of herding, while Wermers (1999) does find some evidence of herd behaviour, which is, however, only slightly stronger than in Grinblatt *et al.* (1995). For a critical review of the early methodology and empirical studies on herding in financial markets, see Bikhchandani and Sharma (2001). A test of the accuracy of the Lakonishok *et al.* (1992) measure of herding is also provided by Wylie (2005).

In a more recent application of the Lakonishok *et al.* (1992) model, Uchida and Nakagawa (2007) find evidence indicative of herding in Japanese banking, while Lin and Swanson (2008) report little evidence of herding by foreigners in US market.

Another string of empirical research is focused on individual stock returns clustering around market returns during periods of large price movements. Christie and Huang (1995) use the cross-sectional standard deviation of returns to test for evidence of herding. They find no evidence of herding during market stress. Chang *et al.* (2000) propose a non-linear relationship between return dispersion and market returns. Their results indicate no evidence of herding in the US and Hong Kong, some evidence of herding in Japan, and significant evidence of herding in South Korea and Taiwan.

Hwang and Salmon (2004) use the cross-sectional dispersion of the factor sensitivity of assets in the US and South Korea in an attempt to evaluate herding towards particular sectors or styles, including the market index itself. They find evidence of herding when investors believe that they know where the market is heading rather than when the market is in crisis. Gleason *et al.* (2004) examine herding in exchange traded funds. They find no evidence of herding among traders during the periods of extreme market movements. This finding provides counter evidence to Lakonishok *et al.* (1992), as traded funds exhibit properties similar to trading in small companies (where there is less public information and greater information asymmetry) (Bowden, 2013).

A more recent study by Demirer *et al.* (2010) employs the models developed by Christie and Huang (1995), Chang *et al.* (2000), and Hwang and Salmon (2004) to test for herding in the Taiwanese market. They find that the linear model of Christie and Huang (1995) yields no significant evidence of herding, while the non-linear model of Chang *et al.* (2000)

and the state-space based models of Hwang and Salmon (2004) indicate strong evidence of herding behaviour. Herding is also found to be stronger during the periods of market losses.

In contrast to previous findings of little to no evidence of herd behaviour in larger more mature markets, a study by Chiang and Zheng (2010) finds evidence of herding in advanced stock markets (except the US) and in Asian markets, while Latin American markets show no evidence of herding. In the majority of cases, investors in national markets herd around the US market and herding exists in both up and down markets. According to Chiang and Zheng (2010), the explanation for previous findings may be the traditional approach of excluding foreign markets in testing for herding.

Nofsinger and Sias (1999) adopt a different approach and examine the cross-sectional relationship between changes in institutional ownership and the stock returns measured over the same period. They document a strong positive relationship for both small and large companies and no post-herding reversal in the subsequent two years. Kim and Nofsinger (2005) use the same methods as Nofsinger and Sias (1999) to test for herding in Japanese markets. The results suggest a lower level of herding in Japan (compared to the US) with a larger impact. This is partially explained by the long-term nature of institutional investment in Japan, where institutional investors build long-term relationships with firms and gain better access to firm-specific fundamental information. As a result, informational asymmetries are reduced, and Japanese investors are less likely to herd. Their trades, however, send a much stronger signal to other investors increasing impact on prices.

A more recent study by Cipriani and Guarino (2012) develops a model of herding in financial markets that can be estimated with financial markets transaction data. Their work builds on Avery and Zemsky (1998) and studies how traders' beliefs change each trading day in order to identify periods in which herding occurs. Their findings indicate that herding behaviour is quite frequent and can last for some time generating informational inefficiencies.

3.4.2 Laboratory experiments

Following Anderson and Holt (1996; 1997), several laboratory and controlled experiments offering more decisive evidence on the validity of the rational view of informational cascades have been conducted. (Holt and Anderson, 1996; Anderson and Holt, 1996; 1997; Drehmann *et al.*, 2005; Alevy *et al.*, 2007; Noeth *et al.*, 1999)[28].

Anderson and Holt (1996; 1997) and Holt and Anderson (1996) confirm the predictions of the model by Bikhchandani *et al.* (1992). They find that cascades form in approximately 80 percent of the cases where the possibility arises. They also find that the 'reverse cascades' that form with the first few misrepresentative signals are not broken by the correct signals received later in the sequence.

Willinger and Ziegelmeyer (1998b) replicate the experiment of Anderson and Holt (1996; 1997), with an attempt to shatter potential informational cascades through raising the amount of agents' private information. Ziegelmeyer *et al.* (2005) attempt to reduce information inefficiency by changing the order of participation to endogenous, i.e. agents are able to choose the moment that they step into the sequence (the agents in the influential subset become endogenously determined, according to the quality of their private information). Their results confirm the findings of Anderson and Holt (1996; 1997) and demonstrate that additional private information increases agents' sensitivity to privately-held information and is sufficient to improve economic efficiency.

Hung and Plott (2001) extend the study of Anderson and Holt (1996; 1997) and examine information production and gathering under three different scenarios of institutional organisation: individualistic institution – agents rewarded according to the right or wrong decision, as in Anderson and Holt (1996; 1997); the majority rule institution – agents rewarded if the majority of announced decisions are right; and the conformity-rewarding institution – where agents have an incentive to be right but are rewarded more if they do

[28] See also e.g. Goidel and Shields (1994), Bounmy *et al.* (1998), Allsopp and Hey (2000), Noth *et al.* (1999), Sadiraj *et al.* (1999), Huck and Oechssler (2000), Ashiya and TakeroDoi (2001), Hung and Plott (2001), Oberhammer and Stiehler (2001), Noth and Weber (2003), Plott *et al.* (2003), Kubler and Weizsacker (2004), Kramer *et al*. (2005), Cipriani and Guarino (2005), and Drehmann *et al.* (2005).

not deviate from the others' decisions. They find that individual decisions change with the change of an institution. Agents place significantly higher weight on public information rather than on private information in the conformity-rewarding scenario. Under the majority rule scenario, the situation is reversed and private information has much higher value relative to the public information. The findings of Hung and Plott (2001) indicate that the choices of others carry important information that needs to be incorporated with agents' own decisions, and following the crowd reflects an element of wisdom. On the other hand, the rules of the institutions make a difference and great care should be exercised when designing collective decision processes.

A number of laboratory experiments address the deviation from Bayes' rule in decision making. Huck and Oechssler (2000) find that subjects deviate from Bayesian updating of beliefs when faced with more complex decision-making frameworks. Anderson (2001) changes the payoff structure and finds that most deviant decisions are based on a private signal. Guarino *et al.* (2006) suggest that individuals can relate only to their own experiences; they are unaware of the experiences of the previous decision makers and, therefore, tend to follow their own signal.

Goeree and Palfrey (2007) conduct laboratory experiments with very long sequences of varying signal informativeness. Their findings are different to the short horizon experiments of Anderson and Holt (1996; 1997). While standard cascade theory predicts that information stops aggregating after a few initial decisions, Goeree and Palfrey (2007) show that learning is continuous and for long sequences public beliefs tend to be correct.

Kübler and Weizsäcker (2004) introduce a cost for obtaining a signal. According to their results, early investors attribute a high error rate to the preceding signals and overinvest in obtaining information, while later investors ignore the possibility of being in a cascade, spend less on buying the signals and end up in a cascade. Grebe *et al.* (2008) provide an explanation as to why decision-makers deviate in early stages, but follow the predecessor once the cascade sets in. They find that overconfidence results in a higher chance of agents assuming that the action of their predecessor reveals his signal; they ignore the possibility of being in a cascade and follow the predecessor's choice.

Laboratory evidence provides four general lessons:

1. Agents often neglect their own private information and defer to the information provided by their predecessors.
2. Agents are alert to whether their predecessors are especially informed; more informed people can shatter a cascade.
3. Perhaps most intriguingly, cascade effects are greatly reduced if agents are rewarded not for correct individual decisions but for correct decisions by a majority of the group to which they belong.
4. Cascade effects are significantly increased if agents are rewarded not for correct decisions but for decisions that conform to the decisions made by the majority. In the real world, we are sometimes rewarded not for being right but for doing what others do. Such a system of rewards is likely to lead both individual and groups in bad directions.

These general lessons have implications for policy and law. They show that errors are most likely when people are rewarded for conforming and least likely when people are rewarded for helping groups and institutions to decide correctly.

3.5 Chapter Summary

The chapter synthesises the theoretical overview of the IPO clusters. It starts with the general review of the concept of herding, presents the approaches to studying herding in cognitive psychology and outlines the main development in the theory and the different sources of convergence in human behaviour.

Informational cascade is presented as a sub-category of herding. It denotes a situation where imitation is inevitable. There are several characteristics of an informational cascade: idiosyncrasy, simultaneity, paradoxicality, and path dependence. They are reviewed in sections 3.1.2 of the current chapter.

The chapter also discusses the informational cascades in the IPO markets and relates the concept to the IPO clustering. An informational cascade is a consequence of informational externalities and is formed when the spillover information dominates the private information. IPO clusters are formed as a result and once an IPO wave starts consecutive issuers blindly follow the heard.

The cascade model, Model of Observational Learning introduced by Bikhchandani *et al.* (1992), is discussed in section 3.2. The section presents the model settings and the scenarios of the model. It also looks at the formation and breaking of a cascade under the MOL and outlines the main criticisms of the model. The last sections examine the MOL in the IPO settings. Three scenarios are possible under the model settings: the perfect communication scenario, the simple path dependence and a cascade scenario. The cascade scenario assumes no communication among investors and is the more realistic representation of real-life setting in the theoretical form.

The empirical evidence on the theory of informational cascades is presented on two aspects. Herding in its general form is widely researched while informational cascades are studied mainly through the laboratory experiments. Laboratory evidence, however, does provide some general lessons that have implications for general practitioners as well as for designing policy and law.

Overall, relations between the IPO activity and internal and external factors have been investigated by many researchers. Stock markets around the world are interconnected through the communication channels and information can spread very quickly among investors. Many researchers attribute time variation in IPO volume to market inefficiency, arguing that IPO volume is high when shares are "overvalued." Such an argument assumes that the periodic market mispricing can somehow be detected by the owners of the firms going public, but not by the investors providing IPO funds. However, a few offer a rational explanation of optimal IPO timing and occurrence of IPO waves. The question of why many private firms wait to go public and exercise their options around the same time, causing IPOs to cluster in time and form an IPO wave, still remains.

The aim of this research is to test for the link of IPO volumes to market conditions, external factors and internal characteristics of an IPO firm by analysing how IPO waves are formed through the market timing argument, the investigation of the potential factors that facilitate the formation of an IPO wave and by addressing the characteristics of early movers within a wave.

Chapter 4

RESEARCH DATA AND METHODOLOGY

‘What we find changes who we become.’

Peter Morville (2009)

CHAPTER FOUR – RESEARCH DATA AND METHODOLOGY

The chapter specifies the methodology used to address the questions of the study. It commences with an overview of the research objective and the main research questions, and proceeds with specifying the sub-questions and describing the methods used to address each one of them. It continues then with the description of the data collection process and the data sources. The last section of the chapter discusses the issues of reliability and validity.

4.1 Research objective and research questions

The overall objective of this study is to investigate the pricing and performance of new offers in IPO clusters in the UK. In order to analyse this, short-term and aftermarket performance of IPOs are examined first, followed by the investigation of the evidence of IPO waves in the UK market. Lastly, the IPO waves and the potential factors initiating a wave are looked at in relation to each other. To address this, three main research questions (RQ) are examined:

4. Research Question 1: What is the performance of IPOs in the UK market and what are the potential factors influencing it?
5. Research Question 2: Are there IPO waves in the UK market?
6. Research Question 3: How IPO waves are formed?

The data sample for the analysis of the performance of IPOs in the UK includes IPOs in the period of January 1984 to December 2016. However, due to the limitation in the data availability, the IPO underpricing is measured for a subset of data that includes IPOs in the UK in the period of January 2002 to December 2016. While this subset is limited in time, it provides sufficient data for the analysis of IPO performance in and out of a wave and incudes the pre-, during, and post- financial crisis periods.

4.1.1 Research Question 1: What is the performance of IPOs in the UK market and what are the potential factors influencing it?

In order to analyse the performance of IPOs in the UK markets, short-term and aftermarket performance of IPOs are examined first. To investigate this, three research sub-questions are addressed:

(iv) RQ 1a: Is there evidence of IPOs underpricing in the UK?
(v) RQ 1b: What is the aftermarket performance of IPOs in the UK?
(vi) RQ 1c: What are the potential factors influencing IPO underpricing in the UK?

4.1.1.1 Research question 1a: Is there evidence of IPOs underpricing in the UK?

Research question 1a examines the historical levels of IPO underpricing in the UK. Theories and empirical tests that attempt to explain this underpricing are reviewed by Jenkinson and Ljungqvist (2001); Ritter and Welch (2002); Ljungqvist (2007) among others. To analyse the evidence, the levels IPO underpricing are measured following Ritter (2013) specification. Underpricing of an IPO refers to the average first-day return computed as the percentage return from the offering price to the first closing market price. The level of underpricing, the abnormal short-term return (RET_{it}) for firm *i,* is the change in the share price to the first closing market price as compared to the offer price:

$$RET_{it} = \left(\frac{P_{it}}{P_{i0}} - 1\right) \qquad \textbf{(Equation 1)}$$

where, P_{it} = the closing price at the end of the specified period and P_{i0} = the offer price.

The greater the underpricing, the lower the gross IPO proceeds, and, therefore, the greater the money that issuing firms, and selling shareholders in particular, ‘leave on the table’. This is due to the information asymmetry that surrounds IPOs. As more information becomes available the price adjusts to market valuation of the IPO (Loughran and Ritter, 2002).

4.1.1.2 Research question 1b: What is the aftermarket performance of IPOs in the UK?

Research question1b examines the aftermarket performance of IPOs in the UK. Aftermarket performance of IPOs refers to the price behaviour of the IPOs beyond the listing day. Findings of previous research provide inconclusive results indicating that in some countries IPOs on average underperform the markets (Ritter, 1991) and in other countries they outperform the market (Loughran and Ritter, 1995; Cai and Wei, 1997).

Several studies have expressed growing doubts on the aftermarket IPO performance evaluations: the previous literature mixed results may be attributable to a variety of factors. One, which is debated widely, is the appropriate measurement method for long-run returns. The two main methods for the evaluation of aftermarket performance of IPOs used by previous studies are Cumulative Abnormal Returns (CAR) and Buy-and Hold Abnormal Returns (BHAR). CAR is the differences between the issuing firm's returns and the benchmark returns summed up over the number of specified periods. BHAR is calculated by subtracting the benchmark returns from the long run returns of the issuing firm over a specified period.

A criticism of the CAR approach is that on average monthly return does not accurately measure the return to an investor who holds a security for a long post-event period. Barber and Lyon (1997) state that long-term investors' investment experience is more precisely reflected in the BHAR model as it presents compound returns. Much of the recent literature tests buy-and-hold abnormal returns for periods up to five years after an event. Investor experience is interesting, and long-term BHARs are thus interesting. However, Smith (2008)argues that the BHAR approach is faulty as not all investors are interested in measuring their returns against an investment strategy based on a buy-and-hold investment.

Moreover, AARs and CARs also pose fewer statistical problems than long-term BHARs. For example, Barber and Lyon (1997) who favour BHARs and provide the most complete discussion of the inference problems in tests on long-term returns (also see Kothari and Warner, 1997), show that inferences are less problematic for average monthly returns

(AARs or CARs)[29]. Also, Mitchell and Stafford (2000) point out that BHARs can give false impressions of the speed of price adjustment to an event. The reason is that BHARs can grow with the return horizon even when there is no abnormal return after the first period[30].

Furthermore, Brav (2000) emphasises that all existing methods for drawing inferences from BHARs fail to correct fully for the correlation of returns across events not absorbed by the model used to adjust for expected returns. The problem is more severe in long-term BHARs because more firms have events within a given five-year window than within a three-day window. Brav (2000) presents an elaborate scheme to adjust for the cross-correlation of long-term BHARs in special cases (e.g., when it is due to industry effects). However, a full solution is not typically available because the number of return covariances to be estimated is greater than the number of time-series observations. Mitchell and Stafford (2000) find that the calendar-time portfolio procedure has more power to identify reliable evidence of abnormal performance than the BHAR approach, after accounting for dependence and, like Fama (1998), strongly advocate for a calendar-time portfolio approach.

Gompers and Lerner (2003) and Gregory *et al.* (2008) argue that abnormal performance measures such as cumulative abnormal returns (CARs) and time-series regressions are less likely to yield spurious rejections of market efficiency than methodologies that calculate buy-and-hold returns (BHARs) by compounding single-period returns at a monthly frequency. First, the buy-and-hold method can magnify underperformance even if it occurs in only a single period. Second, distributional properties and test statistics for cumulative abnormal returns are better understood. Following Fama (1998); Mitchell and Stafford (2000); Gompers and Lerner (2003); Gregory *et al.* (2008), we argue that due to both theoretical and statistical consideration CARs should be used, rather than BHARs.

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[29]In a follow-up paper, Lyon *et al*. (1999) develop elaborate techniques for correcting some of the inference problems of BHARs. However, they acknowledge that their improved methods for BHARs produce inferences no more reliable than simpler methods applied to monthly AARs or CARs. The reason is that average monthly returns avoid the problems (e.g., extreme skewness) produced by compounding monthly returns to get long-term BHARs.

[30]For example, returns for the first year after the event are 10% for event firms and zero for benchmark firms, so the first-year abnormal return is 10%. Suppose event and benchmark firms both have a 100% buy-and-hold return over the next four years. Although there is no abnormal return after the first year, the BHAR after five years grows to 20%.

The CAR return is calculated according to the following formula:

$$CAR_{IPOt} = \sum_{t=1}^{t} AR_{IPOt} \qquad \textbf{(Equation 2)}$$

$$AR_{IPO} = R_{IPOt} - R_{mt} \qquad \textbf{(Equation 3)}$$

Where CAR_{IPOt}= cumulative abnormal returns of an IPO in period t, AR_{IPOt}= abnormal returns of an IPO in period t, R_{IPOt} = IPO returns in period t, R_{mt} = market returns in period t. The market returns are measured using the FTSE All share index.

As discussed in earlier sections, the biggest adjustment of IPO underpricing takes place in the first year (Guo and Brooks, 2008). Weiss (1989) and Peavy (1990) document that investors in new issues of closed-end funds suffered substantial losses as the funds moved from premiums over net asset value at the time of issue to substantial discounts 6 months later (in Ritter, 1991).

Also, when a company offers shares in an initial public offering, insiders typically enter into a so-called lock-in agreement[31]. Information related to lock-in contracts is contained in the issue agreement between the owners of the issuing firm and the underwriter(s) and is disclosed in the IPO prospectus. The efficient markets hypothesis asserts that as the details of lock-in agreements, including the expiry dates (at least in the case of clear-cut expiry dates), are public knowledge at the time of the IPO, there should be no predictable share price movements at the time of expiry of the lock-in periods. There has been a marked trend towards standardised lock-in periods of 180 days.

Ofek and Richardson (2000) argue that since the date of the lock-in expiration is known when the firm goes public, this price impact should be captured by the offering price or by the market price immediately after the IPO starts trading. Therefore, on average, no price impact is expected around the unlock date. Contrary to the theoretical predictions, negative abnormal returns following the lock-in expiration have been documented (Brav, 2000; Ofek

[31]A lock-in agreement is an arrangement between the existing shareholders of the issuing firm (managers, directors, employees, venture capitalist and other individual and institutional shareholders) and the underwriter, whereby the shareholders agree not to sell a certain percentage of their holdings for a specified length of time after the IPO. This period is called the lock-in period, and the term `lock-in expiry date' refers to the date when pre-IPO shareholders are (first) allowed to sell their locked-in shares.

and Richardson, 2000; Field and Hanka, 2001; Bradley *et al.*, 2003; Brau *et al.*, 2003; Yung and Zender, 2010). Given that the lock-in expiry date is public information at the time of the IPO, these findings are surprising. It might represent the fourth IPO anomaly besides the findings of positive abnormal initial returns (often interpreted as evidence of `underpricing'), long-term underperformance and hot-issue periods.

For that reason the timeframe for measuring aftermarket returns is set at a six-month period from the IPO date (180 calendar days). To reflect the dynamic of the change in IPO performance CAR is also calculated for the first month and the third month (30 and 90 calendar days) following the IPO date. First month, third month and sixth month CAR is calculated according to the formula specified above using the offer price and the closing share price on the 30th, the 90th, and the 180th calendar day after the IPO date. These periods are sufficiently long to allow for a significant amount of private information to enter into the market price. By the end of the first month the price will begin to reflect the adjustment after the initial reaction. By the end of the third month the firm will have released an earnings report, the ‘quiet period’ will have ended, and analysts may start following the stock. By the end of the sixth month the firms will have released a second earnings report and, perhaps more importantly, in most cases the lockup period will have expired and insider trading decisions will have been revealed[32].

4.1.1.3 Research question 1c: What are the factors influencing IPO mispricing in the UK?

Question 1c examines possible factors that potentially influence the level of underpricing. Generally, the literature relates the underpricing to ex-ante uncertainty that surrounds the IPO (Rock, 1986; Beatty and Ritter, 1986; Kiymaz, 2000; Chan *et al.*, 2004; Zouari *et al.*, 2009; Samarakoon, 2010). Since it is not possible to measure ex-ante uncertainty directly, three variables potentially influencing the ex-ante uncertainty and the level of underpricing that are most commonly referred to by previous research are identified. In line with previous studies, these variables are used as proxies for ex-ante uncertainty. They include:

[32]Yung *et al.*, (2008) and Cornelli *et al.*, (2006) make similar choices.

(i) Company size (VALUE), (ii) offer price (PENNY), (iii) use of an underwriter (UW), and (iv) reputation of the employed underwriter (UWrank):

(i) Company size (VALUE): Karlis (2000) and Kiymaz (2000) argue that IPOs issued by larger firms carry less ex-ante uncertainty. They are generally better known to the public and benefit from a higher demand for their shares compared to smaller firms (Kiymaz, 2000). Therefore, larger firms need to underprice less compared to smaller firms.

(ii) Offer price (PENNY): In the early stages of an IPO, the lead underwriter is responsible for assessing the premarket demand for its client's prospective IPO in an effort to set the offer price. Presumably, a very modest offer price will signal little demand, little value, or both. Interestingly, however, some researchers note that firms with unusually low offer prices (e.g., less than three US dollars) experience very high levels of underpricing. It has also been demonstrated that lower-priced stocks are associated with higher 'mortality rates' (Ibbotson, 1988; Jain and Kini, 1994; Aggarwal *et al.*, 2002). Therefore, lower offer price ('penny stocks')leads to higher level of underpricing.

(iii) Use of an underwriter (UW): Demand for IPO shares as a function of several signalling mechanisms. Hiring an underwriter has an information and insurance signalling effect (Willenborg (1999). The underwriters alleviate some of the risks of undersubscription, and secure the distribution of the new shares for a premium (Pilbeam, 2010). The informational signal to the investors is that the firm will stand to benefit from having its financial statements more accurately analysed. The use of an underwriter also acts as an insurance signalling against possible overpricing of an IPO and future securities litigations (Willenborg, 1999; Karlis, 2000). Therefore, the use of an underwriter is associated with lower underpricing.

(iv) Reputation of the employed underwriter (UWrank): Research states that firms prefer to hire a more reputable underwriter to reduce the ex-ante uncertainty surrounding the IPO. As the ranking of the underwriter increases, the incentive to protect the reputation also increases so the underwriting agent is more motivated to produce truthful information leading to reduced ex-ante uncertainty and lesser underpricing (Kiymaz, 2000; Chen *et al*., 2004; Zouari *et* *al*., 2009; Samarakoon, 2010). Therefore, the increase in underwriter's reputation is associated with reduced information uncertainty leading to lower IPO underpricing.

In addition, based on the findings to objective one, three additional variables have been added to the regression. They are: (v) type of the IPO offer (OT), national, international or mixed, (vi) type of market (MT) used for the IPO, Main Market versus AIM, and (vii) industry sector of the IPO (SECTOR):

(v) Type of offer (OT): Given the variations in the reported levels of underpricing for objective one (section 1.a), two dummy variables for the type of offer used for an IPO has been introduced. According to Welch's (1992) theorem, the issuer is best off in a situation with an informational cascade scenario, meaning that issuers seek to prevent communication among investors and hire underwriters who provide issuers with an investor base that cannot communicate with each other easily. This geographical dispersion of investors is deliberately pursued by the underwriters as this puts the issuer and the underwriter at an informational advantage (Welch, 1992). This suggest that depending on the prevailing market conditions in the home country issuers and underwriters select the investor base and offer shares locally in 'hot' markets and on a wider geographical scale in 'cold' markets. This indicates that underpricing is higher for national IPOs.

(vi) Type of market (MT): Based on the finding of the earlier sections, in addition to the offer type variable, a binary dummy variable for the market type is used. This variable is used as an alternative measures that can potentially serve as a signal of the IPO firm quality, especially during the periods of 'hot' market. AIM (is a sub-market of the LSE, allowing smaller firms to float shares in a more relaxed regulatory system than is applicable to the Main Market. AIM accounts for an increasing proportion of the total number of new listings; however, most of the money raised is due to the new lists on the Main Market. Therefore, companies that choose to have their IPO on the Main Market may do so as a success/performance measure and with the view to signal their quality. This measure of performance is used not only as a stage in the company growth but also as a strategic decision. Earlier researchers, for example, Pagano *et al*. (1998) associate IPOs with larger firms, higher market-to-book ratio and lower cost of credit. This more traditional view of the decision to go public pertains more to the requirements and process of launching an IPO on the LSE's 'stricter' Main Market.

Later researchers, on the other hand, argue that arrival of a new technology or the introduction of an innovative product creates a positive shock to the economy driving several companies to launch an IPO with an aim to raise funds. This improves investment opportunities and raises the price at which firms can sell securities. Higher prices create the temptation for bad firms to pool and marginal firms entering the market given improved market conditions (and higher capital yields) are of relatively lower quality generally associated with higher underpricing (Lowry, 2003; Batnini and Hammami, 2015). These poorer quality firms will choose the AIM for launching their IPO due to its more flexible regulatory regime. Therefore, Main Market is associated with lower underpricing, while firms on AIM are expected to underprice more.

(vii) Industry sector (SECTOR): Findings relating to objective one show high variations in IPO underpricing between different industry sectors. Given this variations 11 dummy variables for industry sectors are introduced. The introduction of a new technology creating an exogenous shock and inducing more companies to raise funds through an IPO leads to higher prices. This could potentially explain the higher underpricing in certain sectors that are characterised by higher R&D or an innovation of a new product/technology (Lowry, 2003; Jain and Kini, 2006; Batnini and Hammami, 2015). Therefore, underpricing is expected to be higher for innovative industries.

Table 4.1 summarises the identified variables and hypotheses. These variables have been chosen in line with the overall objective of the study and in order to be able to examine the IPO waves and the behaviour of the pioneering IPOs within those waves. Other variables that could potentially provide further insight in the performance of IPOs are outlined in the Appendix A: 'Factors influencing IPO underpricing'.

To provide a test of the ability of these factors to explain variation in IPO underpricing (UP) a regression analysis has been carried out.

UP (IPO underpricing) = f (use of underwriter + underwriter rank+ company size + offer price + offer type + market type + industry)

Prior to running a regression test the variables have been tested through the anova test to identify the significance of the impact of the explanatory variables on the dependent variable. The regression models are specified as follows:

for all IPOs: UP = α + β_1(UW) + β_2(VALUE) + β_3(PENNY) + β_4(MT) + γ_1(OT Mixed) + γ_2(OT International) + ρ_1(Consumer Product & Services) + ρ_2(Energy & Power) + ρ_3(Financials) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

for the underwritten IPOs only: UP = α + β_1(UWrank) + β_2(VALUE) + β_3(PENNY) + β_4(MT) + γ_1(Mixed) + γ_2(International) + ρ_1(Consumer Product & Services) + ρ_2(Energy & Power) + ρ_3(Financials) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

Table 4.1: Summary of variables and hypotheses for IPO underpricing

Variable	Description (Measurement)	Expected relationship	Hypothesis
IPO Underpricing (UP)	*Dependent variable measured as:* $\mathrm{RET_{i1}} = \left(\frac{\mathrm{P_{i1}}}{\mathrm{P_{i0}}} - 1\right)$	*Negative with **VALUE, UW, UWrank, OT, MT**, and **SECTOR**, and positive for **PENNY.***	
*Firm size logged (VALUE)**	Log of the total number of shares offered at the IPO multiplied by the offering price of those shares.	Prior studies identify a negative relationship, between the size of the firms and the level of underpricing.	**H_1:** There is a negative relationship between the size of a firm and the levels of underpricing, i.e. bigger companies underprice less.
*Offer Price (PENNY)**	Binary dummy variable for penny stocks: stocks with offer price less than 3.00 are coded as penny stocks, equal to one and zero otherwise.	Previous studies identify positive relationship between the offer price and the level of underpricing, i.e. lower offer price leads to higher levels of underpricing.	**H_2:** There is a positive relationship between the offer price and the level of underpricing, i.e. lower offer price leads to higher level of underpricing.
Use of an Underwriter (UW)	Binary dummy variable: firms that employed an underwriter are coded as equal to one and zero otherwise.	Hiring an underwriter is an insurance signalling against overpricing of an IPO and future securities litigations (Willenborg, 1999; Karlis, 2000)	**H_3:** There is a negative relationship between the use of an underwriter and the level of underpricing, i.e. companies that hire an underwriter underprice less.
*Reputation of the employed underwriter (UWrank)**	Binary dummy variable for prestigious underwriter: all underwriters who subscribed 16 and more IPOs are coded as prestigious underwriters, equal to one and zero otherwise.	Previous studies identify a negative relationship, i.e. hiring a more reputable underwriter reduces the level of underpricing.	**H_4:** There is a negative relationship between the reputation of the used underwriter and the levels of underpricing, i.e. companies with prestigious underwriters underprice less.
*Offer Type (OT)**	Two dummy variables for the type of offer: National IPOs are coded as the base group.	Based on the findings to objective one, national offers are expected to have higher underpricing.	**H_5:** There is a negative relationship between offer type and underpricing, i.e. National IPOs underprice more compared to International and Mixed offers.
Market Type (MT)	Binary dummy variable for the type of IPO market: Main Market IPOs are coded as one; AIM IPOs are equal to zero.	Based on the findings to objective one, AIM IPOs are expected to have higher underpricing.	**H_6:** There is a negative relationship between market type and underpricing, i.e. AIM IPOs underprice more compared to MM IPOs.
*Industry (SECTOR)**	11 dummy variables for 12 industry sectors: IPOs in the 'Consumer Staples' sector are coded as the base group.	Based on the findings to objective one, underpricing is expected to be higher in 'Consumer Staples' sector.	**H_7:** There is a negative relationship between industry and underpricing, i.e. IPOs in 'Consumer Staples' underprice more compared to other sectors.

*The description of the process for the specification of the variables is provided in Appendix C.

4.1.2 Research Question 2: Is there evidence of IPO waves in the UK market?

Research question two examines the evidence of IPO waves in the UK market. According to the literature review, there is a wide evidence of fluctuations in IPO volumes and clustering of IPOs (Ritter and Welch, 2002; Lowry and Schwert, 2002). To analyse this, question two is broken into three sub-questions:

(i) RQ 2a: Is there evidence of IPO waves in the UK?
(ii) RQ 2b: When do IPO waves occur in the UK?
(iii) RQ 2c: What industries are more prone to IPO waves?

RQ 2a examines the IPO activity in order to identify patterns in the number of IPO transactions, RQ 2b identifies repetitions in those patterns, and RQ 2c studies the patterns in IPO activity according to industry sectors.

4.1.2.1 Research Question 2a: Is there evidence of IPO waves in the UK?

Research question2a examines the wave-like patterns in the number of IPOs transactions in the UK. The existing methods for identifying the waves in IPO markets vary across the papers. The majority of the methods are based on simply identifying the periods of 'hot' and 'cold' markets. Ritter (1984) defines a 'hot market' as one in which average underpricing is high. Helwege and Liang (2004) and Pástor and Veronesi (2005) use monthly IPO volume to detect IPO waves. However, they use different cut off levels to classify months as 'hot' or 'cold' and model IPO waves in an environment with fully rational investors and do not account for information asymmetry. Coakley *et al.* (2008) classify IPOs into 'hot' and 'normal' markets by applying three criteria. They use above-average number of IPO issues, above-average initial returns and non-negative autocorrelation in volume of yearly IPOs (number of IPOs in a hot market year should be no lower than that in the previous year) for identifying 'hot' markets. Yung *et al.* (2008), Çolak and Gunay (2011), Banerjee *et al.* (2013) identify three categories of market state, 'hot', 'normal' and 'cold', on a quarterly basis (comparing the moving average to historic average), whereas Bustamante (2012) identifies them on an annual basis. Batnini and Hammami (2015) graphically single out the periods of intense IPO activity.

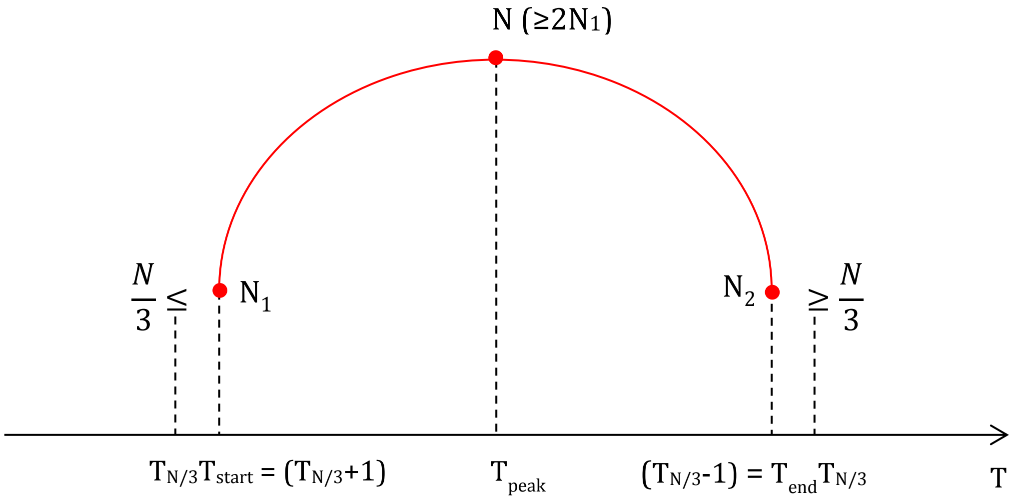
All of the discussed methods focus solely on identify the periods of higher or lower IPO activity without examining the development of the cluster. The ‘hot’ and ‘cold’ markets are classified according to different time intervals and the methods differ in terms of the ways they smooth and deflate the time series of IPO volumes. Current research relies not only on identifying the periods of higher or lower IPO issuance but also on comparison between new issues that took place in and out of IPO waves and also the dynamics of IPO activity within a wave. For this reason, the methodology for the wave identification has been adopted from the research in the mergers and acquisitions literature. Carow *et al.* (2004) and McNamara and Haleblian (2008) offer a comprehensive technique for wave identification that takes into account periods of ‘hot’ and ‘cold’ markets, different types of waves, and the stages in the development of a wave. The identified waves then are validated using the combined methods of Harford (2005) and Duchin and Schmidt (2013) applied for validating waves in the mergers and acquisitions markets.

A strand of theoretical literature on IPO clustering focuses on information spillovers. Late IPOs may free-ride on the information production occurring in earlier IPOs, thereby causing a wave. Informed investors may therefore, have a strategic incentive to withhold their information (Alti, 2005). The resulting market breakdowns create a role for investment banks in bundling IPOs and cross-subsiding early wave offerings (Benveniste *et al.,* 2002). These analyses represent purely theoretical modelling and predications. However, these theoretical analyses, in which insiders and informed investors have firm-specific private information and industry-wide shocks are publicly observed, are complementary to methodology chosen for the purpose of this research.

To investigate the evidence of IPO waves in the UK, the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008) is followed. The process of wave identification is presented in figure 4.1.

Figure 4.1: Wave identification process

The graph shows the process for identifying waves in an IPO market. The methodology is adopted form the research on the mergers and acquisitions market and is based on the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008).



In this approach waves are identified by starting with a period where the market activity peaks and at least doubles compared to the previous period. Following McNamara and Haleblian (2008), relatively short periods of heightened activity are identified, limiting the wave periods to a maximum of six years. Most of the waves described by Carow *et al.* (2004) and McNamara and Haleblian (2008) moved from inception to peak within three years, suggesting that acquisition waves tend to play out within six years. Following this line of argument, the periods for peak identification are broken into three-year cycles[33]. The authors then work backwards in time until they find a period where the number of transactions in the sample is equal or less than one-third of the number of transactions in the peak period (i.e. the peak period includes at least three times as many transactions as a 'trough' period to be considered a wave). The start of the wave is defined as the first period after which the number of transactions in a particular period (prior to the peak year) is equal or less than one-third of the number in the peak period.

[33] The waves corresponding to the peaks identified within the three-year periods are corresponding to the waves relating to the peaks identified within the six-year periods used in the study of acquisitions waves by McNamara and Haleblian (2008).

The conclusions of a wave (if they exist) are identified in a similar fashion. Specifically, rolling forward through time (after the peak period) a period where the number of transactions is equal or less than one-third of the total in the peak period is identified. The preceding period then is considered to be the end of the wave. Following this methodology, waves have complete and incomplete cycles. For complete waves a peak, a beginning, and an end of a cycle are clearly identifiable using the process described above. For incomplete waves, the wave cycles have a clear peak and a beginning, but the decline in transactions is not large enough to suggest a clear end to the IPO wave prior to the end of the sample period.

Previous studies used the terms of a complete cycle and an incomplete cycle for identifying waves in financial markets (specifically in the merger and acquisitions markets). However, as the findings of this study suggest it is appropriate to introduce another term for describing the types of waves – 'an overlapping wave'. An overlapping wave is a wave that covers one or more shorter waves within a specified period. Often, for the overlapping wave the beginning of the wave corresponds to the beginning of a complete cycle wave (the first complete cycle wave if the overlapping wave covers more than one complete cycle wave), but the peak and the end differ. In that regard, it is different to the incomplete wave which has a clear beginning and a peak but an unclear end.

4.1.2.2 Research Question 2b: When do IPO waves occur in the UK?

For a more detailed picture of the IPO activity within a wave measured by yearly intervals, monthly and quarterly overviews of the IPO transactions were added to the analyses. To achieve this, the IPO activity over the specified period is broken into the six months periods (for quarterly waves, it is three quarters[34]) that are coded as potential waves[35]. The waves

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[34] In the absence of a generally accepted methodology for wave identification, the three quarters cut off point for quarterly waves is chosen following the procedure of Banerjee *et al.* (2015) who identify rising IPO cycles as periods during which the four-quarter moving average has risen for three quarters in a row.

[35]Harford (2005) and Duchin and Schmidt (2013) use the 24-month periods to identify the peaks and the potential waves in the IPO activity. The examination of the IPO activity by the six months period, proposed in this study, provides a more detailed presentation of the IPO activity by month and the identified peaks correspond to the 24-month peaks identified by the methodology of Harford (2005) and Duchin and Schmidt (2013).

are identified by the method of Carow *et al.* (2004) and McNamara and Haleblian (2008) described earlier, i.e. firstly, the peaks in the number of IPO transactions in any six-month period (three quarters periods for quarterly waves) are determined, and subsequently the beginnings and the ends of the cycles are identified in line with the outlined procedure. This approach allows for a more accurate study of the pioneering IPOs as opposed to the later movers (followers) and provides a clearer picture of the effect of the early movers on the pricing decisions of the following IPOs. Following the theoretical argument of Yung *et al.* (2008) grouping firms into yearly cohorts is probably too broad, as the heat of an IPO market can (and frequently does) change midyear. Using months slices the data too finely, however, as many months have few IPOs. Using quarterly cohorts strikes an appropriate balance in this trade-off. Nonetheless, looking at monthly IPO waves may provide a more detailed picture in cases where it may be necessary.

Following Carow *et al.* (2004) and Duchin and Schmidt (2013), in order to ensure that the analysed waves have sufficient number of transactions, only waves consisting of ten or more transactions in at least one year over the sample period are considered. Waves that do not meet these criteria are excluded from further analysis.

The author realises that if other researchers examine the same issue, their approach for identifying IPO waves, and then categorising new issues according to their timing (pioneering IPOs or otherwise) may differ. However, subject to this caveat, this procedure is consistently applied, objective and replicable.

4.1.2.3 Research Question 2c: What industries are more prone to IPO waves?

Research question 2c investigates IPO waves by industry. Jain and Kini (2006) identify industry conditions that influence IPO clustering and analyse differences in characteristics of clustered and non-clustered IPOs. They find that IPO clustering is more likely to occur in high-growth and fragmented industries characterised by strong investment opportunities, favourable investor sentiment and higher requirement of investment in research and development. Their approach is following the process of cluster identification in the M&A markets of Mitchell and Mulherin (1996). However, this process identifies only whether an industry includes an IPO cluster and classifies industries as either clustered or non-clustered industry. The goal of this research is to investigate not only the evidence of IPO waves but also to examine the formation of the waves and the influence of the pioneering IPOs on the later-joiners. In order to analyse this, IPO activity has been broken down according to the industry sectors. The industry sectors are defined as by Thomson One database.

The process of wave identification by industry follows the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008) as described earlier. Monthly and quarterly overviews of the IPO transactions are added to the analyses for a more detailed picture of the IPO activity within a wave. Similar to the previous sections, to achieve this, the six months and the three quarters intervals are used to identify the peak and the potential waves.

Following Carow *et al.* (2004) and Duchin and Schmidt (2013), in order to ensure that the analysed industries have sufficient number of transactions, only waves consisting of ten or more transactions in at least one period over the sample are considered. Industries that do not meet these criteria are excluded from further analysis.

4.1.3 Research Question 3: How IPO waves are formed?

There is substantial evidence of 'hot' and 'cold' IPOs markets. Many researchers report the trends in fluctuations in IPO volumes leading to clustering of IPOs and formation of IPO waves (Ritter and Welch, 2002; Lowry and Schwert, 2002). Research question three examines how these waves are formed. In order to analyse this, the research question is broken into three sub-questions:

(i) RQ 3a: Is there evidence of market timing in the UK?
(ii) RQ 3b: What are the potential factors initiating an IPO wave?
(iii) RQ 3c: What are the characteristics of pioneering IPOs?

4.1.3.1 Research Question 3a: Is there evidence of market timing in the UK?

As the stock market index mirrors the investor´s willingness to invest or not, the number of IPOs vary accordingly. Enterprises are more likely to implement IPOs when the stock market promises higher returns and therefore profit for enterprises and also for potential investors. Studies by Loughran *et al.* (1994), Rees (1997) and Rydqvist and Högholm (1995) detect a significantly positive influence of stock index levels and stock index returns on the number of IPOs. Ljungqvist (1995) suggests that high number of IPOs is positively correlated with both high stock index levels and good business conditions and tends to follow phases of extensive IPO underpricing.

To test for the link of IPO volumes to market conditions, the study of Banerjee *et al.* (2013) is followed. The authors test for the relationship between market conditions and IPO volume, through regressing IPO volumes on the variables that capture different aspects of market conditions. Proxies for market conditions are defined as in Ljungqvist (1995), Pastor and Veronesi (2005) and Banerjee *et al.* (2013). The variables relating to changes in market conditions are: (i) the monthly market returns (MR) as the return on the FTSE All-Share Index (MR_{FTSE}) as in Pastor and Veronesi (2005) and Banerjee *et al.* (2013), (ii) the change in market volatility as standard deviation of daily market returns within the month (ΔMV_{FTSE}) as in Pastor and Veronesi (2005) and Banerjee *et al.* (2013), and (iii) IPO underpricing (UP) as in Ljungqvist (1995). Table 4.2 summarises the identified variables and hypotheses.

To test for the relationship between market conditions and IPO volume a regression analysis has been carried out. Prior to running a regression test each variable has been tested through the independent sample t-test to identify statistical significance of each variable. The regression model is specified as follows:

$$\text{(Lagged) No IPOs} = \alpha + \beta_1(MR_{FTSE}) + \beta_2(\Delta MV_{FTSE}) + \beta_3(UP) + \varepsilon$$

The model uses a one-month delay for all the explanatory variables in relation to the dependent variable.

Table 4.2: Summary of variables and hypotheses for Market Timing

Variable	Description (Measurement)	Expected relationship	Hypothesis
No IPO	*Dependent variable*	Lagged number of IPO transactions (by 1 month). Positive with $\mathbf{MR_{FTSE}}$ and **UP**, negative with $\mathbf{\Delta MV_{FTSE}}$	
Market Returns (MR_{FTSE})	The market returns on the FTSE All-Share Index.	IPO volume increases following periods of positive market returns and low market volatility. In particular, IPO volume is positively related to past market returns and negatively related to past changes in market volatility (Pastor and Veronesi, 2005; Banerjee *et al.*, 2013).	$\mathbf{H_8}$: There is a positive relationship between the stock market index returns and the number of IPOs.
Market Volatility (ΔMV_{FTSE})	Standard deviation of daily market returns within the month on the FTSE All-Share Index.		$\mathbf{H_9}$: There is a negative relationship between the market volatility and the number of IPOs.
IPO underpricing (UP)	Average monthly IPO underpricing (for the previous month)	High number of IPOs tends to follow phases of extensive IPO underpricing (Ljungqvist, 1995). There is a lead-lag relationship between IPO initial returns and volume (Lowry and Schwert, 2002; Banerjee *et al.*, 2013).	$\mathbf{H_{10}}$: There is a positive relationship between IPO underpricing and the number of IPOs.

4.1.3.2 Research Question 3b: What are the potential factors initiating an IPO wave?

Research question 3b examines the formation of a wave and the development of its cycle. According to previous research and findings to objective one, eight factors potentially influencing the formation of a wave have been identified. They are: (i) size of the company at the time of IPO (VALUE), (ii) offer price (PENNY), (iii) level of IPO mispricing (UP), (iv) the use of an underwriter (UW), (v) the reputation of the employed underwriter (UWrank), (vi) offer type (OT), (vii) market type (MT), (viii) industry sector (SECTOR) (Welch, 1992; Lowry and Schwert, 2002; Benveniste *et al.*, 2003). Table 4.3summarises the variables and the hypotheses.

Table 4.3: Summary of variables and hypotheses for the probability of an IPO being in or out of a wave.

Variables	Description (Measurement)	Expected relationship	Hypothesis
Probability of an IPO being inside a wave (WAVE)	*Dummy dependent variable identified as one for IPOs within a wave and zero otherwise.*	IPO waves are positively related to **PENNY**, **UP**, **UW, UWrank and OT**. The relationship is negative with **VALUE, SECTOR** and **MT**.	
*Firm size logged (VALUE)**	The total number of shares offered by the offering price of these shares.	Being in or out of an IPO wave depends on the size of the firm (bigger companies are out of an IPO wave as they do not depend on hot IPO periods).	**H_{11}**: There is a negative relationship between VALUE and WAVE, i.e. probability of an IPO being within a wave decreases as the company size increases.
*Offer Price (PENNY)**	Binary dummy variable for penny stocks: stocks with offer price less than 3.00 are coded as penny stocks, equal to one and zero otherwise.	Based on the findings to objective one, IPOs with lower offer price (penny stocks) are more prone to be within a wave.	**H_{12}:** There is a positive relationship between PENNY and WAVE, i.e. probability of an IPO being within a wave increases for penny socks, companies with lower offer price.
IPO mispricing (UP)	$\mathrm{RET_{i1}} = \left(\frac{\mathrm{P_{i1}}}{\mathrm{P_{i0}}} - 1\right)$	More firms go public after observing more underpriced IPOs because potential issuers learn from the experiences of previous issuers (Lowry and Schwert, 2002). Higher underpricing happens within an IPO wave.	**H_{13}**: There is a positive relationship between UP and WAVE, i.e. probability of an IPO being within a wave increases with higher underpricing.
Use of Underwriter (UW)	Binary dummy variable: firms that employed an underwriter are coded as equal to one and zero otherwise.	IPOs tend to cluster because of the underwriters' ability to bundle IPOs (Benveniste *et al.*, 2002). More firms within an IPO wave employ an underwriter.	**H_{14}**: There is a positive relationship between UW and WAVE, i.e. probability of an IPO being within a wave increases for the underwritten IPOs.
*Reputation of the employed underwriter (UWrank)**	Binary dummy variable: underwriters who subscribed 16 and more IPOs are coded as prestigious, equal to one and zero otherwise.	The choice of the underwriter relies on the underwriter's general reputation and expertise (Benveniste *et al.*, 2002). Firms employ underwriters with higher ranking within an IPO wave.	**H_{15}**: There is a positive relationship between UWrank and WAVE, i.e. probability of an IPO being within a wave increases for the IPOs with prestigious underwriters.
*Offer Type (OT) *: National, International or Mixed IPOs*	Two dummy variables: national IPOs are coded as the base group.	Issuers hire underwriters to distribute an offering to investors who find it difficult to communicate. This puts the issuer at an informational advantage (Welch, 1992).	**H_{16}**: There is a positive relationship between OT and WAVE, i.e. probability of an IPO being within a wave increases for the international and mixed IPOs.
Market Type (MT): AIM vs Main Market	Binary dummy variable: Main Marker IPOs are coded as one; AIM IPOs are equal to zero.	Based on the findings to objective one, more companies choose to have an IPO on the AIM due to its relaxed regulatory regime. IPOs within a wave are AIM IPOs	**H_{17}**: There is a negative relationship between MT and WAVE, i.e. probability of an IPO being within a wave decreases for Main Market IPOs. .
*Industry (SECTOR)**	11 dummy variable: IPOs in the 'Financials' sector are coded as the base group.	Based on the findings to objective one, more IPO waves happen in 'Financials' sector compared to other sectors.	**H_{18}**: There is a negative relationship between SECTOR and WAVE, i.e. probability of an IPO being within a wave decreases for IPOs in sectors other than the 'Financials'.

*The description of the process for the specification of the variables is provided in Appendix C.

In order to understand the influence of these factors on the formation of an IPO wave (periods of higher IPO activity), each of the factors has been examined through a multivariate probit[36] regression model. Prior to running a regression test each variable has been tested through the independent sample t-test to identify statistical significance of each variable.

Prob (InWave) = f (level of underpricing + use of underwriter + underwriter rank + company size + offer price + offer type + market type + industry)

The probability of an IPO being inside a wave depends on the company size, the level of IPO mispricing, the use of an underwriter and the reputation of the employed underwriter, the type of offer (national, international or mixed IPO), the type of market (Main Market or AIM), and the industry sector of the IPO. The regression model is specified as follows:

for all IPOs: $WAVE = \alpha + \beta_1(UP) + \beta_2(UW) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(International) + \gamma_2(Mixed) + \rho_1(Consumer\ Product\ \&\ Services) + \rho_2(Consumer\ Staples) + \rho_3(Energy\ \&\ Power) + \rho_4(Healthcare) + \rho_5(High\ Technology) + \rho_6(Industrials) + \rho_7(Materials) + \rho_8(Media\ \&\ Entertainment) + \rho_9(Real\ Estate) + \rho_{10}(Retail) + \rho_{11}(Telecommunications) + \varepsilon$

for the underwritten IPOs only: $WAVE = \alpha + \beta_1(UP) + \beta_2(UWrank) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(Mixed) + \gamma_2(International) + \rho_1(Consumer\ Product\ \&\ Services) + \rho_2(Consumer\ Staples) + \rho_3(Energy\ \&\ Power) + \rho_4(Healthcare) + \rho_5(High\ Technology) + \rho_6(Industrials) + \rho_7(Materials) + \rho_8(Media\ \&\ Entertainment) + \rho_9(Real\ Estate) + \rho_{10}(Retail) + \rho_{11}(Telecommunications) + \varepsilon$

where WAVE is a dummy variable for IPOs being in or out of a wave identified as being in the wave equal to one and being out of the wave equal to zero.

[36] Although OLS can be used to estimate a model with a qualitative dependent variable, doing so would result in an error term that is heteroskedastic and is not normally distributed.

4.1.3.3 Research Question 3c: What are the characteristics of pioneering IPOs?

Research question 3c analyses the characteristics of pioneering IPOs compared to the followers. To achieve this, the IPO transactions are categorised as being in the early portion of the wave or otherwise. Banerjee *et al.* (2015) define 'early movers' as firms that go public within the first two quarters of a rising IPO cycle. However, using this method for the purpose of the current research is problematic as the cut-off point is not easily transferrable to other time intervals. The goal is to make the procedure for categorising IPOs as pioneering IPOs, based on the timing of their issue relative to the wave, as objective as possible. For this, the methodology adopted by Carow *et al.* (2004) and McNamara and Haleblian (2008) is followed. In view of Carow *et al.* (2004), the companies in the first 20 percent of the transactions in the waves with complete cycles (i.e., periods with a clear peak, beginning, and an end of the cycle) are classified as early movers (pioneering IPOs). For the remaining waves with incomplete cycles (where there is a clear starting point and a peak year) the first 20 percent of the transactions in the wave are also classified as early movers and the remainder otherwise. The aim of this process is to compare early movers (pioneering IPOs) with non-early movers (as opposed to late movers). The characteristics and performance of early movers (pioneering IPOs) can, therefore, be contrasted with that of IPOs occurring at later stages of the wave even if the wave has not clearly finished.

To measure this, a number of variables have been identified based on previous research and the findings to objective one. They are: (i) size of a firm at the time of IPO (VALUE), (ii) offer price (PENNY), (iii) level of IPO mispricing (UP), (iv) the use of an underwriter (UW), (v) the reputation of the employed underwriter (UWrank), (vi) offer type (OT), (vii) market type (MT), (viii) industry sector (SECTOR). Table 4.4 summarises the identified variables and hypotheses.

Table 4.4: Summary of variables and hypotheses for the probability of an IPO being a pioneering IPO.

Variables	Description (Measurement)	Expected relationship	Hypothesis
Pioneering IPO (PIONEER)	*Dummy variable identified as one for pioneering IPOs and zero otherwise.*	Positive with **VALUE, UW, UWrank,** and **MT**, negative with **PENNY, UP, OT** and **SECTOR**.	
Firm size (VALUE)	The total number of shares offered by the offering price of these shares.	IPO activity begins once the firm with the largest cash flows in an industry decides to go public. This can lead to a number of firms in the same industry going public within a relatively short period of time (Benninga *et al.*, 2005).	**H_{19}**: There is a positive relationship between VALUE and PIONEER, i.e. early movers are larger firms.
Offer Price (PENNY)	Binary dummy: stocks with offer price less than 3.00 are coded as penny stocks, equal to one and zero otherwise.	Based on the findings to objective one, IPOs with higher offer price are more prone to be pioneering IPOs.	**H_{20}**: There is a negative relationship between PENNY and PIONEER, i.e. early movers have higher offer price.
IPO mispricing (UP)	$\mathrm{RET_{i1}} = \left(\frac{\mathrm{P_{i1}}}{\mathrm{P_{i0}}} - 1\right)$	The pricing of an IPO is aimed at incentivising investors (Welch, 1992; Lowry and Schwert, 2002). As pioneering IPOs are large confident firms with established cash flow, the need for underpricing as an incentive is reduced.	**H_{21}:** There is a negative relation between UP and PIONEER, i.e. early movers have lower underpricing.
Use of Underwriter (UW)	Binary dummy variable: firms that employed an underwriter are coded as equal to one and zero otherwise.	Demand for IPO shares is a function of information and insurance signalling. Hiring an underwriter is a signal that the firm will benefit from having its financials more accurately analysed. This also acts as an insurance signalling against possible overpricing of an IPO and future securities litigations (Willenborg, 1999; Karlis, 2000)	**H_{22}**: There is a positive relationship between UW and PIONEER, i.e. early movers employ an underwriter.
Reputation of the employed underwriter (UWrank)	Binary dummy variable: all underwriters who subscribed 16 and more IPOs are coded as prestigious underwriters, equal to one and zero otherwise.	The use of higher ranking underwriter signals the confidence of the issuer in timing of an IPO inducing other firms to perceive market conditions as favourable and proceed with their IPO.	**H_{23}:** There is a positive relationship between UWrank and PIONEER, i.e. early movers have underwriters with higher ranking.
Offer Type (OT)	Two dummy variables: National IPOs are coded as the base group.	Based on the findings to objective one, pioneering IPOs are National IPOs as they are established firms that do not depend on information asymmetry between issuers and investors.	**H_{24}:** There is a negative relationship between OT and PIONEER, i.e. early movers are national IPOs.
Market Type (MT)	Binary dummy variable: Main Marker IPOs are coded as one; AIM IPOs are equal to zero.	Based on the findings to objective one, pioneering IPOs are expected to be Main Market IPOs.	**H_{25}**: There is a positive relationship between MT and PIONEER, i.e. early movers are Main Market IPOs.
Industry (SECTOR)	11 dummy variable: IPOs in the 'Financials' sector are coded as the base group.	Based on the findings to objective one, pioneering IPOs are expected to be in the 'Financials' sector.	**H_{26}**: There is a negative relationship between SECTOR and PIONEER, i.e. early movers are more often 'Financials' sector's IPOs.

Probability of an IPO being a pioneering IPO (PIONEER) depends on the company size, the level of IPO mispricing, the use of an underwriter, the reputation of the hired underwriter, the type of the IPO offer, the type of market used for the IPO, and pertains to industries with specific characteristics:

Prob (Pioneering IPO) = f (level of underpricing + use of underwriter + underwriter rank + company size + offer price + offer type + market type + industry)

The regression model is specified as follows:

for all IPOs: PIONEER = α + β_1(UP) + β_2(UW) + β_3(VALUE) + β_4(PENNY) + β_5(MT) + γ_1(International) + γ_2(Mixed) + ρ_1(Consumer Product & Services) + ρ_2(Consumer Staples) + ρ_3(Energy & Power) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

for the underwritten IPOs only: PIONEER = α +β_1(UP) +β_2(UWrank) +β_3(VALUE) +β_4(PENNY) + β_5(MT) + γ_1(Mixed) + γ_2(International) + ρ_1(Consumer Product & Services) + ρ_2(Consumer Staples) + ρ_3(Energy & Power) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

where PIONEER (a pioneering IPO) is a dummy variable identified as being in the first 20 percent of the IPOs within a wave equal to one and zero otherwise.

4.2 Data sample and data source

The initial source of data is Thompson One. The Thompson One data sample for the UK includes 2426 IPOs in the period from January 1984 to December 2016. 110 IPOs have been excluded due to incomplete data. The final sample consists of 2316 IPOs in the UK from January 1984 to December 2016 and includes IPOs from the Main Market (MM) and the AIM London Stock exchange.

AIM (formerly the Alternative Investment Market) is a sub-market of the London Stock Exchange, allowing smaller companies to float shares with a more flexible regulatory system than is applicable to the main market. Since its launch in 1995, AIM has grown rapidly to account for an increasing proportion of the total number of new lists. However, while the number of new lists has been large on AIM, most of the money raised is due to the new lists on the Main Market.

Due to the limitations in the data availability the levels of IPO underpricing are measured for a sub-set of data that includes IPOs in the period from January 2002 to December 2016. The initial subset includes 1050 IPOs issued in 2002-2016. 30 observations have been removed due to incomplete or missing data and 12 IPOs have been removed as outliers (see Appendix B: Outliers for the subset of data for the UK IPOs in 2002-2016) reducing the dataset to 1008 observations (96 percent of the initial 1050 IPOs). Despite the obvious limitation, it provides an extensive dataset for analysing IPO performance in and out of a wave. The data subset also includes the pre-, during-, and post- financial crisis periods and is sufficiently large to allow for generalisation of the findings and conclusions streaming from the analysis.

The dataset includes market-level and firm-level data. The market-level data includes annual time series of the number of listed firms and their total market value. The firm-level data includes a list of new issues on the Main Market since 1984 and on the AIM since its launch in 1995. It also includes date of issue and the industry sector. The sample period ends in December 2016.

The Financial Times All Share (FTSE) is used as a benchmark index for measuring market conditions and volumes. FTSE is a capitalisation-weighted index representing the largest cross-section of listed shares (98-99% of the market capitalisation of listed companies in the UK) and is comparable to the S&P 500 index. Is has been largely used in previous studies on the UK market (Coakley *et al.*, 2008).Table 4.5 summarises the sample selection for the full dataset (1984-2016) and the subset of data (IPOs issued in 2002-2016).

Table 4.5: Sample selections

Panel A: Sample selections for the full dataset		
Characteristic	**No of IPOs**	**% of total data sample**
Number of the UK based IPOs in 1984-2016	2426	
Less firms with incomplete or missing data	110	5%
Net usable observations (1984-2016)	**2316**	**95%**
Panel B: Sample selections for the subset of data 2002-2016		
Number of the UK based IPOs in 2002-2016	**1050**	
Less total:	**42**	4%
firms with incomplete data for	30	3%
change in stock price 4 weeks after offer	15	
change in stock price 60 days after offer	4	
change in stock price 90 days after offer	4	
change in stock price 180 days after offer	7	
outliers* (Appendix B for removed outliers)	12	1%
Net usable observations (2002-2016)	**1008**	**96%**

Table 4.6 summarises the sample characteristics for the full of data for the UK-based IPOs issued from January 1984 to December 2016.

Table 4.6: Sample characteristics for the full data set 1984-2016.

Year	No of IPOs	% of total sample	Gross proceeds (mil)	% of total sample proceeds
Panel A: Frequency of IPOs and gross proceeds by years (2002-2016)				
1984	5	0%	5643.312	2%
1985	4	0%	1409.149	0%
1986	7	0%	7888.377	3%
1987	5	0%	5645.221	2%
1988	6	0%	4955.561	2%
1989	15	1%	15073.682	5%
1990	16	1%	8359.393	3%
1991	8	0%	11039.287	4%
1992	18	1%	1782.639	1%
1993	24	1%	1568.612	1%
1994	155	7%	25038.129	8%
1995	77	3%	5299.742	2%
1996	185	8%	14188.23	5%
1997	163	7%	19990.327	7%
1998	72	3%	5941.711	2%
1999	48	2%	8524.383	3%
2000	275	12%	16310.765	5%
2001	136	6%	7621.667	3%
2002	41	2%	3196.00	1%
2003	64	3%	3717.50	1%
2004	197	9%	7361.15	2%
2005	147	6%	10296.97	3%
2006	138	6%	16076.81	5%
2007	101	4%	17490.79	6%
2008	17	1%	733.83	0%
2009	8	0%	807.99	0%
2010	37	2%	6767.44	2%
2011	32	1%	3464.36	1%
2012	36	2%	3470.46	1%
2013	58	3%	13737.78	5%
2014	101	4%	23766.96	8%
2015	68	3%	15315.72	5%
2016	52	2%	6618.74	2%
Total	**2316**	100%	**299102.66**	**100%**

Industry sector	No of IPOs	% of total sample	Gross proceeds (mil)	% of total sample proceeds
Panel B: Division of IPOs and gross proceeds by industry sector				
Consumer Products & Services	214	9%	17393.30	6%
Consumer Staples	74	3%	6922.65	2%
Energy & Power	134	6%	51076.89	17%
Financials	587	25%	96060.54	32%
Healthcare	146	6%	8090.77	3%
High Technology	370	16%	25852.67	9%
Industrials	175	8%	19554.63	7%
Materials	156	7%	19914.44	7%
Media & Entertainment	190	8%	15884.98	5%
Real Estate	83	4%	10154.45	3%
Retail	110	5%	16659.92	6%
Telecommunications	75	3%	11526.19	4%
Government and Agencies	2	0%	11.23	0%
Total	**2316**	**100%**	**299102.66**	**100%**
Panel C: Number of IPOs by the type of offer				
National only IPOs (local IPOs)	1682	73%	104993.39	35%
International IPOs	482	21%	109073.86	36%
Mixed IPOs	152	7%	85035.42	28%
Total	**2316**	100%	**299102.66**	**100%**

Table 4.7 summarises the sample characteristics for the subset of data for the UK-based IPOs issued during from January 2002 to December 2016.

Table 4.7: Sample characteristics for the subset of data 2002-2016

Year	No of IPOs	% of total sample	Gross proceeds (mil)	% of total sample proceeds
Panel A: Frequency of IPOs and gross proceeds by years (2002-2016)				
2002	19	2%	887.67	1%
2003	64	6%	3717.50	3%
2004	190	19%	7321.26	6%
2005	147	15%	10296.97	9%
2006	133	13%	15460.54	13%
2007	93	9%	13946.31	12%
2008	15	1%	724.58	1%
2009	7	1%	767.21	1%
2010	35	3%	6626.87	6%
2011	31	3%	3463.19	3%
2012	30	3%	3121.49	3%
2013	51	5%	11522.47	10%
2014	95	9%	22846.84	19%
2015	56	6%	13956.78	12%
2016	42	4%	4126.43	3%
Total	**1008**	**100%**	**118786.08**	**100%**
Panel B: Division of IPOs and gross proceeds by industry sector				
Consumer Products & Services	102	10%	8496.27	7%
Consumer Staples	25	2%	4127.15	3%
Energy & Power	78	8%	6567.89	6%
Financials	233	23%	41800.77	35%
Healthcare	77	8%	4245.36	4%
High Technology	143	14%	12450.94	10%
Industrials	63	6%	5692.21	5%
Materials	95	9%	9441.02	8%
Media & Entertainment	66	7%	5030.71	4%
Real Estate	48	5%	6391.83	5%
Retail	48	5%	12890.26	11%
Telecommunications	30	3%	1651.68	1%
Total	**1008**	**100%**	**118786.08**	**100%**
Panel C: Number of IPOs by the market (Main Market vs AIM)				
UK Main Market	207	21%	78690.17	66%
AIM Market	699	69%	26307.65	22%
market not specified	102	10%	13788.27	12%
Total	**1008**	**100%**	**118786.08**	**100%**
Panel D: Number of IPOs by the type of offer				
National only IPOs (local IPOs)	647	64%	30469.40	26%
International IPOs	349	35%	85436.03	72%
Mixed IPOs	12	1%	2880.65	2%
Total	**1008**	**100%**	**118786.08**	**100%**

4.3 Reliability and validity

To ensure validity of the findings every method used to calculate the measures of this study is based on previous research and previous empirical analysis. The sample data and characteristics of each observation are gathered from the reliable sources only (Thomson One, London Stock Exchange). The dataset is ensured to be sufficiently large and include as many observations in the sample as possible. Outliers that significantly distorted findings are excluded from the dataset where necessary. The independent variables of the regression model are chosen based on the previous research and theoretical assumptions. The use of proxies for measuring the concept is also based on previous research and empirical studies. The data is analysed using the Excel and the STATA software packages.

To ensure the reliability of the findings each variable is tested for the normality of distribution through the one-sample statistics test and results are reported at the 95 per cent level of significance. Where results are not statistically significant it has been explicitly stated. Prior to running a regression each variable is tested for statistical significance through the independent samples test and the results are reported at the 95 per cent confidence level. The independent variables are also tested for the multicollinearity issues through the correlation matrix. The data is also checked for the assumption of a linear relationship between the independent and dependent variables and homoscedasticity by using the plot of standardized residuals.

4.4 Chapter summary

The chapter provided an overview of the methods to address each of the research questions. All of the specified methods and the choice of variables are based on the previous research. The methodology for the wave identification has been adapted from the research on mergers and acquisitions as it provides the most comprehensive procedure to address the overall objective of this study. This section also described the data sources and the process of data collection and addressed the issues of data validity and the reliability of the undertaken analysis.

Chapter 5

RESEARCH FINDINGS

"Great investment opportunities come around when excellent companies are surrounded by unusual circumstances that cause the stock to be misappraised"

Warren Buffet

CHAPTER FIVE – RESEARCH FINDINGS

This chapter presents the findings of the research on the pricing and performance of new offers in IPO clusters in the UK in the period of 1984-2016. The layout of the chapter follows the research objective and questions. Section 5.1 presents the levels of IPO underpricing by the type of offering, time periods, and industry sectors, followed by the aftermarket performance of IPOs. It concludes with the summary of the results of the statistical analyses used to investigate the influence of potential factors affecting IPO underpricing. Section 5.2 outlines the evidence of IPO waves in the UK market by presenting the patterns in IPO activity examined by yearly, quarterly and monthly intervals and according to industry sectors. Section 5.3 presents the results of the statistical analysis investigating the potential factors initiating an IPO wave.

5.1 Research Question 1: What is the performance of IPOs in the UK and what are the potential factors influencing it?

This section reports the findings for the performance of the new issues in the UK for a subset of data covering the period from January 2002 to December 2016. Section 5.1.1 reports the evidence on the short-term underpricing anomaly; section 5.1.2 examines the evidence on the aftermarket underperformance anomaly, and section 5.1.3 evaluates potential factors influencing the initial mispricing of new offers in the UK market.

5.1.1 Research question 1a: Is there evidence of IPOs underpricing in the UK?

Research question 1a examines the evidence of IPO underpricing in the UK. The analysis of the IPO short-term and aftermarket performance is based on the sample of 1008IPOs of the UK-based companies in period of 2002-2016, of which 647 had their IPOs as a national only offering, 12 companies had IPOs on both national and international markets, and 349 companies had international only offering. Previous studies use the term ‘underpricing’ to refer to the levels of abnormal performance of IPOs on the first day of trading. However, the results of the current study indicate that while for overall yearly results IPOs show only underpricing, for quarterly and monthly returns they show underpricing and overpricing on the first day of trading. Therefore, mispricing[37] is a more appropriate term to use when describing quarterly and monthly results. Figure 5.1 shows the overall mean level of IPO mispricing for IPOs of UK-based companies in 2002-2016.

Figure 5.1: Mean levels of IPO underpricing in 2002-2016
The figure graphically represents the mean IPO underpricing levels measured yearly for all IPOs in the UK market for the period from January 2002 to December 2016. The level of IPO underpricing is calculated as the abnormal short-term return (RET_{it}).

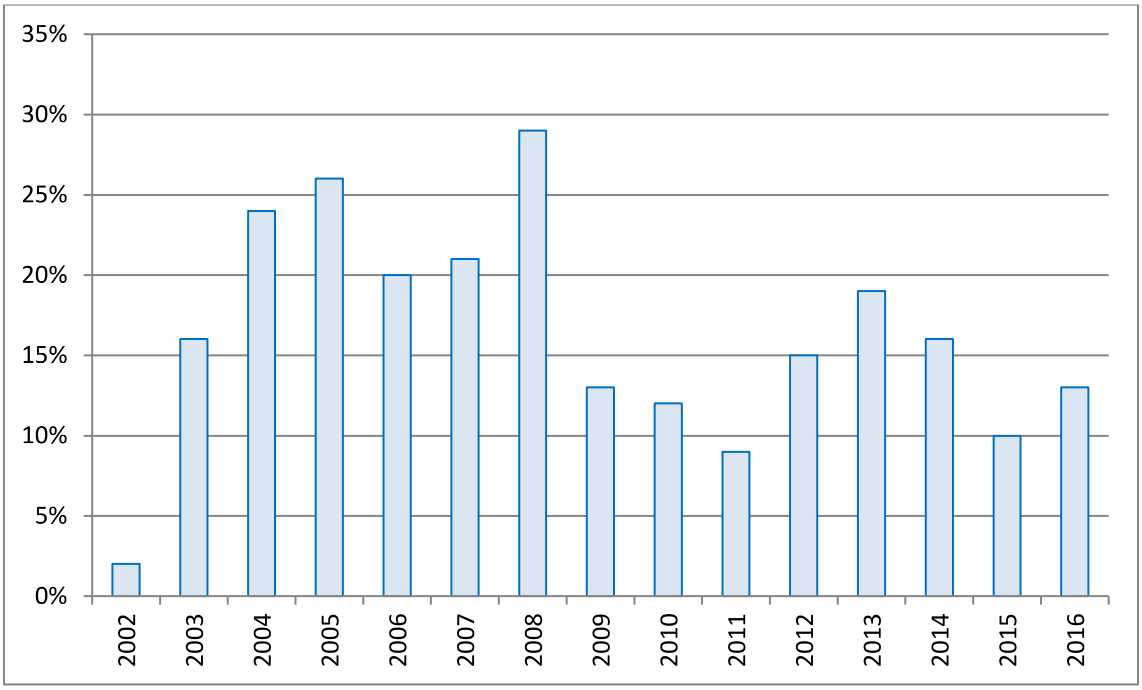


Table 5.1 provides an overview of the mean levels of IPO underpricing for the UK based companies in 2002-2016. Overall, the mean yearly level of underpricing is 19 percent and it remains quite high throughout the 2003-2008 period, with the highest level of mean IPO underpricing of 26 percent in 2005, and the lowest of two percent in 2002 for all IPOs in the sample. There is an increase in the general level of IPO underpricing between 2003 and 2008, after declining significantly in 2009-2011, the mean level of underpricing remains relatively stable between 2012 and 2016 and does not exceed 19 percent. However, the results differ when the IPOs mispricing is examined by the type of offering as seen in the

[37]Mispricing is calculated as the difference between the offer price and the closing price on the first day of trading of the IPO.

table 5.2. National offers display highly irregular levels of underpricing ranging from the highest of 99 percent in 2008 to the lowest of minus fifteen percent in 2015, while international offers show a more stable trend with the mean underpricing of 14 percent, the highest of 32 percent in 2006 and the lowest of 5 percent in 2010.

Table 5.1: Mean yearly IPO underpricing levels by the type of offering
The table reports the mean mispricing levels of IPOs in the UK market for the period from January 2002 to December 2016. The results are measured yearly using daily data for all IPOs as well as for the different types of offer (national only IPOs, mixed offer IPOs and international only IPOs). The level of IPO underpricing is calculated as the abnormal short-term return (RET_{it}).

Mean yearly IPO underpricing levels				
Year	**All IPOs**	*National offers*	*Mixed offers*	*International offers*
2002	2%	2%		
2003	16%	16%	18%	11%
2004	24%	26%	4%	8%
2005	26%	27%		6%
2006	20%	19%		32%
2007	21%	29%		17%
2008	29%	99%		24%
2009	13%	22%		6%
2010	12%	26%		5%
2011	9%	10%		6%
2012	15%	23%		6%
2013	19%	28%		11%
2014	16%	14%		16%
2015	10%	-15%		13%
2016	13%	8%		13%
Mean	19%	22%	8%	14%
Median	9%	10%	11%	10%
St. Dev.	0.37	0.37	0.34	0.37
Max	29%	99%	18%	32%
Min	2%	-15%	4%	5%

Figure 5.2 graphically represents the mean yearly levels of IPO underpricing for the UK based companies in the period of 2002 to 2016 by the type of offer and in relation to each other. For national only offerings the mean yearly level of underpricing is higher than for

the overall sample, i.e. mean underpricing for the national offerings is 22 percent, with highest level of IPO underpricing of 99 percent in 2008 and lowest of minus 15 percent in 2015. For the mixed offerings the mean yearly level of underpricing is 8 percent and the highest level is 18 percent in 2003. For the international only offerings the peak of IPO underpricing is observed between 2006 and 2008 with a sharp decline in 2009 (from 24 percent in 2008 to only 6 percent in 2009). It continues to remain low, between five and six percent throughout 2009-2012, before increasing again in 2013 to 11 percent and remaining quite stable throughout the rest of the period. The mean yearly level of IPO underpricing for the international only offers is 14 percent, and the highest level is 32 percent in 2006.

Figure 5.2: Mean levels of IPO underpricing by the type of offering in 2002-2016.
The figure graphically represents the mean IPO underpricing levels measured yearly for different types of offers in the UK market for the period from January 2002 to December 2016. The level of IPO underpricing is calculated as the abnormal short-term return (RET_{it}).

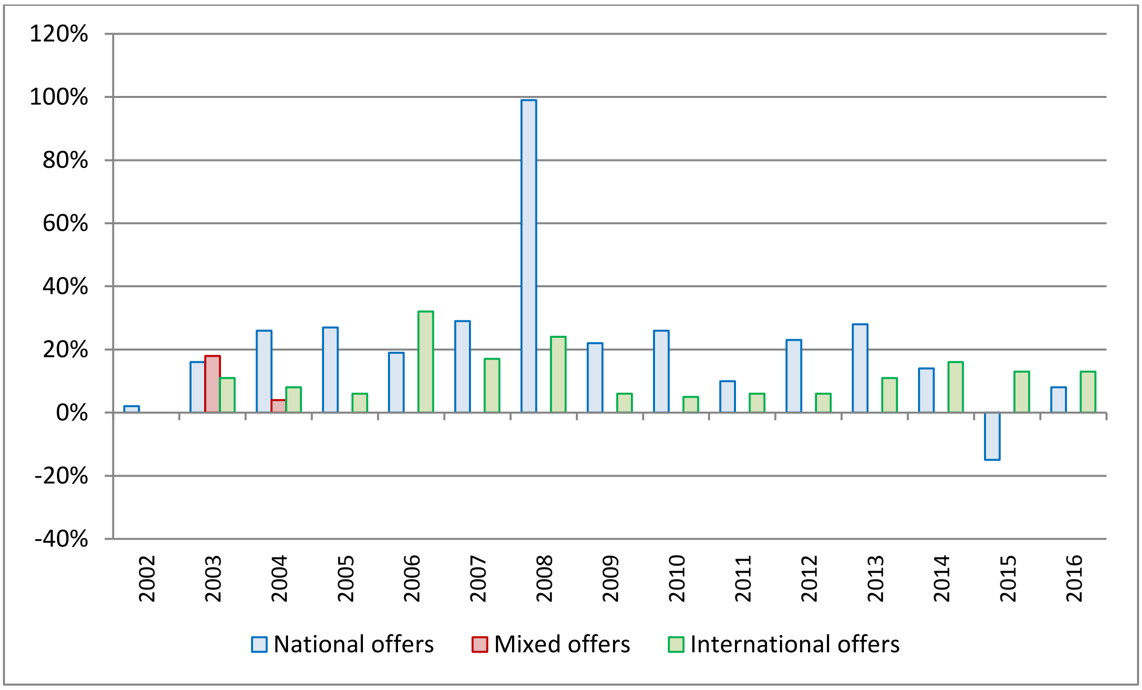


Figure 5.3 shows the mean levels of IPO underpricing in relation to the number of IPOs in each year. As is seen on the graph the increases in the level of IPO underpricing generally follow the increase in the number of IPOs in each year. The correlation coefficient for the two variables is 0.54 indicating a sufficiently strong relationship between the number of IPOs and the level of IPO underpricing.

Figure 5.3: No of IPOs and the mean level of IPO underpricing

The figure presents yearly number of IPOs and the mean IPO underpricing levels measured yearly. The results are presented for all IPOs in the UK in the period from January 2002 to December 2016. The level of IPO underpricing is calculated as the abnormal short-term return (RET_{it}).

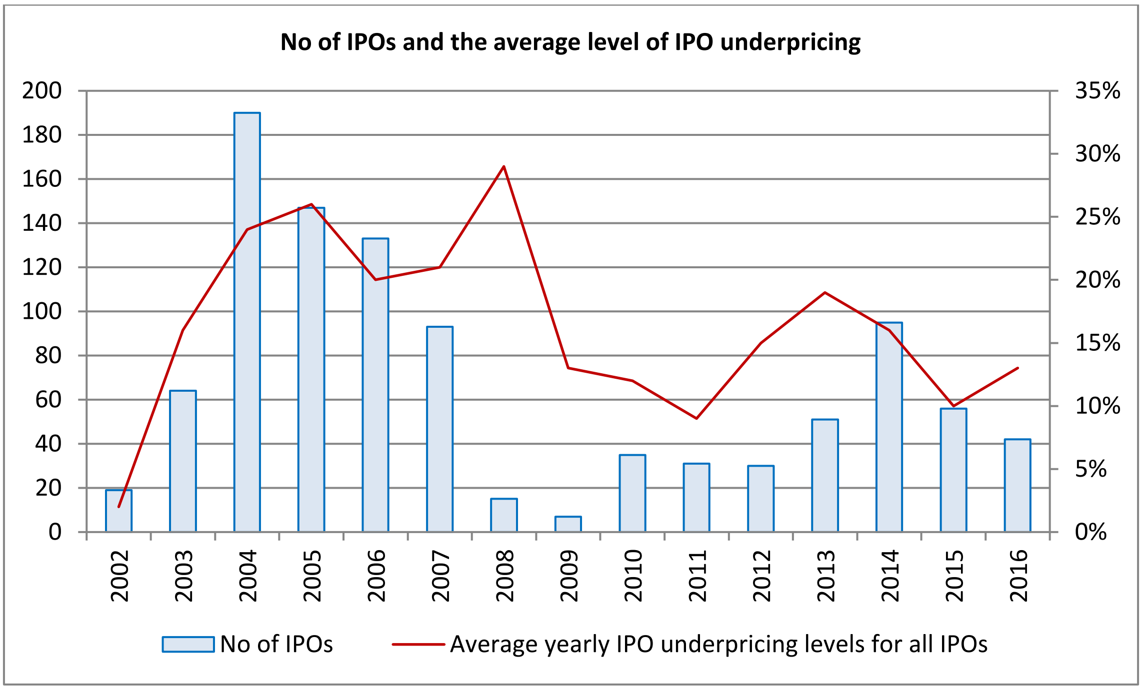


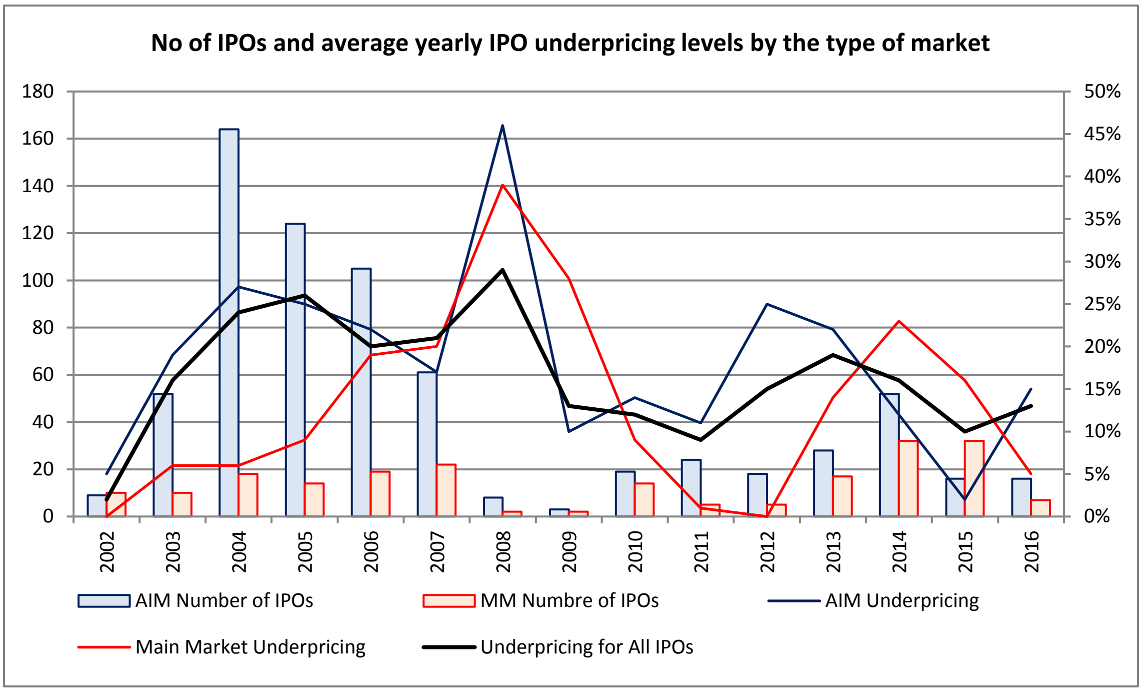
Table 5.2 shows the mean levels of the number of IPOs by the type of market. As the figure shows, the number of IPOs is driven primarily by the AIM, especially in the pre-crisis years where the high number of transactions is almost exclusively due to the AIM IPOs. In 2004, the year with the highest number of IPO transactions, the number of IPOs on the AIM is 164 versus 18 IPOs on the Main Market, the situation is similar for 2005 and 2006 (124 and 125 AIM IPOs versus 14 and 19 MM IPOs). The number of IPOs is low for both markets during the crisis years of 2008-2009 and for the post-crisis period the number of transactions is higher for the AIM than for the Main Market.

Table 5.2: Number of IPOs and the mean yearly levels of IPO underpricing by the type of market.
The table reports the number of IPOs and the mean mispricing levels of IPOs in the UK for the period from January 2002 to December 2016. The results are measured yearly using daily data for all IPOs as well as for the two different UK markets (Alternative Investment Market and Main Market). The level of IPO underpricing is calculated as the abnormal short-term return (RETit).

No of IPOs and mean yearly IPO underpricing levels by the type of market						
Year	**All IPOs**		*UK Alternative Investment Market (AIM)*		*UK Main Market (MM)*	
	No. of IPOs	**UP**	*No. of IPOs*	*UP*	*No. of IPOs*	*UP*
2002	19	2%	9	5%	10	0%
2003	64	16%	52	19%	10	6%
2004	190	24%	164	27%	18	6%
2005	147	26%	124	25%	14	9%
2006	133	20%	105	25%	19	19%
2007	93	21%	61	22%	20	19%
2008	15	29%	8	46%	2	39%
2009	7	13%	3	10%	2	28%
2010	35	12%	19	14%	14	9%
2011	31	9%	24	11%	5	1%
2012	30	15%	18	25%	5	0%
2013	51	19%	28	22%	17	14%
2014	95	16%	52	12%	32	23%
2015	56	10%	16	2%	32	16%
2016	42	13%	16	15%	7	5%
Mean	67	19%	47	21%	14	14%
Median	51	9%	24	11%	14	5%
St. Dev.	53.89	0.037	48.23	0.039	9.50	0.028
Max	190	29%	164	46%	32	39%
Min	7	2%	3	2%	2	0%

Figure 5.4 shows the mean yearly levels of IPO underpricing for different markets, the UK Alternative Investment Market and the UK Main Market. As the figure shows, the high levels of IPO underpricing are mostly due to the underpricing on the AIM market. This is especially evident for the pre-crisis and early post-crisis periods. Underpricing is high for both markets in 2008 and significantly higher for the Main Market in 2009 compared to the AIM. The Main Market IPOs also show higher levels of underpricing for 2014-2015. The number of IPOs on the MM market is also the highest in these two years.

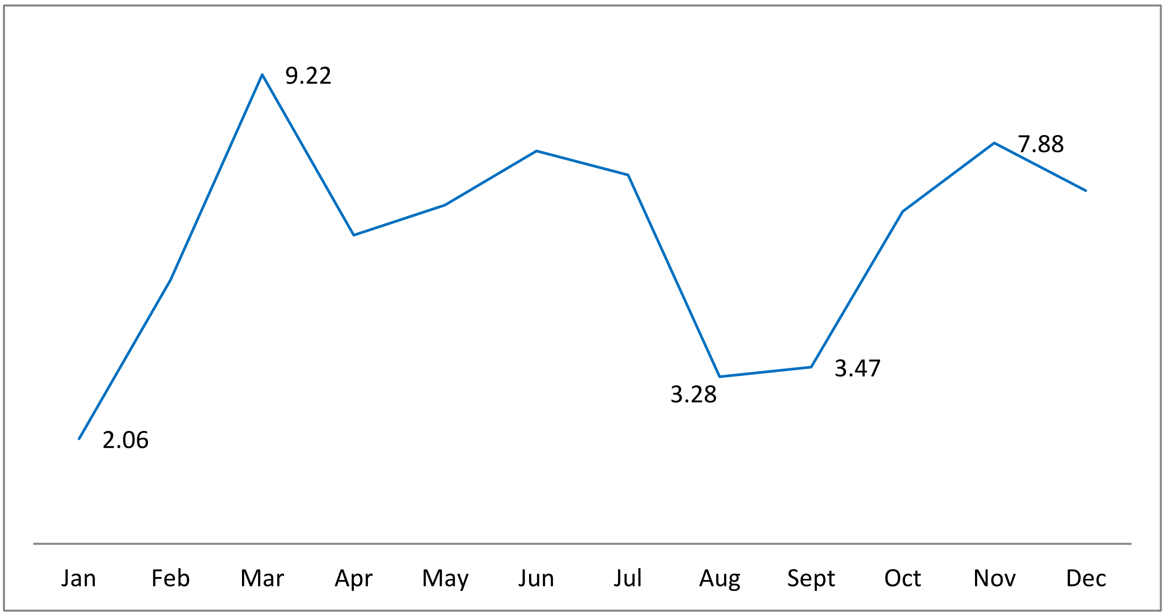
Figure 5.4: Mean yearly IPO underpricing by the type of market
The figure reports the number of IPOs and the mean underpricing levels of IPOs in the UK market for the period from January 2002 to December 2016. The results are measured yearly using daily data for all IPOs as well as for the two different UK markets (Alternative Investment Market and Main Market).



Broken by type of offer, monthly IPO activity shows quite irregular dynamic with the months of January and August-September displaying sudden drops in the number of IPO transactions and the spring months and the end of a calendar year showing higher IPO activity (figure 5.5). To avoid the seasonality issue, while still ensuring a more detailed overview of the IPO activity and the dynamic of IPO mispricing, the number of IPO transactions has been measured and presented quarterly in each year.

Figure 5.5: Dynamic of the mean monthly IPO activity

The figure presents the change in the mean number of IPO issues measured monthly for all IPOs in the UK for the period from January 2002 to December 2016.



As is presented by figure 5.6, the level of mispricing is systematically higher for the national IPOs compared to the two other types (international and mixed type offers), except for the 2008-2009 period, when new issues pertained exclusively to the international IPOs. An interesting observation is that international offers were overpriced in quarter three 2010 (four percent) and the first two quarters of 2012 (six and 13 percent). National offers show overpricing (underpricing of minus percent) in quarter three of 2002 and 2001 (underpricing of minus 11 and minus five percent respectively) and in quarters two and four in 2015 (minus 28 and minus six percent). For mixed offers overpricing of three percent happens in quarter four 2004.

Figure 5.6: Mean quarterly level of IPO underpricing by the type of offer

The figure presents the mean IPO mispricing levels measured by quarters for different offer types in the UK in the period from January 2002 to December 2016. The level of IPO mispricing is calculated as the abnormal short-term return (RET_{it}). Positive values indicate underpricing, negative values indicate overpricing.

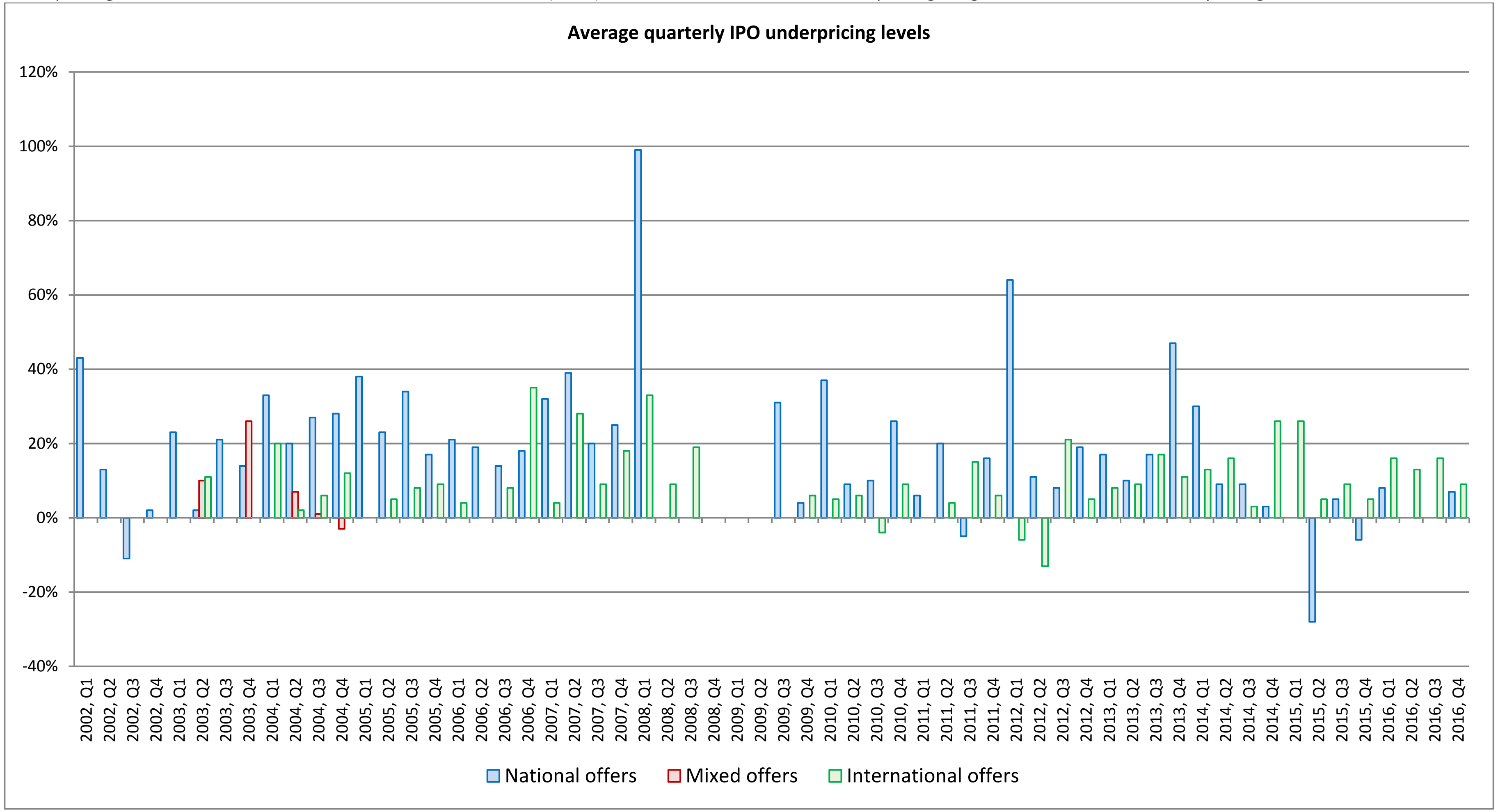


Table 5.3 presents an overview of the mean levels of IPO mispricing by industry sectors in the period of 2002-2016. The ‘consumer staples’, ‘consumer product and services’ and ‘financials’ sectors show the highest levels of mean underpricing (32, 25, and 22 percent respectively). The lowest mean level of underpricing (12 percent) is observed in the ‘industrials’ sector in 2002. Overall, the highest yearly level of IPO underpricing is seen in the ‘consumer staples’ (172 percent in 2008) and the ‘materials’ (117 percent in 2013) sectors. The lowest of minus 11 percent is observed in 2015 in the ‘real estate’.

For the pre-crisis years (2002-2008) the highest outperforming sectors are the ‘consumer staples’, the ‘media and entertainment’, the ‘telecommunications’, the ‘financials’, the ‘consumer product and services, and ’the ‘real estate’,

The highest underpricing in 2002 is seen in the ‘telecommunications’ sector (30 percent), in 2003 two sectors outperform the rest, the ‘materials’ and the ‘telecommunications’ sectors (30 and 29 percent). In 2004 the ‘consumer staples’ and the ‘financials’ display the highest underpricing (49 and 40 percent), while in 2005 it is the ‘consumer product and services’ and the ‘real estate’ (48 and 44 percent underpricing), they are followed by the ‘energy and power’ (41 percent) and the ‘consumer staples’ (37 percent). In 2006, the best performing sectors are the ‘telecommunications’ (41 percent), the ‘healthcare’ and the ‘retail’ (35 percent each). The ‘media and entertainment’ and the ’telecommunications’ sectors substantially outperform the rest in 2007. They show 71 and 61 percent underpricing respectively while the mean for the remaining sectors for that year is 15 percent.

The 2008 shows an interesting dynamic. The highest underpricing is observed in the ‘consumer staples’ and the ‘financials’ sector. In the former the underpricing reaches 172 percent (the highest between all the industries, albeit represented by only one IPO on that year) before IPO activity in the sector dies out completely until 2013 (no IPOs in the sector during 2009-2012). The latter displays underpricing of 59 percent and is the only industry that shows high underpricing throughout the crisis years (2008-2009). It also displays the highest levels of underpricing for 2014-2015.

Table 5.3: Overview of the IPO underpricing by industry sectors in the period of 2002-2016

The table presents the mean levels of IPO mispricing measured yearly for different industry sectors for all IPOs in the UK during the period from January 2002 to December 2016. The level of IPO mispricing is calculated as the abnormal short-term return (RET_{it}). Positive values indicate underpricing, negative values indicate overpricing.

Industry /Year	Mean	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Consumer Products & Services	25%	-1%	20%	29%	48%	23%	23%	18%	–	59%	29%	29%	16%	7%	12%	20%
Consumer Staples	32%	0%	12%	49%	37%	19%	16%	172%	–	–	–	–	3%	14%	–	42%
Energy & Power	17%	–	8%	16%	41%	25%	4%	-6%	7%	4%	8%	1%	6%	11%	–	4%
Financials	22%	-3%	13%	40%	24%	19%	22%	59%	19%	10%	9%	23%	14%	30%	17%	11%
Healthcare	17%	9%	10%	30%	8%	35%	15%	5%	–	–	13%	11%	22%	13%	10%	4%
High Technology	18%	17%	16%	15%	29%	15%	10%	19%	–	14%	22%	22%	30%	16%	9%	25%
Industrials	12%	3%	10%	16%	13%	21%	11%	-8%	5%	7%	–	8%	10%	3%	6%	9%
Materials	17%	-3%	29%	20%	14%	17%	21%	-7%	–	8%	1%	15%	117%	2%	4%	4%
Media & Entertainment	21%	30%	-5%	22%	27%	7%	71%	–	–	15%	3%	7%	13%	11%	4%	1%
Real Estate	17%	–	14%	27%	44%	7%	27%	–	4%	3%	–	7%	12%	11%	-11%	5%
Retail	17%	–	8%	12%	27%	35%	2%	–	–	3%	–	–	18%	17%	7%	20%
Telecommunications	15%	–	30%	8%	6%	41%	61%	–	–	11%	–	–	19%	14%	–	10%

For the after-crisis period the industries with the highest underpricing are the 'consumer product and services', the 'financials' and the 'high technology'.

Table 5.4 represents the overall summary statistics for the levels of first day mispricing according to the industry sector. It includes the summary statistics for each industry measured by year.

Table 5.4: Summary statistics for mean IPO mispricing by industry sector

The table presents the summary statistics for the levels of the short-term mispricing according to the industry sector for all IPOs in the UK during the period from January 2002 to December 2016. The level of IPO mispricing is calculated as the abnormal short-term return (RETit). Positive values indicate underpricing, negative values indicate overpricing.

Industry /Year	No of IPOs	max	min	mean	median	st.dev
Consumer Products & Services	102	59%	-1%	25%	23%	0.15
Consumer Staples	25	172%	0%	32%	19%	0.48
Energy & Power	78	41%	-6%	17%	8%	0.12
Financials	233	59%	-3%	22%	19%	0.14
Healthcare	77	35%	4%	17%	12%	0.09
High Technology	143	30%	9%	18%	17%	0.06
Industrials	63	21%	-8%	12%	9%	0.07
Materials	95	117%	-7%	17%	14%	0.29
Media & Entertainment	66	71%	-5%	21%	12%	0.19
Real Estate	48	44%	-11%	17%	11%	0.14
Retail	48	35%	2%	17%	17%	0.10
Telecommunications	30	61%	6%	15%	15%	0.18

5.1.2 Research question 1b: What is the aftermarket performance of IPOs in the UK?

Research question 1b examines the aftermarket performance of Initial Public Offerings in the UK in the period of 2002-2016. The first months of trading usually involve high volatility in the share price due to the information asymmetry between issuers and/or underwriters and investors in the market. For that reason, calculating the Cumulative Abnormal Returns (CAR) for the share price at the end of the first month, the third and the sixth month of trading may provide some insights into how the share price adjusts as more and more information becomes available. To address this, the abnormal aftermarket returns of the IPOs are calculated according to the CAR formula specified in the methodology chapter (chapter 4).

Table 5.5 provides summary statistics for the abnormal returns at the end of the first, the third and the sixth month of trading for all IPOs and according to the type of offer.

Table 5.5: Summary statistics for the average abnormal returns by the type of offer
The table presents average abnormal returns for all IPOs in the UK for the period from January 2002 to December 2016. The returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

Average yearly 1 month Abnormal Returns				
	All IPOs	*National offers*	*Mixed offers*	*International offers*
Sample size	1036	660	14	362
Mean	56%	59%	57%	50%
Median	54%	62%	61%	52%
St. Dev.	0.17	0.23	0.19	0.18
Max	84%	88%	74%	70%
Min	23%	-9%	37%	1%
Average yearly 3 months Abnormal Returns				
Mean	54%	55%	59%	52%
Median	55%	54%	57%	55%
St. Dev.	0.17	0.25	0.18	0.21
Max	81%	95%	78%	78%
Min	15%	-13%	42%	-7%
Average yearly 6 months Abnormal Returns				
Mean	46%	50%	58%	49%
Median	43%	54%	56%	49%
St. Dev.	0.20	0.26	0.15	0.38
Max	77%	94%	73%	141%
Min	9%	-22%	43%	-19%

The average abnormal returns for 'all IPOs' at the end of the first trading month is 56 percent; the highest return is seen in the national offers (59 percent) and the lowest return in the international offers (50 percent). The abnormal returns show a slight increase for the mixed offers after the first trading month; by the end of the third trading month it increases to 59 percent (from 57 percent) and by the end of the sixth month it remains at 58 percent, while overall average returns (for all IPOs) show a decrease over the first 6 months of trading (from 56 percent to 46 percent).

The spread in abnormal returns differ by the type of offer. Thus, for the national offers the spread in returns varies from 88 percent to negative 9 percent in the first month, between 95 percent and negative 13 percent at the end of the third month and between 94 and negative 22 percent at the end of the sixth month. The spread in abnormal returns is the smallest for the mixed type offers, between 74 and 37 percent, 78 and 42 percent and 73 and 43 percent, respectively.

Figure 5.7 graphically represents the average abnormal returns at the end of the first month of trading by year and by the type of offer. The national offers show the highest abnormal returns for the first trading month for almost every year, except in 2003, when mixed offers exhibit the highest returns and in 2015, when abnormal returns turn negative for national offers.

Figure 5.7: Yearly average 1 month Abnormal Returns by the type of offer

The figure presents abnormal returns for the first month post issue date for different types of IPO offers in the UK market for the period from January 2002 to December 2016. The returns are measured as 1 month's CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

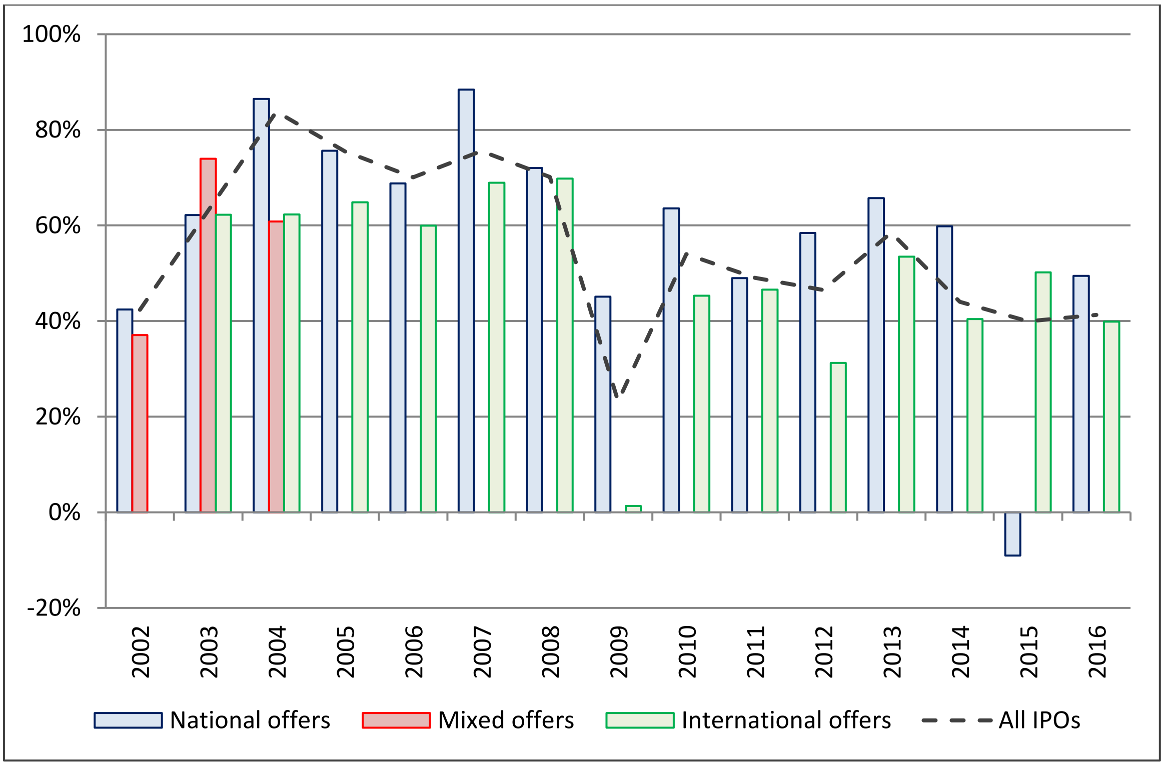


Figure 5.8 shows yearly average abnormal returns for each type of offer at the end of the third trading month. In nine out of 16 years the national offers exhibit the highest abnormal returns; these returns are often matched or exceeded by the international offers. Both national and international offers exhibit negative abnormal returns. For the national offers the negative abnormal returns happen in 2015 and represent negative 13 percent, for the international offers the returns are negative in 2009 (negative seven percent).

Figure 5.8: Yearly average 3 months Abnormal Returns by the type of offer
The figure presents abnormal returns for the third month post issue date for different types of IPO offers in the UK market for the period from January 2002 to December 2016. The returns are measured as 3 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

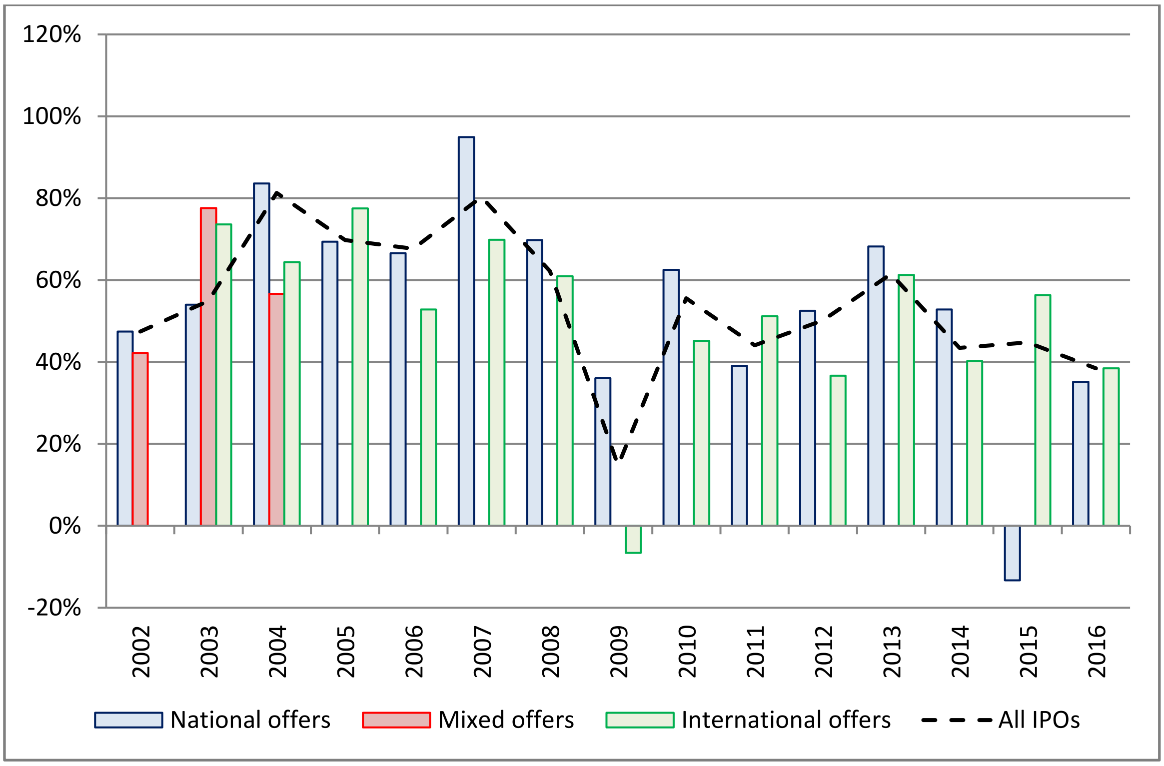


Figure 5.9 graphically represents the yearly abnormal returns at the end of the sixth trading month by the type of offer. The international offers exhibit the highest volatility in abnormal returns during this period, the returns for this type of offer range from 141 percent in 2003 to negative 19 percent in 2009. The abnormal returns for the national offers exceed the returns for other types of offer only in seven years out of 15. Returns are negative for the national offers in 2015 and represent negative 22 percent.

Figure 5.9: Yearly average 6 months Abnormal Returns by the type of offer

The figure presents abnormal returns for the sixth month post issue date for different types of IPO offers in the UK market for the period from January 2002 to December 2016. The returns are measured as 6 month's CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

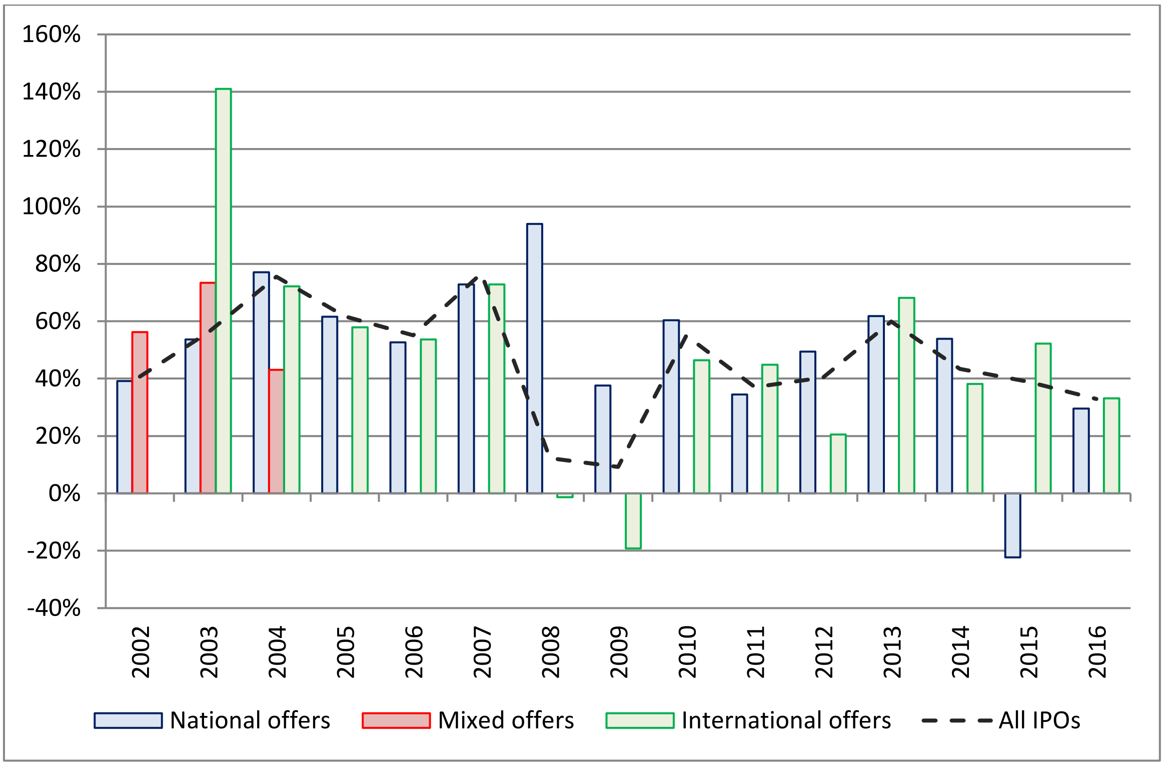
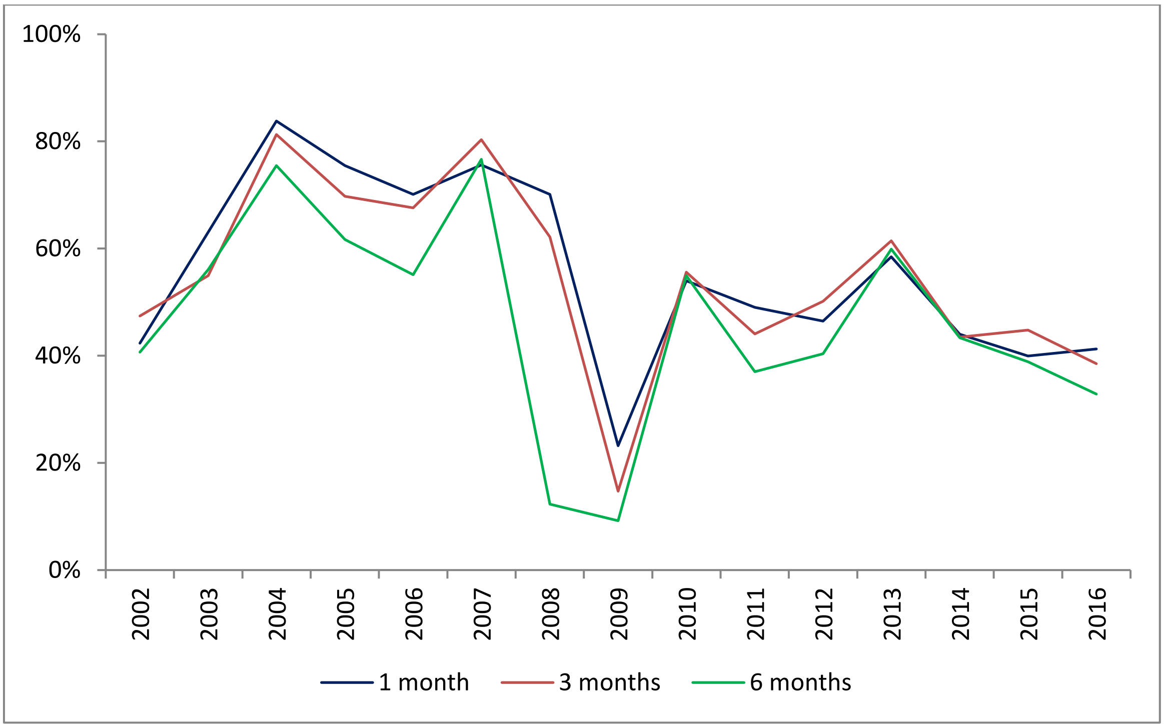


Figure 5.10 shows the difference in the average abnormal returns for all IPOs at the end of the first trading month (blue line) and the 180 days period (green line), the three months abnormal returns (red line) generally follows the trend of the first month.

Figure 5.10: Average Abnormal Returns for all IPOs, 1 month, 3 months, and 6 months
The figure shows the change in the average abnormal returns for different time periods for all IPOs in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date.



The difference in abnormal returns becomes even more visible if IPO abnormal returns are broken by the offer type and represented yearly (figures 5.11 and 5.12). For the national offers when comparing to the international offers, the trends for all three periods (one month, three months and six months) are generally correspondent and do not deviate substantially from each other (figure 5.11). The international offers, however, show a substantial deviation in abnormal returns for the six months period, comparing to the other two periods.

Figure 5.11: Average Abnormal Returns for the national offers, 1 month, 3 months, and 6 months
The figure shows the change in the average abnormal returns for the national only type of IPO offers in the UK for the period from January 2002 to December 2016. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

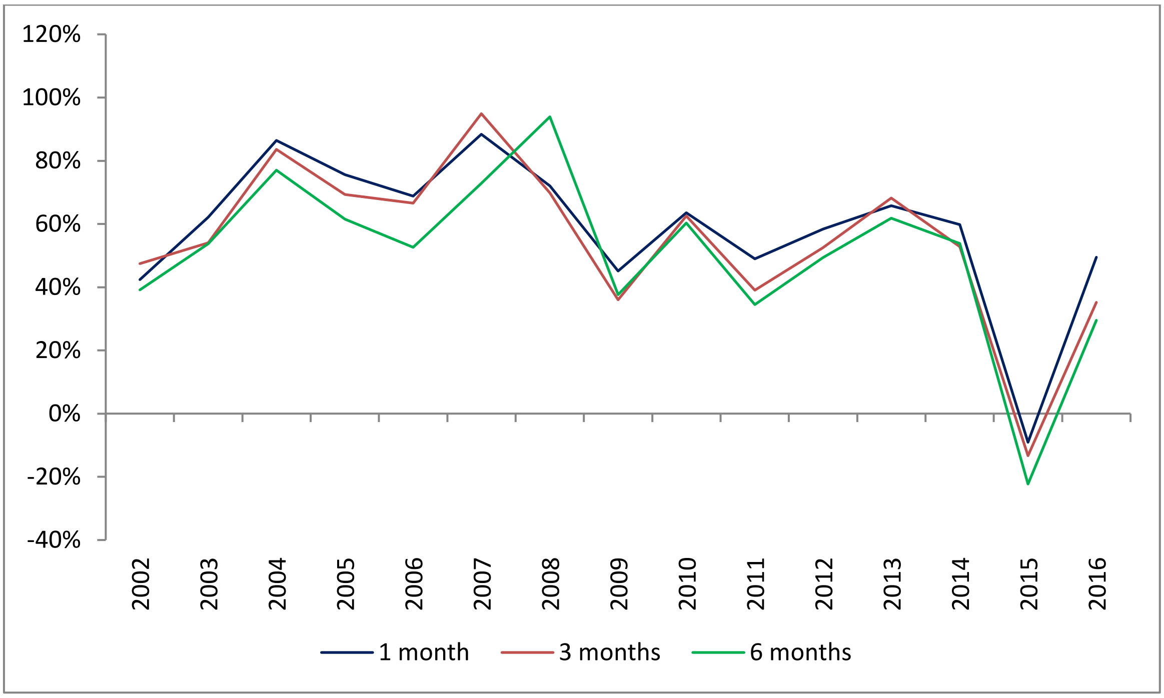
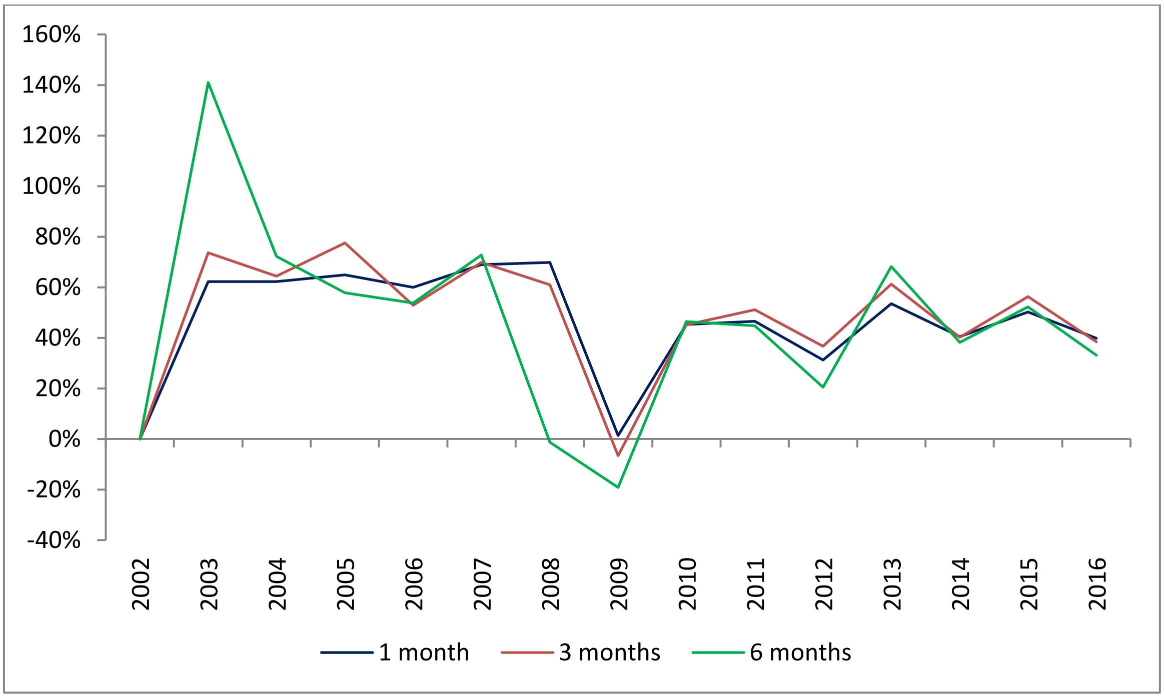
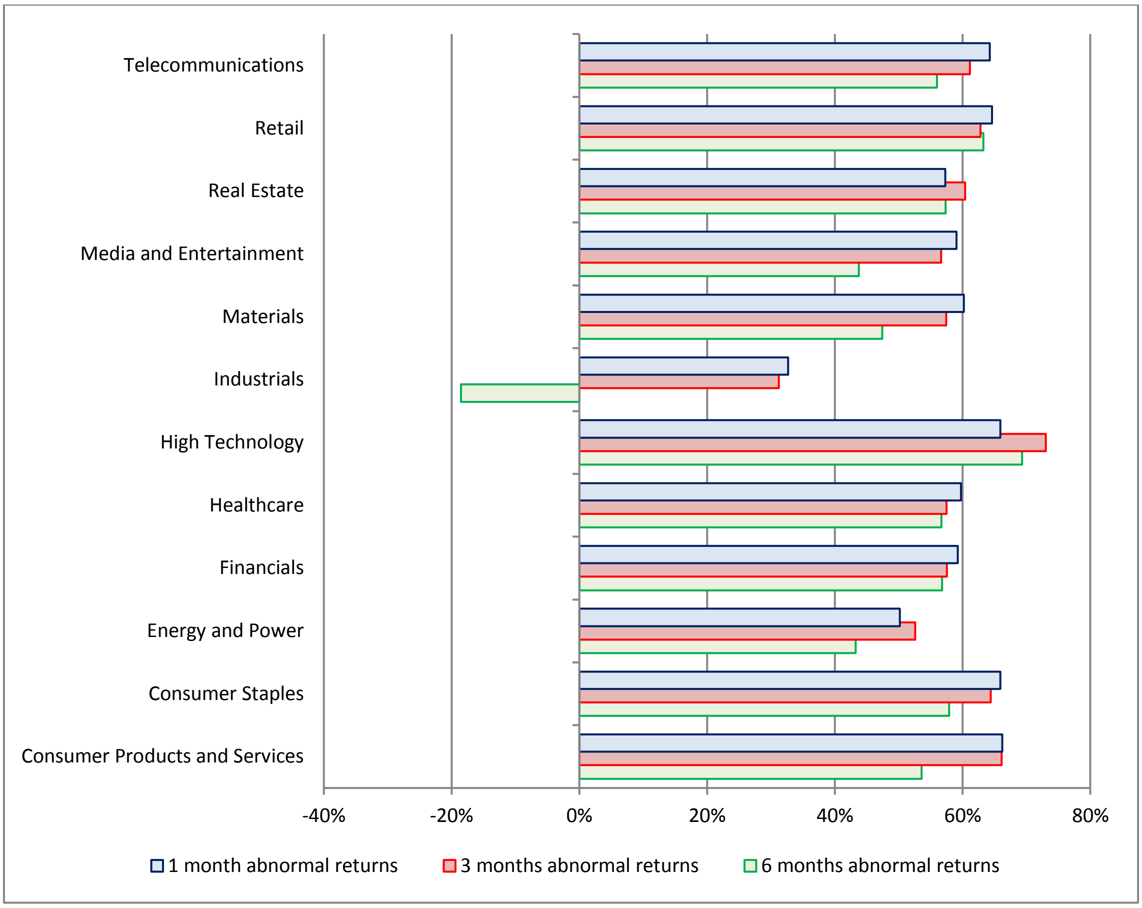


Figure 5.12: Average Abnormal Returns for the international offers, 1 month, 3 months, and 6 months
The figure shows the change in the average abnormal returns for the international only type of IPO offers in the UK for the period from January 2002 to December 2016. Positive values indicate higher than and negative values indicate lower than market abnormal returns.



According to the findings the levels of abnormal returns differ according to the industry sector. Figure 5.13 displays the abnormal returns by industry for the first month, third month and sixth month trading periods.

Figure 5.13: Average yearly Abnormal Returns by industry for 1 month, 3 months, and 6 months
The figure presents average abnormal returns for different industry sectors for all IPOs in the UK for the period from January 2002 to December 2016. The returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.



Tables 5.6, 5.7, and 5.8 present the summary statistics for the abnormal returns in different industry sectors for one month, three months and six months respectively.

Table 5.6: Summary statistics for the average 1 month abnormal returns by the industry sector
The figure presents the average abnormal returns for the first month post issue date for different industry sectors for all IPOs in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

Average yearly 1 month Abnormal Returns					
Industry	*Mean*	*Median*	*St. Dev.*	*Max*	*Min*
Consumer Products and Services	66%	67%	0.14	93%	48%
Consumer Staples	66%	73%	0.25	98%	21%
Energy and Power	50%	53%	0.31	91%	-26%
Financials	59%	55%	0.19	106%	33%
Healthcare	60%	62%	0.16	80%	30%
High Technology	66%	66%	0.11	86%	48%
Industrials	33%	51%	0.64	77%	-174%
Materials	60%	57%	0.31	153%	17%
Media and Entertainment	59%	58%	0.17	98%	36%
Real Estate	57%	61%	0.24	102%	8%
Retail	65%	64%	0.15	96%	42%
Telecommunications	64%	65%	0.19	95%	44%

Table 5.7: Summary statistics for the average 3 months abnormal returns by the industry sector
The figure presents the average abnormal returns for the third month post issue date for different industry sectors for all IPOs in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 3 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

Average yearly 3 month Abnormal Returns					
Industry	*Mean*	*Median*	*St. Dev.*	*Max*	*Min*
Consumer Products and Services	66%	72%	0.15	79%	35%
Consumer Staples	64%	64%	0.21	102%	38%
Energy and Power	53%	61%	0.35	101%	-29%
Financials	58%	54%	0.19	107%	32%
Healthcare	57%	62%	0.14	74%	32%
High Technology	73%	72%	0.16	121%	51%
Industrials	31%	61%	0.69	77%	-171%
Materials	57%	56%	0.36	152%	5%
Media and Entertainment	57%	62%	0.20	94%	15%
Real Estate	60%	66%	0.25	104%	15%
Retail	63%	58%	0.16	94%	45%
Telecommunications	61%	70%	0.29	92%	1%

Table 5.8: Summary statistics for the average 6 months abnormal returns by the industry sector
The figure presents the average abnormal returns for the sixth month post issue date for different industry sectors for all IPOs in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 6 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

Average yearly 6 month Abnormal Returns					
Industry	*Mean*	*Median*	*St. Dev.*	*Max*	*Min*
Consumer Products and Services	54%	55%	0.23	92%	-4%
Consumer Staples	58%	63%	0.29	91%	-20%
Energy and Power	43%	43%	0.48	107%	-42%
Financials	57%	53%	0.22	108%	27%
Healthcare	57%	58%	0.20	87%	18%
High Technology	69%	65%	0.20	122%	47%
Industrials	-19%	51%	1.96	92%	-664%
Materials	47%	46%	0.45	146%	-51%
Media and Entertainment	44%	47%	0.33	105%	-17%
Real Estate	57%	60%	0.24	85%	2%
Retail	63%	61%	0.23	93%	21%
Telecommunications	56%	65%	0.45	127%	-29%

The 'High Technology' sector exhibits the highest abnormal returns for all three periods (66, 73 and 69 percent respectively). It is followed by 'Consumer Products', 'Consumer Staples', 'Retail', and 'Telecommunications' sectors (for the first month's and the third months' abnormal returns), while the 'Industrials' sector shows the lowest returns for the three periods with the abnormal returns turning negative at the end of the 180 days period (negative 19 percent). The 'Financials' and the 'Healthcare' sectors exhibit similar trends in abnormal returns, 59, 58, and 58 percent for the 'Financials', and 60, 57, and 57 percent for the 'Healthcare' sectors respectively.

Examining the industry sectors in more detail shows that 180 days (six months) abnormal returns deviate substantially from the first month's returns. Some of the sectors follow the general economic cycle and trends, such as 'High Technology' (figure 5.14), 'Healthcare' (figure 5.15) and 'Consumer Product and Services' (figure 5.16) sectors.

Figure 5.14: Average Abnormal Returns for the 'High Technology' sector
The figure shows the change in the average abnormal returns for different time periods for the 'High Technology' sector in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date.

Figure 5.15: Average Abnormal Returns for the 'Healthcare' sector
The figure shows the change in the average abnormal returns for different time periods for the 'Healthcare' sector in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date.

Figure 5.16: Average Abnormal Returns for the ‘Consumer Products and Services’ sector
The figure shows the change in the average abnormal returns for different time periods for the ‘Consumer Products and Services’ sector in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month’s, 3 months’ and 6 months’ CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.

All three sectors experience a sudden and significant drop in returns between 2009 and 2010, however, the returns for the ‘High Technology’ sector recover very quickly for all three periods (one month, three months, and six months), while in the ‘Healthcare’ sector the returns for all three periods take longer time to increase. For the ‘Consumer Products and Services’ sector, while one month and three months abnormal returns recover quickly and follow similar trends, the six months’ returns show a much earlier decrease and do not reach the same level as before the drop.

The ‘Financials’ sector (figure 5.17) displays a different dynamic in the abnormal returns. The returns for the three periods are somewhat close to each other, exhibit similar trends, and, unlike other sectors, the 180 days abnormal returns do not deviate substantially from the first month’s and the third month’s returns, compared to other industries.

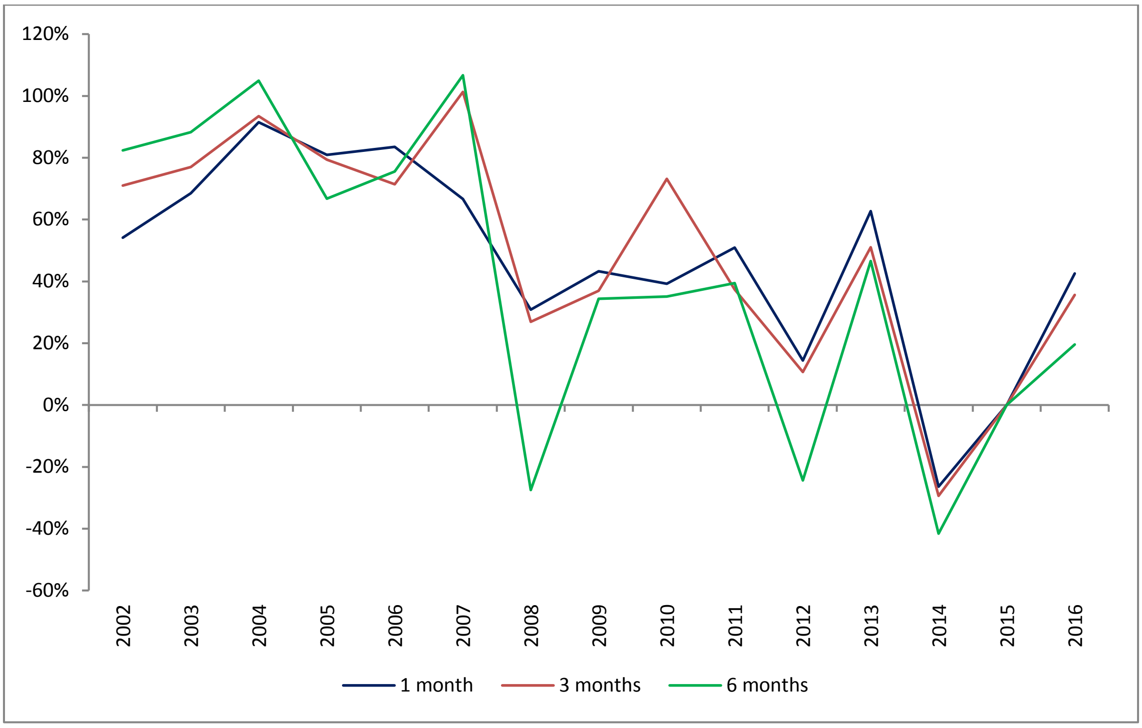
Figure 5.17: Average Abnormal Returns for the ‘Financials’ sector

The figure shows the change in the average abnormal returns for different time periods for the ‘Financials’ sector in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month’s, 3 months’ and 6 months’ CARs post IPO date.

The abnormal returns in the ‘Energy and Power’ sector (figure 5.18) follow their own dynamic. The three types of returns have substantially different patterns that are highly unpredictable and do not correlate to each other (comparing to other industries, where the first month’s and the third month’s returns generally follow each other). In 2008 and 2012 the 180 days abnormal returns show negative values (negative 27 and 24 percent respectively), and in 2014 all three periods (one month, three months, and six months) show negative returns (negative 26, 29 and 42 percent respectively).

Figure 5.18: Average Abnormal Returns for the 'Energy and Power' sector

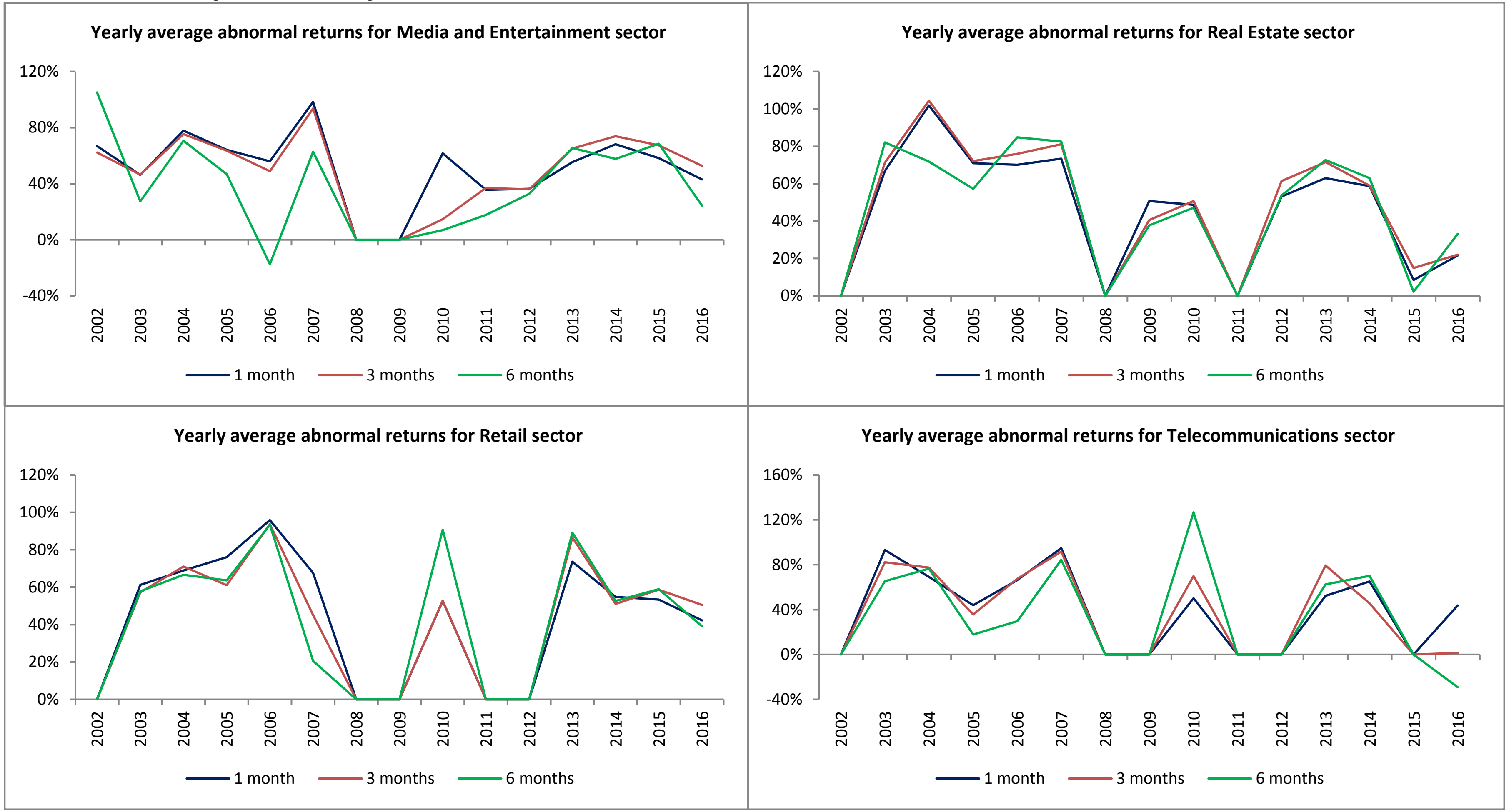
The figure shows the change in the average abnormal returns for different time periods for the 'Energy and Power' sector in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.



The abnormal returns for other sectors, such as 'Media and Entertainment', 'Real Estate', 'Retail' and 'Telecommunications,' show highly volatile, unstable and unpredictable patterns. The dynamic in these sectors is presented in figure 5.19

Figure 5.19: Average Abnormal Returns for the 'Media and Entertainment', 'Real Estate', 'Retail', and 'Telecommunications' sectors

The figure shows the change in the average abnormal returns for different time periods for the 'Media and Entertainment', 'Real Estate', 'Retail', and 'Telecommunications' sectors in the UK for the period from January 2002 to December 2016. The abnormal returns are measured as 1 month's, 3 months' and 6 months' CARs post IPO date. Positive values indicate higher than and negative values indicate lower than market abnormal returns.



5.1.3 Research question 1c: What are the factors influencing IPO mispricing in the UK?

Research question 1c investigates possible factors that influence the levels of underpricing of IPOs in the UK. Previous studies identify a number of variables that potentially influence IPO underpricing. These variables refer to ex-ante uncertainty about the performance of IPOs. To analyse the factors that influence mispricing, seven_explanatory variables have been identified and examined through the statistical tests and regression analyses in line with the previous research. The variables include (i) company size at the time of the IPO (VALUE), (ii) offer price (PENNY), (iii) use of an underwriter, (vi) reputation of the employed underwriter (UWrank), (v) type of offer (OT): national, international or mixed IPO, (vi) type of market (MT): AIM or Main Market, and (vii) industry sector (SECTOR).

Table 5.9 provides summary of the descriptive statistics and the independent sample test for the first day IPO underpricing (dependent variable). The table shows statistical significance for the dependent variables at 0.01 level of significance.

Table 5.9: Independent sample t-test and descriptive statistics for the 1st day IPO underpricing (UP).

IPO underpricing (UP)	
Sample size	1031
t-stat	-17.68
Degrees of freedom	130
sig. (2-tailed)	0.0000*
Mean	19.63
Standard error	1.16
Median	9.75
Mode	10.00
Standard deviation	37.31
Sample Variance	1391.85
min	-96.19
max	370

*The results are significant at the 0.01 level of significance

Table 5.10 present the summary statistics for the selected explanatory variables and table 5.11 shows the correlation matrix. Results of the anova test for the explanatory variables show statistical significance (*F-ratio* value of 28361.27 with critical *F-ratio* of 2.22).

Table 5.10: Descriptive statistics for the explanatory variables for IPO Underpricing

Variable	*Sample size*	*Mean*	*St.err*	*Median*	*Std. Dev*	*Min*	*Max*
Firm size logged (VALUE)	1031	7.08	0.03	7	0.89	3.7	9.45
Offer Price (PENNY)	1031	0.93	0.01	1	0.25	0	1
Use of an underwriter (UW)	1031	0.91	0.01	1	0.29	0	1
Underwriter Reputation (UWrank)	938	0.56	0.02	1	0.50	0	1
Market Type (MT)	1031	0.69	0.01	1	0.46	0	1
Offer Type Mixed	14	0.01	0.00	0	0.12	0	1
Offer Type International	359	0.35	0.01	0	0.48	0	1
Consumer Products & Services	102	0.10	0.01	0	0.30	0	1
Energy & Power	81	0.08	0.01	0	0.27	0	1
Financials	243	0.24	0.01	0	0.42	0	1
Healthcare	79	0.08	0.01	0	0.27	0	1
High Technology	146	0.14	0.01	0	0.35	0	1
Industrials	65	0.06	0.01	0	0.24	0	1
Materials	97	0.09	0.01	0	0.29	0	1
Media & Entertainment	66	0.06	0.01	0	0.24	0	1
Real Estate	49	0.05	0.01	0	0.21	0	1
Retail	50	0.05	0.01	0	0.21	0	1
Telecommunications	30	0.03	0.01	0	0.17	0	1

Table 5.12 and 5.13 present the results of the multivariate regression analysis for the factors of IPO underpricing. Table 5.12 shows results for all IPOs in the sample, while table 5.13 shows the results for the multivariate regression for the underwritten IPOs only.

Table 5.11: Correlation Matrix for the explanatory variables for IPO underpricing

	Use of an Underwriter (UW)	Company Size (VALUE)	Offer Price (PENNY)	Market Type (MT)	Offer Type OT MIXED	Offer Type OT INTERNATIONAL	*Consumer Products & Services*	*Consumer Staples*	*Energy & Power*	*Healthcare*	*High Technology*	*Industrials*	*Materials*	*Media & Entertainment*	*Real Estate*	*Retail*	*Telecommunications*
Use of an Underwriter (UW)	1																
Company Size (VALUE)	0.12	1															
Offer Price (PENNY)	-0.06	-0.34	1														
Market Type (MT)	-0.10	0.55	-0.34	1													
Offer Type OT MIXED	0.04	0.12	0.00	0.12	1												
Offer Type OT INTERNATIONAL	0.05	0.47	-0.28	0.46	-0.09	1											
Consumer Products & Services	0.07	-0.08	0.07	-0.07	-0.04	-0.06	1										
Consumer Staples	0.00	0.03	-0.07	-0.02	0.03	-0.01	-0.10	1									
Energy & Power	-0.10	0.09	-0.06	0.18	0.01	0.11	-0.18	-0.15	1								
Healthcare	0.04	0.00	0.02	-0.02	-0.03	-0.02	-0.10	-0.08	-0.16	1							
High Technology	0.02	-0.02	0.01	-0.05	0.02	-0.03	-0.13	-0.12	-0.23	-0.12	1						
Industrials	0.00	0.00	-0.01	-0.02	-0.03	0.01	-0.09	-0.08	-0.14	-0.07	-0.11	1					
Materials	-0.06	-0.11	0.01	-0.09	-0.04	-0.06	-0.11	-0.09	-0.18	-0.09	-0.13	-0.08	1				
Media & Entertainment	0.05	-0.04	0.01	-0.07	0.00	-0.06	-0.09	-0.08	-0.15	-0.08	-0.11	-0.07	-0.08	1			
Real Estate	0.01	0.05	0.02	0.04	-0.03	0.05	-0.07	-0.07	-0.12	-0.06	-0.09	-0.06	-0.07	-0.06	1		
Retail	0.06	0.12	-0.01	0.07	0.01	0.10	-0.07	-0.07	-0.13	-0.07	-0.09	-0.06	-0.07	-0.06	-0.05	1	
Telecommunications	-0.01	-0.04	0.05	-0.02	0.03	-0.08	-0.06	-0.05	-0.10	-0.05	-0.07	-0.04	-0.06	-0.05	-0.04	-0.04	1

Table 5.12: Regression results for all IPOs (R sq. = 0.1027, adjusted R sq. = 0.0876)

UP = $\alpha + \beta_1(\text{UW}) + \beta_2(\text{VALUE}) + \beta_3(\text{PENNY}) + \beta_4(\text{MT}) + \gamma_1(\text{OT Mixed}) + \gamma_2(\text{OT International}) + \rho_1(\text{Consumer Product \& Services}) + \rho_2(\text{Energy \& Power}) + \rho_3(\text{Financials}) + \rho_4(\text{Healthcare}) + \rho_5(\text{High Technology}) + \rho_6(\text{Industrials}) + \rho_7(\text{Materials}) + \rho_8(\text{Media \& Entertainment}) + \rho_9(\text{Real Estate}) + \rho_{10}(\text{Retail}) + \rho_{11}(\text{Telecommunications}) + \varepsilon$

Use of an Underwriter (UW) - firms that employ an underwriter are coded as 1, others 0. The level of IPO underpricing (UP) is expected to be negatively related to UW, i.e. companies that hire an underwriter underprice less.
Company Size (VALUE) - log of the total number of shares offered at the IPO multiplied by the offering price. UP is expected to be negatively related to VALUE, i.e. bigger companies underprice less.
Offer Price (PENNY) - stock with offer price less than 3.00 are coded as penny stocks equal to 1, others are coded as 0. UP is expected to be positively related to PENNY, i.e. lower offer price leads to higher level of underpricing.
Market Type (MT) - AIM IPOs are coded as 0, MM as 1. UP is expected to be negatively related to UP, i.e. AIM IPOs underprice more compared to MM IPOs.
Offer Type (OT) - national IPOs are coded as the base/reference group. UP is expected to be negatively related to OT, i.e. international and mixed IPOs underprice less.
Industry (SECTOR) - IPOs in 'Consumer Staples' sector are coded as the base/reference group. UP is expected to be negatively related to SECTOR variable, i.e. IPOs in 'Consumer Staples' sector have higher underpricing compared to other industry sectors.

Variable code	*Coefficients*	*St. err*	*t-stat*	*P-value*	*Significance**
Intercept	129.043	14.513	8.890	0.000	
Use of an Underwriter (UW)	-10.172	4.040	-2.520	**0.012**	**significant**
Company Size (VALUE)	-13.161	1.626	-8.090	**0.000**	**significant**
Offer price (PENNY)	3.134	4.911	0.640	0.524	insignificant
Market Type (MT)	7.843	3.141	2.500	**0.013**	**significant**
Offer Type OT Mixed	-11.161	9.948	-1.120	0.262	insignificant
Offer Type OT International	0.022	2.827	0.010	0.994	insignificant
Consumer Products & Services	-8.796	8.012	-1.100	0.273	insignificant
Energy & Power	-12.966	8.123	-1.600	0.111	insignificant
Financials	-9.129	7.505	-1.220	0.224	insignificant
Healthcare	-14.714	8.233	-1.790	**0.074**	**marginally significant**
High Technology	-13.109	7.750	-1.690	**0.091**	**marginally significant**
Industrials	-19.628	8.435	-2.330	**0.020**	**significant**
Materials	-18.069	8.049	-2.240	**0.025**	**significant**
Media & Entertainment	-11.016	8.419	-1.310	0.191	insignificant
Real Estate	-12.659	8.811	-1.440	0.151	Insignificant
Retail	-8.058	8.794	-0.920	0.360	Insignificant
Telecommunications	-19.857	9.685	-2.050	**0.041**	**significant**

* The results are significant at the 0.05 level of significance

Table 5.13: Regression results for the underwritten IPOs only ((R sq. = 0.1004, adjusted R sq. = 0.0838)

UP = $\alpha + \beta_1$(UWrank) + β_2(VALUE) + β_3(PENNY) + β_4(MT) + γ_1(Mixed) + γ_2(International) + ρ_1(Consumer Product & Services) + ρ_2(Energy & Power) + ρ_3(Financials) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

Underwriter reputation (UW rank) - prestigious underwriters (underwriters who subscribed 16 and more IPOs) are coded as 1, others are 0. UP is expected to be negatively related to UW rank, i.e. companies who hire more prestigious underwriter tend to underprice less.

Variable code	***Coefficients***	***St. err***	***t-stat***	***P-value***	***Significance****
Intercept	124.941	14.416	8.670	0.000	
Underwriter Reputation (UW rank)	1.733	2.269	0.760	0.445	Insignificant
Company Size (VALUE)	-13.072	1.666	-7.840	**0.000**	**significant**
Offer price (PENNY)	1.924	4.685	0.410	0.681	Insignificant
Market Type (MT)	9.073	3.154	2.880	**0.004**	**significant**
Offer Type OT Mixed	-13.198	9.307	-1.420	0.156	Insignificant
Offer Type OT International	-1.844	2.783	-0.660	0.508	Insignificant
Consumer Products & Services	-14.511	7.893	-1.840	**0.066**	**marginally significant**
Energy & Power	-20.464	8.042	-2.540	**0.011**	**significant**
Financials	-17.585	7.466	-2.360	**0.019**	**significant**
Healthcare	-20.398	8.112	-2.510	**0.012**	**significant**
High Technology	-18.881	7.677	-2.460	**0.014**	**significant**
Industrials	-23.808	8.360	-2.850	**0.004**	**significant**
Materials	-24.012	8.044	-2.990	**0.003**	**significant**
Media & Entertainment	-16.510	8.268	-2.000	**0.046**	**significant**
Real Estate	-17.090	8.695	-1.970	**0.050**	**significant**
Retail	-14.979	8.580	-1.750	**0.081**	**marginally significant**
Telecommunications	-24.557	9.583	-2.560	**0.011**	**significant**

*The results are significant at the 0.05 level of significance

The results are similar in both cases and indicate statistical significance for the 'Use of an Underwriter', 'Company Size', 'Market Type' and the 'Industry' variables for all IPOs and for the underwritten IPOs only. The 'Company size' variable is negatively related to the level of IPO underpricing, i.e. bigger companies tend to underprice less. The 'market type' variable has a positive relationship with the underpricing suggesting that companies having IPOs on the AIM tend to underprice as much as offers on the Main Market. While the 'company size' variable confirms the previously expected negative relationship with the level of IPO underpricing, the negative sign of the 'market type' variable is unexpected.

‘Industry’ variable shows statistical significance for some sectors when all IPOs are considered and for all sectors for the underwritten IPOs only. The variable is negatively related to the level of IPO underpricing as expected. This confirms the findings of the earlier sections indicating that in general IPOs in the ‘Consumer Staples’ sector are underpriced more than IPOs in the other sectors for the specified period and sample.

As the findings indicate, the use of an underwriter is a significant factor in the level of IPO underpricing. The variable is negatively related to the level of IPO underpricing, as expected, indicating that companies who use an underwriter tend to underprice less. However, as shown by the table 5.13, the reputation of the used underwriter does not have a significant impact on the level of underpricing. Variables for the offer price and the type of offer (national, international or mixed) do not have significant impact on the level of IPO underpricing.

Therefore, for the specified sample and the time period for the UK based IPOs, the use of an underwriter, the size of the company, the type of the market used, and the industry of the IPO act as potential factors influencing the level of IPO underpricing. However, the reputation of the employed underwriter, type of offer and the offer price do not affect the level of underpricing. The summary of the results for the hypothesis testing is presented in the table 5.14

Table 5.14: Results of the Hypotheses Testing

H	Hypothesis	Statistical Relationship	Result
H_1:	There is a negative relationship between the size of a firm and IPO underpricing.	Negative, significant	Accepted
H_2:	There is a positive relationship between the offer price and IPO underpricing.	Positive, insignificant	Not accepted
H_3:	There is a negative relationship between the use of an underwriter and IPO underpricing.	Negative, significant	Accepted
H_4:	There is a negative relationship between the reputation of the used underwriter and IPO underpricing.	Positive, insignificant	Not accepted
H_5:	There is a negative relationship between offer type and IPO underpricing. (National IPOs underprice more).	Negative, insignificant	Not accepted
H_6:	There is a negative relationship between market type and IPO underpricing. (AIM IPOs underprice more compared to MM IPOs.	Positive, significant	Not accepted
H_7:	There is a negative relationship between industry sector and IPO underpricing. (IPOs in ‘Consumer Staples’ sectors underprice more).	Negative, significant	Accepted

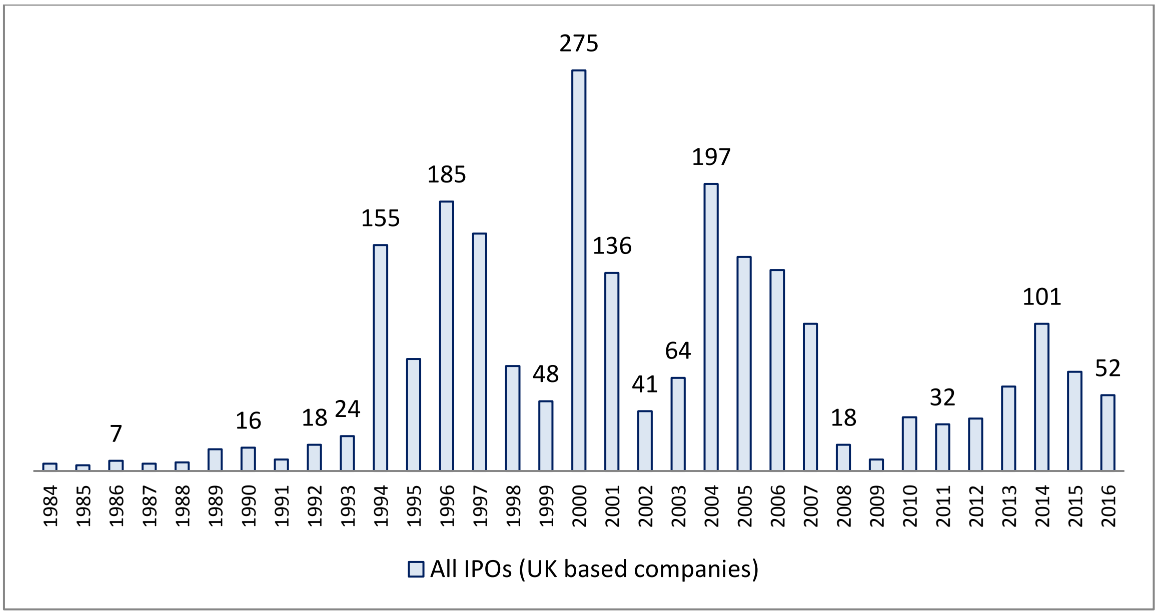
5.2 Research Question 2: Are there IPO waves in the UK market?

This section presents the overview of the waves in the UK IPO market during the 1984-2016period. Although extant research suggests that IPOs occur in waves, the author is unaware of any existing study that formalises an objective approach to identifying the start, peak, and conclusion of an IPO wave.

The analysis of the average number of IPOs is based on the sample of 2317 UK-based companies in period of 1984 -2016, of which 1683 had their IPOs as a national only offering, 152 companies had IPOs on both national and international markets (mixed offer), and 482 companies had international only offering. Figure 5.20 presents an overview of the average number of IPOs by year in the full sample period 1984 - 2016.

Figure 5.20: Average number of IPOs by year

The figure shows the dynamic in the number of IPO transactions in the UK during the period from January 1984 till December 2016. The data is taken from the Thomson One database and includes new issues from the UK Main Market and the AIM.



There is a general increase in the number of IPOs since 1994 that almost completely subsided by 2009 when the number of IPOs reached only eight in the whole year. However, there is an increase in IPO activity from 2010 with a 101 IPOs in 2014. The graph shows a few years when IPO activity peaked with the maximum number of IPOs of 275 in 2000.

Table 5.15 provides an overview of the total number of IPOs by the year and the type of offering. The average number of IPOs per year is 70, and the minimum number of IPOs for all types of offerings is four.

The dynamics of IPO activity in the national only offerings generally follows the pattern of IPO activity in the overall sample. There is an obvious increase in IPO activity since 1994, with the maximum number of IPOs for the national only offerings in 2000; the same as the overall number of IPOs. This surge in IPO activity is followed by a sharp decline in IPO activity by 2007 with virtually no IPO transactions in the national only offerings for 2008-2009. The number of transactions in the national only offerings gradually increases after 2010. However, it does not reach the same peak as the total number of IPOs, the highest number of IPOs for the national only offerings is 25 IPOs in 2013.

The activity in the mixed type of IPO offerings shows a very different dynamic. The period of heightened IPO activity covers only one decade, from 1994 to 2004, with no companies issuing mixed type of offerings after 2005. The highest number of IPOs with the mixed type of offering is 43 IPOs in 2000.

The international only type of IPO issues follows a different pattern. There are some international only offerings in every year except for 2002. The number of IPOs with the international only offerings slightly increases in 1996 to 12 IPOs; however, the most dramatic increase is seen after 2004, with 66 IPOs in 2007 and 77 IPOs (maximum number of IPOs for this type of offering) in 2014. This is a reversed pattern of IPO activity for the other types of offering (national only and mixed offerings) during the same time period, and this increase in IPO activity remains relatively high until the end of 2016.

Table 5.15: Number of IPOs by year
The table represents the descriptive statistics for the sample of 2317 IPOs of the UK based companies from January 1984 to December 2016. The new issues are classified according to the type of offer.

No of IPOs by year (UK based companies)				
Year		*Local (National) Offerings only*	*Mixed Offerings*	*International Offerings only*
	All IPOs	**UK market only**	**UK and other markets**	**Other markets only**
1984	5	2	1	2
1985	4	–	–	4
1986	7	–	1	6
1987	5	2	–	3
1988	6	–	1	5
1989	15	8	1	6
1990	16	8	–	8
1991	8	3	1	4
1992	18	13	1	4
1993	24	19	2	3
1994	155	143	6	6
1995	77	61	12	4
1996	185	159	14	12
1997	163	140	15	8
1998	72	54	13	5
1999	48	26	17	5
2000	275	228	43	4
2001	136	128	6	2
2002	41	35	6	–
2003	64	59	4	1
2004	197	179	8	10
2005	147	141	–	6
2006	138	118	–	20
2007	101	35	–	66
2008	18	2	–	16
2009	8	3	–	5
2010	37	15	–	22
2011	32	21	–	11
2012	36	17	–	19
2013	58	25	–	33
2014	101	24	–	77
2015	68	10	–	58
2016	52	5	–	47
Total	2317	1683	152	482
Mean	70	56	8	15
Median	48	25	6	6
Max	275	228	43	77
Min	4	2	1	1

5.2.1 Research question 2a: Is there evidence of IPO waves in the UK?

Research question 2a examines the evidence of IPO waves in the UK markets. By drawing on the logic of wave identification used by Carow *et al.* (2004), ten IPO peaks have been identified when examining the number of transactions in any given year during the period of 1984 to 2016. Following Harford (2005), the peaks in IPO activity are the periods where the number of transactions over the identified period increased by an amount greater than would be expected by chance. These peaks are 15 IPOs in 1989, 18 IPOs in 1992, 155 IPOs in 1994, 185 IPOs in 1996, 275 IPOs in 2000, 197 IPOs in 2004, 147 IPOs in 2005, 37 IPOs in 2010, 58 IPOs in 2013, and 101 IPOs in 2014. Thus, there are eight IPO waves relating to the identified IPO peaks in the specified sample (two of the peaks have exactly the same wave cycles). The waves are summarised in table 5.16 and graphically presented in figure 5.21.

Following the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008), only three of those peak years signify an IPO wave with a *complete cycle* (i.e., the peak, the beginning, and the end of the cycle are identifiable using the process described earlier): 185 IPOs in 1996 (and 155 IPOs in 1994), 275 IPOs in 2000, and 197 IPOs in 2004 (and 145 IPOs in 2005). The peaks of 15 IPOs in 1989, 18 IPOs in 1992, 37 IPOs in 2010, 58 IPOs in 2013, and 101 IPOs in 2014 relate to waves with *incomplete cycles* (i.e., the clear starting point and the peak are easily determined, but the decline in activity following the peak year is not large enough to suggest a clear end to the IPO wave).The peaks of 15 IPOs in 1989 and 18 IPOs in 1992 indicate an incomplete wave covering almost the whole period of the sample due to the low IPO activity in the initial years of LSE and for this reason have not been coded as waves.

Table 5.16: IPO waves in the UK in 1984-2016

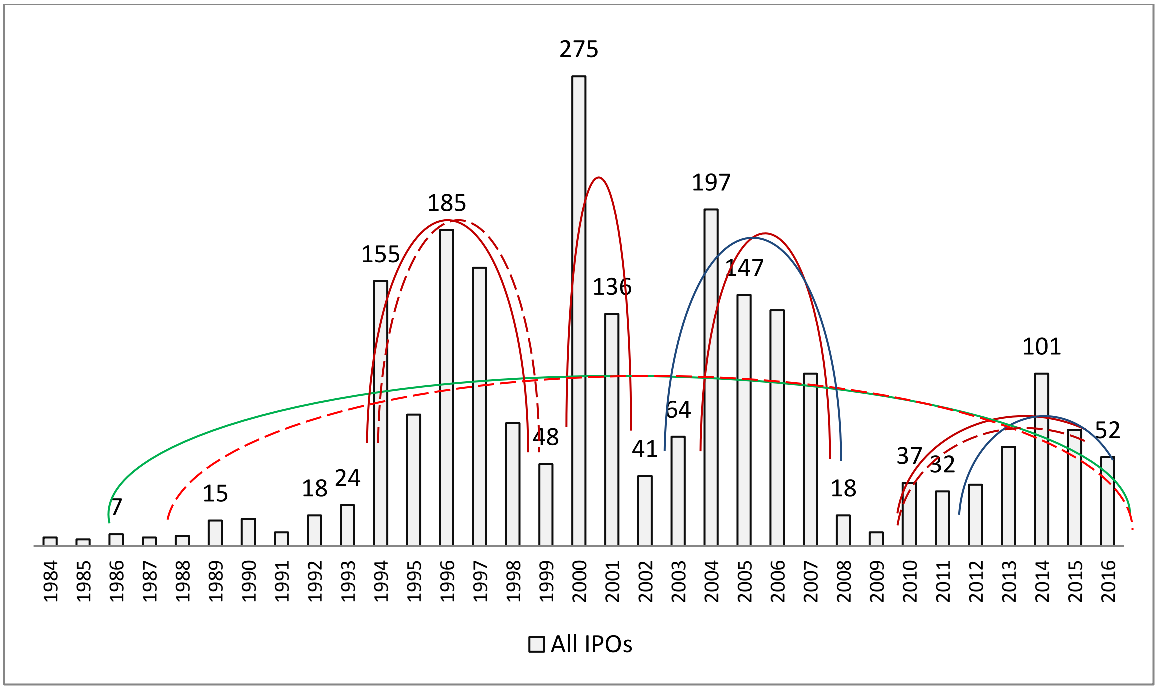
The table presents the IPO peaks and corresponding waves in the UK market during the period from January 1984 to December 2016. The peaks and waves are identified based on the sample of 2317 IPOs and following a methodology for wave identification adopted from the research on the M&A markets.

*Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak, No of IPOs	Peak, Dates	Description	Duration, years
1	1986 - *(2016)**	15	1989	Incomplete	31
2	1988 - *(2016)**	18	1992	Incomplete	29
3	1994 – 1998	155	1994	Complete	5
	1994 – 1998	185	1996	Complete, Overlapping	5
4	2000 – 2001	275	2000	Complete	2
5	2004 – 2007	197	2004	Complete	4
6	2003 – 2007	147	2005	Complete, Overlapping	5
7	2010 - *(2016)**	37	2010	Incomplete	7
	2010 - *(2016)**	58	2013	Incomplete, Overlapping	*7*
8	2012 - *(2016)**	101	2014	Incomplete, Overlapping	*5*

Figure 5.21: Number of IPOs and IPO waves by year in 1984 – 2016

The figure presents yearly IPO peaks and corresponding waves for the sample of 2317 IPOs in the UK market during the period from January 1984 to December 2016.



While the beginnings of the last three waves are clearly detectable, the ends of the waves are not currently traceable. The decrease in the number of IPOs after the peak year does not meet the required 1/3 of the number of transactions in the peak year as specified in the current methodology. Therefore, it is possible to conclude that the last three IPO waves have started in 2010 and 2012 but have not yet finished by the end of 2016. This conclusion could be confirmed with further investigation once the data on the subsequent years becomes available. The three incomplete waves with peaks of 37, 58 and 101 IPOs respectively have clear different starting points but merge together in later years, for this reason they have been coded as an *extended wave* of 2010 – *(2016)* (i.e. a wave that combines two or more merging waves that have either different start dates but the same end date or different end dates but the same start date). Table 5.17 summarises these waves. There are four waves in the specified period, three of which have a complete cycle and one has an incomplete cycle. The length of the waves varies between two and seven years, with the average length of five years.

Table 5.17: Yearly IPO waves in the UK in 1984 – 2016
The table presents the summary of the identified waves for the UK market for the period from January 1984 to December 2016. *Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak No of IPOs	Peak, date	Description	Duration, years
1	1994 - 1998	185	1996	Complete	5
2	2000 - 2001	275	2000	Complete	2
3	2003 - 2007	197	2004	Complete, Extended	4
4	2010 - *(2016)**	101	2014	Incomplete, Extended	*7*

Figure 5.22 provides an overview of the yearly IPO waves by the type of offer. The three waves with complete cycles that happened between 1994 and 2007 include all three types of offers and are predominantly driven by the national type of offers. However, the last wave beginning in 2010 contains only national and international offers and is driven mainly by the international type of offers. Figure 5.23 shows yearly IPO proceeds in relation to yearly IPO waves. As the figure indicates, the highest IPO proceeds happen within IPO waves; they generally follow the increase in IPO numbers and decline dramatically during the trough periods.

Figure 5.22: Yearly IPO waves and the type of offer
The figure presents yearly IPO waves for the new issues according to the type of offer in the UK market for the period from January 1984 to December 2016.

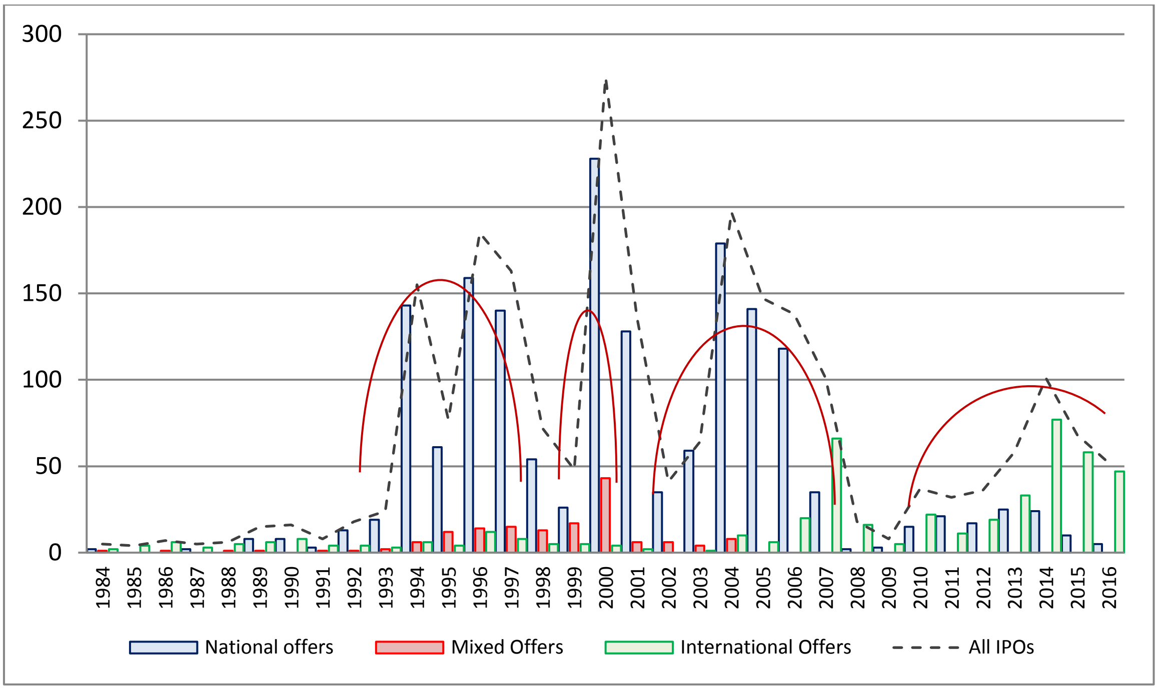
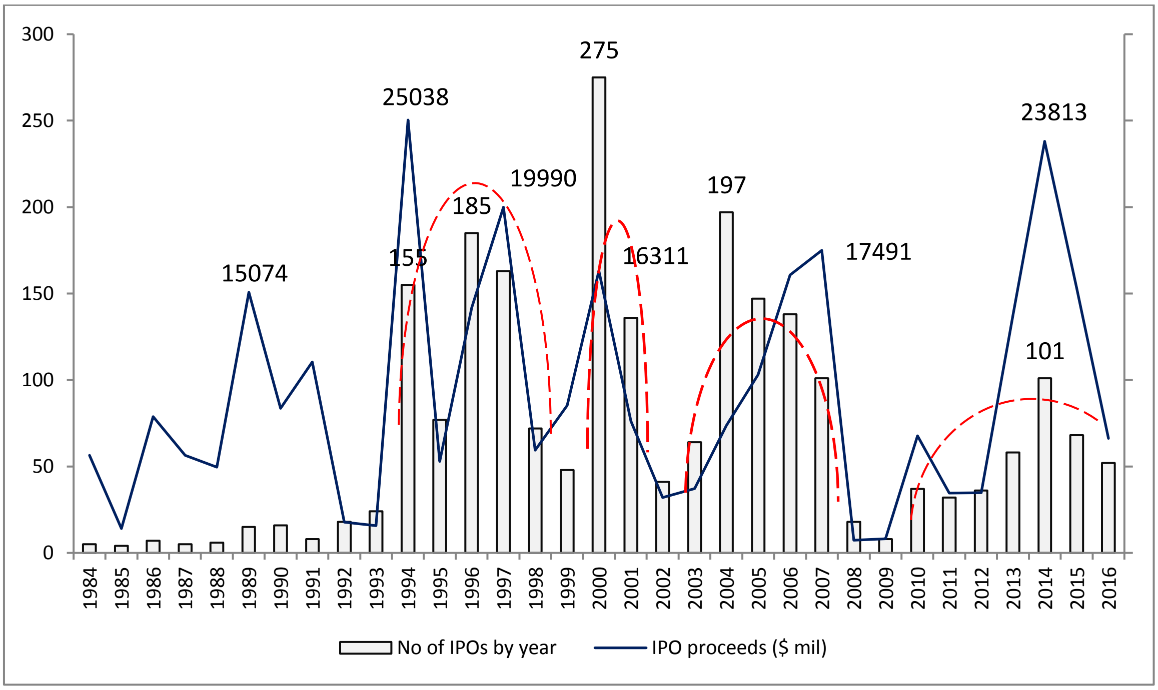


Figure 5.23: IPO waves and IPO proceeds by year
The figure presents an overview of the identified IPO waves and the IPO proceeds for the new issues in the UK market during the period from January 1984 to December 2016.



An interesting observation is that IPOs in 1989 (with just six IPOs) generated almost the same level of IPO proceeds as IPO transactions in 2000 (the year with the highest number of IPOs in the sample, 275 IPOs).

Figure 5.24 summarises the IPO proceeds within the yearly IPO waves by the type of offering. During the first two waves (between 1994 and 2001) the high level of IPO proceeds come mainly from the national and the mixed type of offerings. While during this period the number of mixed type of offers is significantly lower compared to the national type of offers (figure 5.25), the highest IPO proceeds are driven often by the mixed type of IPOs. For the third wave (2003 – 2007) the highest IPO proceeds come from the national offers, with exception for the last year of the wave (2007), when the highest IPO proceeds are driven mainly by the international type of offers. For the last wave (incomplete) starting in 2010 almost all IPO proceeds are due to the international offers.

Figure 5.24: IPO waves and IPO proceeds by the type of offer

The figure presents and overview of the IPO proceeds in relation to the identified yearly IPO waves and according to the type of offer. The sample includes 2317 IPOs issued in the UK during the period from January 1984 to December 2016.

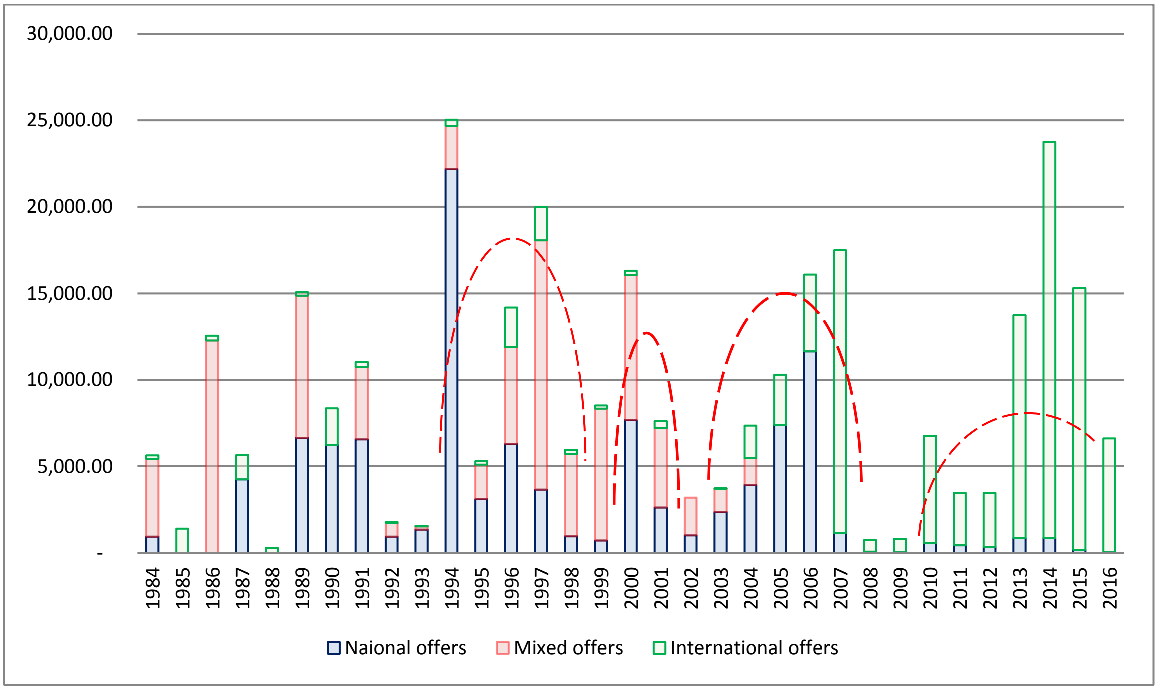
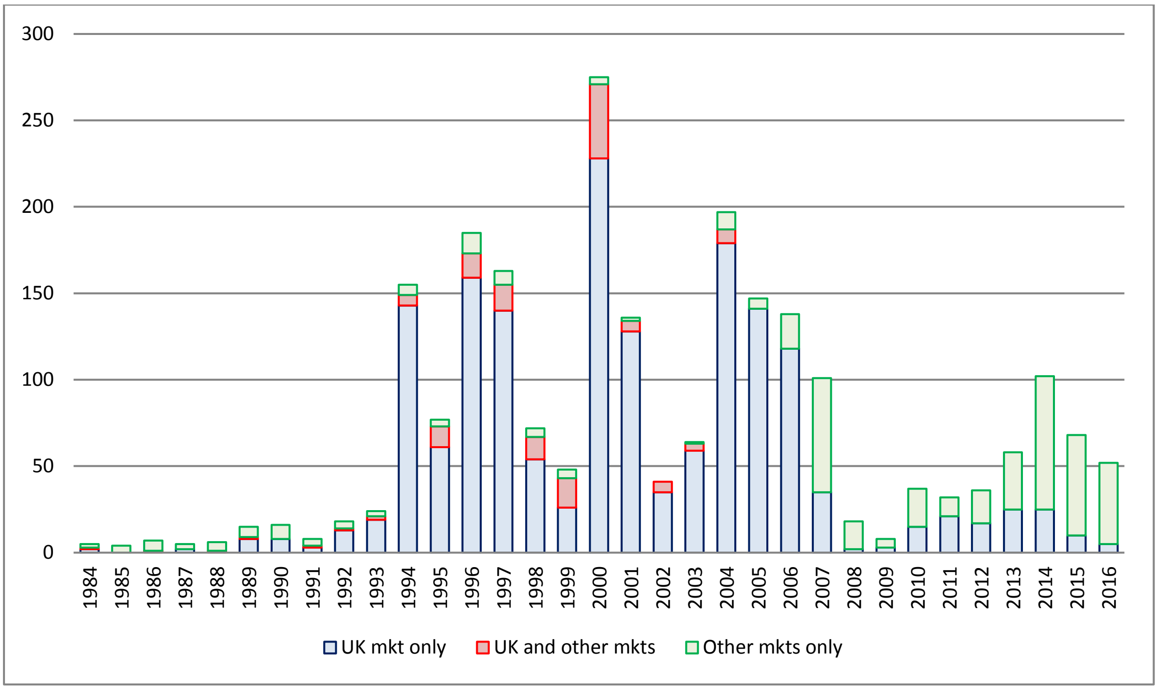


Figure 5.25: No of IPOs according to the offer type by year

The figure presents the number of IPO transactions by year according to the offer type for the sample of 2317 IPOs issued in the UK during the period from January 1984 to December 2016.



5.2.2 Research question 2b: When do IPO waves occur in the UK?

Research question 2b looks at the dynamic of the formation of IPO waves and the time periods they occur. The monthly IPO transactions provide a more detailed picture of the dynamics of the IPO activity. Using the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008), 26 monthly IPO waves were detected. Out of these, 22 waves have complete cycles (with a clear beginning, a peak and an end), and four waves have overlapping cycles. Table 5.18 presents an overview of the IPO activity by year and months in 1984-2016.

The identified waves are very irregular in duration. The average duration of a monthly IPO wave is seven months, with the longest wave lasting 19 months and the shortest one lasting only three months. On average, the number of IPOs per month in 1984 - 2015 is six IPOs. The IPO activity within each of the identified wave is irregular, with the months of January and August-September displaying lower activity, and spring months and the end of the calendar years showing higher IPO activity as shown in the figure 5.5 in section 5.1.1.

Table 5.18: Monthly IPO waves in the UK in 1984 – 2016

The table presents monthly IPO peaks and corresponding waves in the UK market during the period from January 1984 to December 2016. The peaks and waves are identified based on the sample of 2317 IPOs and following a methodology for wave identification adopted from the research on the M&A markets.

No	Wave	Peak, Date	Description	Duration months
1	February 1994 - June 1994	31, March 1994	Complete	5
2	September 1994 - November 1994	19, November 1994	Complete	3
3	October 1995 - December 1995	14, November 1995	Complete	3
4	February 1996 - July 1996	19, June 1996	Complete	6
5	September 1996 - December 1996	28, November 1996	Complete	4
6	February 1997 - July 1997	26, March 1997	Complete	6
7	February 1997 - July 1997	20, July 1997	Complete	6
8	February 1998 - July 1998	13, May 1998	Complete	6
9	February 1998 - July 1998	14, July 1998	Complete	6
10	February 2000 - December 2000	40, March 2000	Complete	11
11	February 2000 - December 2000	32, July 2000	Complete	11
12	February 2000 - August 2001	15, March 2001	Overlapping	19
13	October 2001 - January 2002	15, December 2001	Complete	4
14	October 2003 - December 2003	16, December 2003	Complete	3
15	February 2004 - December 2004	22, June 2004	Overlapping	11
16	March 2004 - December 2004	28, July 2004	Complete	10
17	May 2005 - July 2005	26, June 2005	Complete	3
18	October 2005 - August 2006	21, November 2005	Complete	11
19	October 2005 - August 2006	21, March 2006	Complete	11
20	October 2005 - December 2006	16, November 2006	Overlapping	15
21	February 2007 - July 2007	14, April 2007	Complete	6
22	February 2007 - July 2007	13, July 2007	Complete	6
23	October 2013 - December 2013	13, November 2013	Complete	3
24	March 2014 - July 2014	18, June 2014	Complete	5
25	February 2014 - August 2014	12, July 2014	Overlapping	7
26	February 2015 - May 2015	14, March 2015	Complete	4

As stated earlier, to ensure a more detailed overview of the IPO activity, while avoiding the seasonality issue, the number of IPO transactions has been measured quarterly in each year. Figure 5.26shows all of the quarterly IPO waves in the UK in 1984-2016.

Following the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008), 15 peaks in the number of IPO transactions corresponding to 13 IPO waves have been identified (peaks of 64 IPOs in quarter four 1995 and 48 IPOs in quarter four 1997 relate to the same wave starting in quarter four 1995 and ending in quarter four 1997; similarly, the peaks of 76 IPOs in quarter two in 2000 and 70 IPOs in quarter four in 2000 relate to the same wave starting in quarter one and ending in quarter four 2000. Table 5.19provides a summary of the identified peaks and corresponding waves.

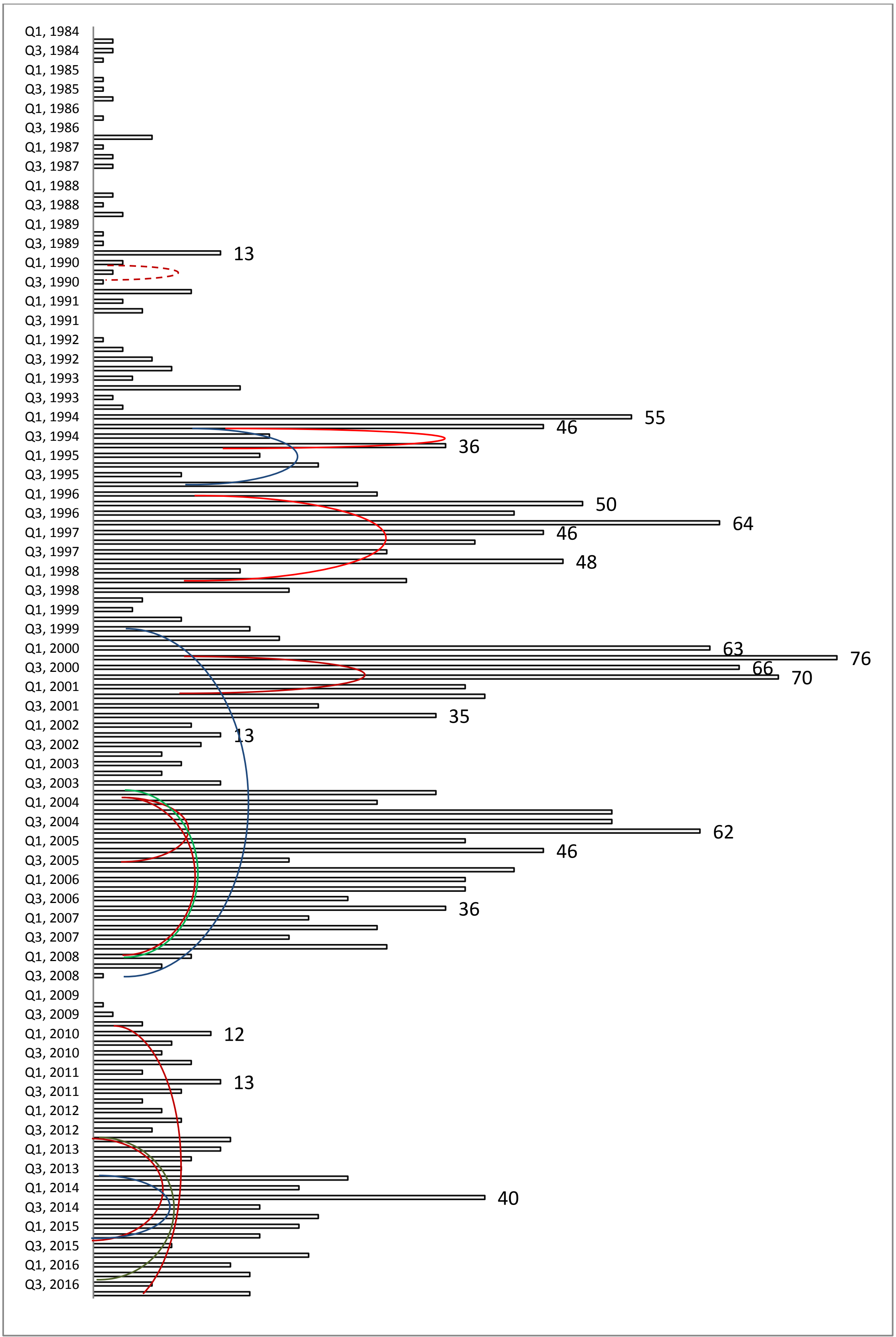
Table 5.19: Quarterly IPO peaks and corresponding waves in the UK in 1984-2016

The table presents all of the quarterly IPO peaks and the corresponding waves in the UK market during the period from January 1984 to December 2016. The peaks and waves are identified based on the sample of 2317 IPOs and following a methodology for wave identification adopted from the research on the M&A markets. *Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak	Date	Description	Duration, quarters
1	Q1, 1994 - Q2, 1994	55	Q1, 1994	Complete	2
2	Q1, 1994 - Q2, 1995	36	Q4, 1994	Overlapping	6
3	Q4, 1995 - Q4, 1997	64, 48	Q4, 1996; Q4, 1997	Complete	9
4	Q1, 2000 - Q4, 2000	76, 70	Q2, 2000; Q4, 2000	Complete	6
5	Q2, 1999 - Q2, 2008	13	Q2, 2002	Overlapping	37
6	Q4, 2003 - Q2, 2005	62	Q4, 2004	Complete	7
7	Q4, 2003 - Q4, 2007	46	Q2, 2005	Overlapping	17
8	Q3, 2003 - Q4, 2007	36	Q4, 2006	Overlapping	18
9	Q4, 2009 - *(2016)**	12	Q1, 2010	Incomplete	29
10	Q4, 2009 - *(2016)**	13	Q2, 2011	Incomplete	29
11	Q4, 2012 - Q2, 2015	26	Q4, 2013	Complete	11
12	Q4, 2013 - Q2, 2015	40	Q2, 2014	Overlapping	7
13	Q4, 2012 - Q2, 2016	22	Q4, 2015	Overlapping	15

Figure 5.26: Quarterly IPO waves in the UK in 1984-2016

The figure presents quarterly IPO peaks and corresponding waves for the sample of 2317 IPOs in the UK market during the period from January 1984 to December 2016. Only peaks of over 10 IPOs and only waves of at least 2 quarters in duration are considered.



The average duration of quarterly IPO waves is 15 quarters, with the longest quarterly IPO wave of 29 quarters and the shortest of two quarters. Only five of the identified waves have a complete cycle, two of the waves, both beginning in quarter four 2009, have incomplete and overlapping cycles. The remaining six waves have overlapping cycles. These waves have been coded as extended waves. Table 5.20 provides the summary of the extended waves. The period of 1984-2016 shows four IPO waves with complete cycles.

Table 5.20: Quarterly IPO waves in the UK in 1984-2016
The table presents the quarterly IPO waves summarised according to the wave cycle for the sample of 2317 IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

No	Wave	Peak	Dates	Description	Duration, quarters
1	Q1, 1994 - Q2, 1995	55	Q1, 1994	Extended	6
2	Q4, 1995 - Q4, 1997	76	Q2, 2000	Complete	9
3	Q2, 1999 - Q2, 2008	13	Q2, 2002	Extended	37
4	Q4, 2012 - Q2, 2016	40	Q2, 2014	Extended	15

Figure 5.27 shows quarterly IPO waves by the type of offering. As the figure indicates, the first three waves are driven mainly by the national offers, however, the last wave, starting in quarter four 2012, is dominated primarily by the international type of offers. Figure 5.28 relates quarterly IPO proceeds to quarterly IPO waves. The proceeds for IPO are the highest within the identified waves, with dramatic decrease in IPO proceeds just before the end of a wave.

Figure 5.29 displays the proceeds within the quarterly IPO wave by the type of offering. While within the first wave the IPO proceeds come mainly from the national type of offering, during the second wave the IPO proceeds are mainly backed by the mixed type of offering. During the third wave the IPO proceeds come from all three types of offering depending on the timing of an IPO within the wave. The beginning of the wave is characterised by the higher number of the national types of offering, however, the higher proceeds during this time are mainly due to the mixed type of offerings. By the end of the wave the dynamic in the type of offering and the highest IPO proceeds coincide, they both come from the international type of offering. This dynamic stays the same for the last wave and the high IPO proceeds are almost entirely due to the international type of offering.

Figure 5.27: Quarterly IPO waves and the type of offer

The table presents the quarterly IPO waves and the quarterly number of IPOs according to the offer type for the sample of 2317 IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

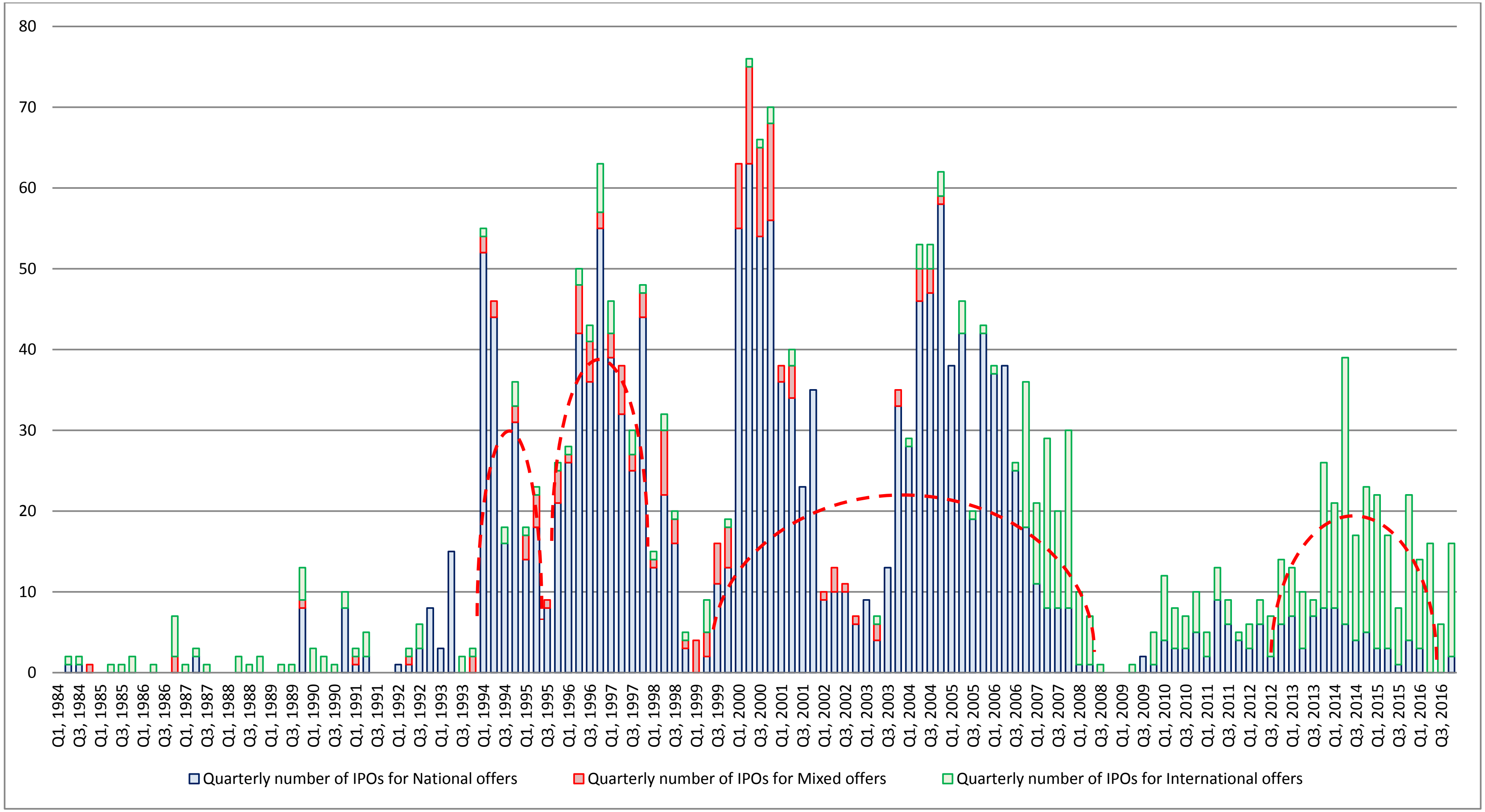


Figure 5.28: IPO waves and IPO proceeds by quarter

The table presents an overview of the IPO proceeds (in $ mil) measured by quarter in relation to the quarterly IPO waves for the sample of 2317 IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

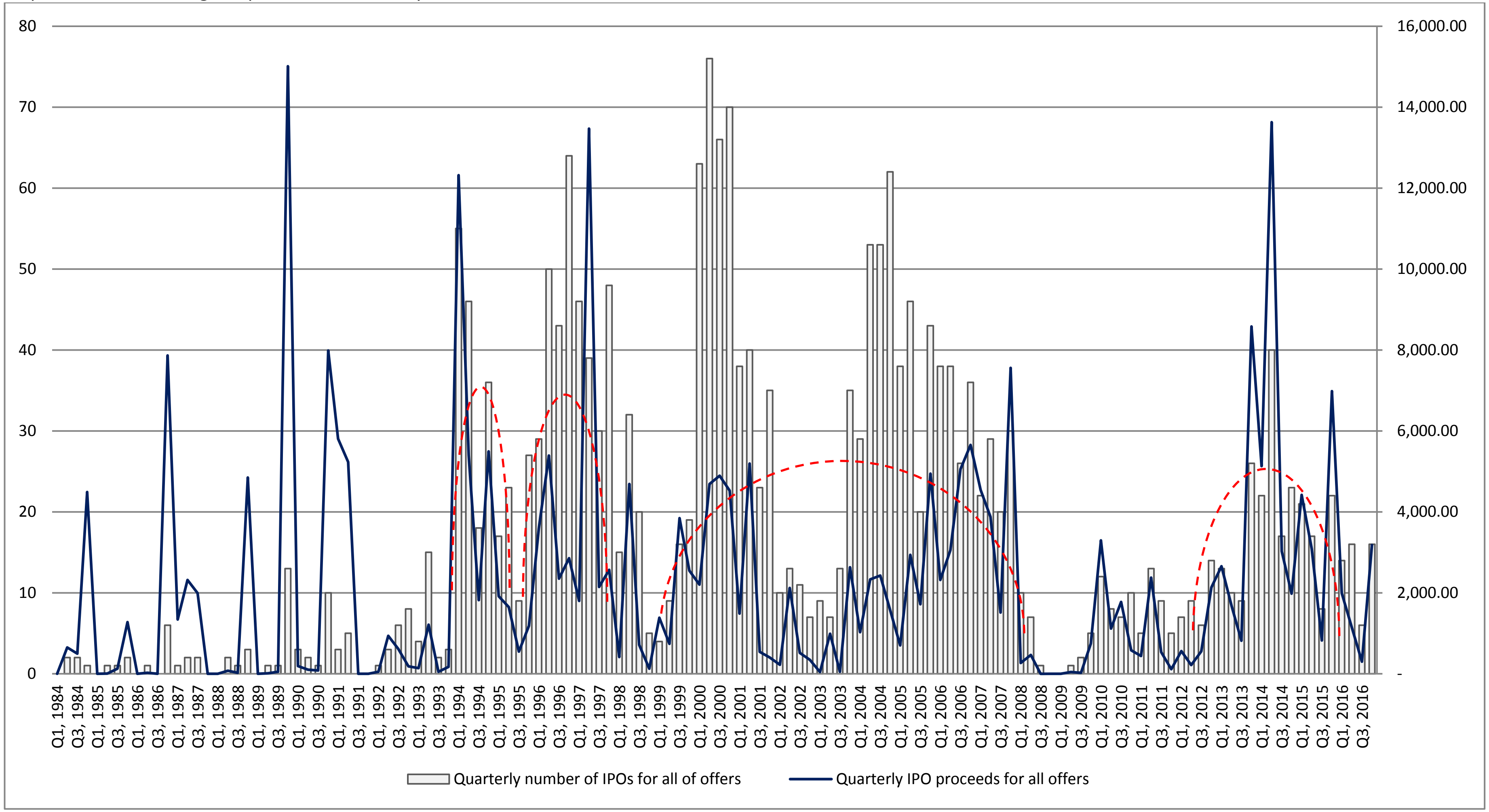
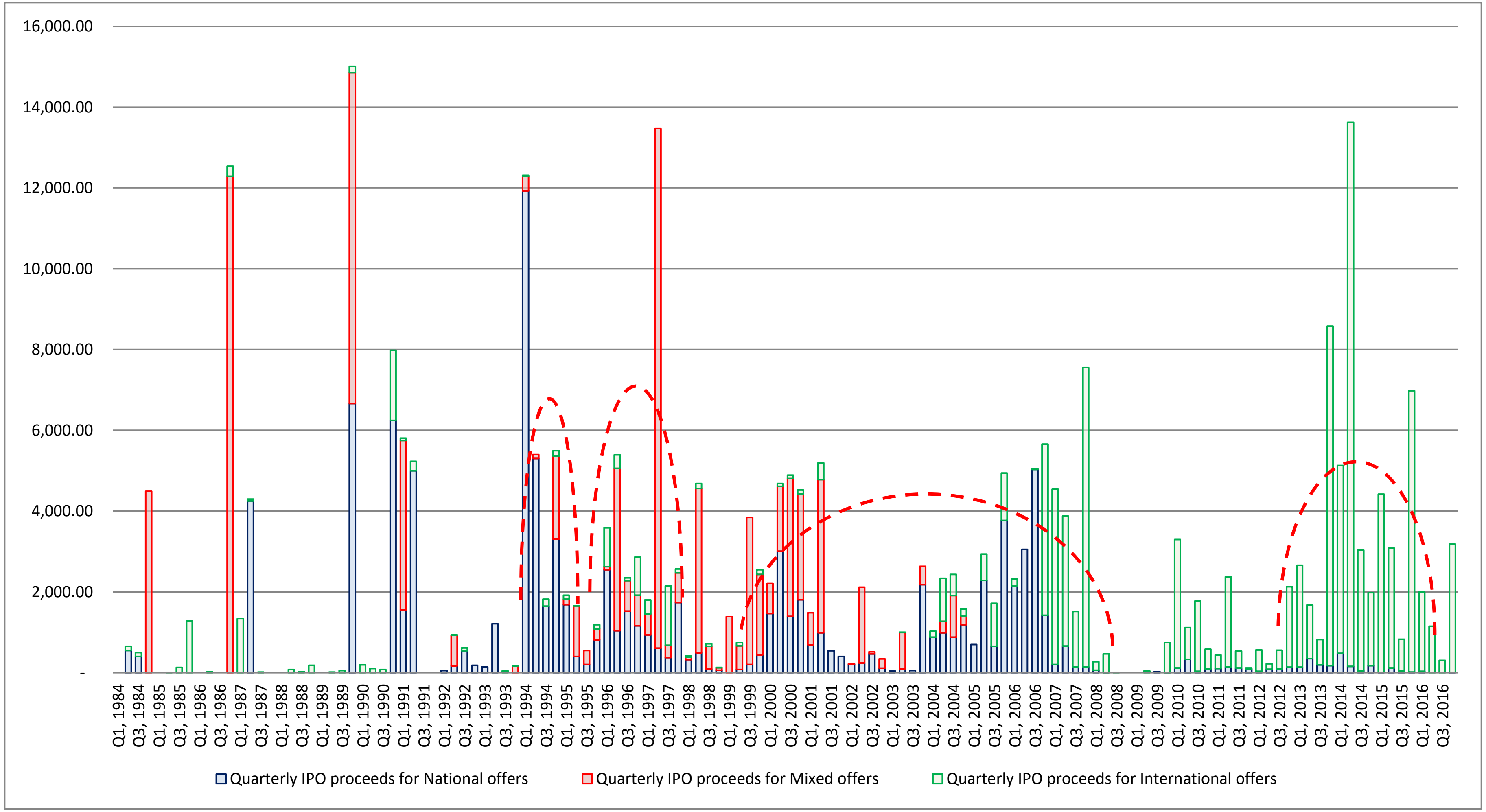


Figure 5.29: Quarterly IPO waves and IPO proceeds by offer types

The table presents an overview of the quarterly IPO proceeds in relation to the quarterly IPO waves for different types of offers for the sample of 2317 IPOs of the UK-based companies issued during the period from January 1984 to December 2016.



5.2.3 Research question 2c: What industries are more prone to IPO waves?

Research question 2c attempts to identify the industries that are more prone to IPO waves and investigate how often these waves occur in the industry sectors. Figure 5.30 provides a general overview of the IPO activity in different industry sectors during the 1984 – 2016. The industry sectors are defined as specified by Thomson Reuters.

According to the figure, the IPOs in the 'Financials' sector (in purple) have outperformed every other sector year on year from the 1994 onwards, starting at 54 IPOs in 1994 and reaching its peak of 86 IPOs in 2000.The number of IPOs in 2016 in the 'Financials' sector still continues to outperform every other sector. The sector with the second highest number of IPOs in 1984-2016 is the 'High Technology' sector (in light blue). It outperforms other sectors for the majority of the specified period and peaks in 2000 at 85 IPOs. Some sectors, such as 'Media and Entertainment', 'Consumer Product and Services', and 'Industrials' sectors exhibit higher IPO activity during the years 1994 to 2007 compared to other industries.

For the majority of industries the heightened IPO activity is observed in the years 1994 – 2002 and the 2004 – 2007, with a very sharp decrease in the number of IPOs in 2008. The lowest IPO activity is detected for the period of 1984 – 1993 and 2008 – 2009. The 1984 – 1993 trough could be due to the fact that, while the London Stock Exchange was opened in 1801, the AIM was not launched until 1995. And the global financial crisis is most likely the cause of the 2008 – 2009 trough.

Looking at the total number of IPOs by industry sectors in 1984 – 2016, as presented in table 5.21, it is possible to identify the sectors where IPO activity was the highest during the specified period (in italics).

Figure 5.30: IPO activity by industry sector

The figure presents the yearly number of IPOs for different industry sectors for the IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

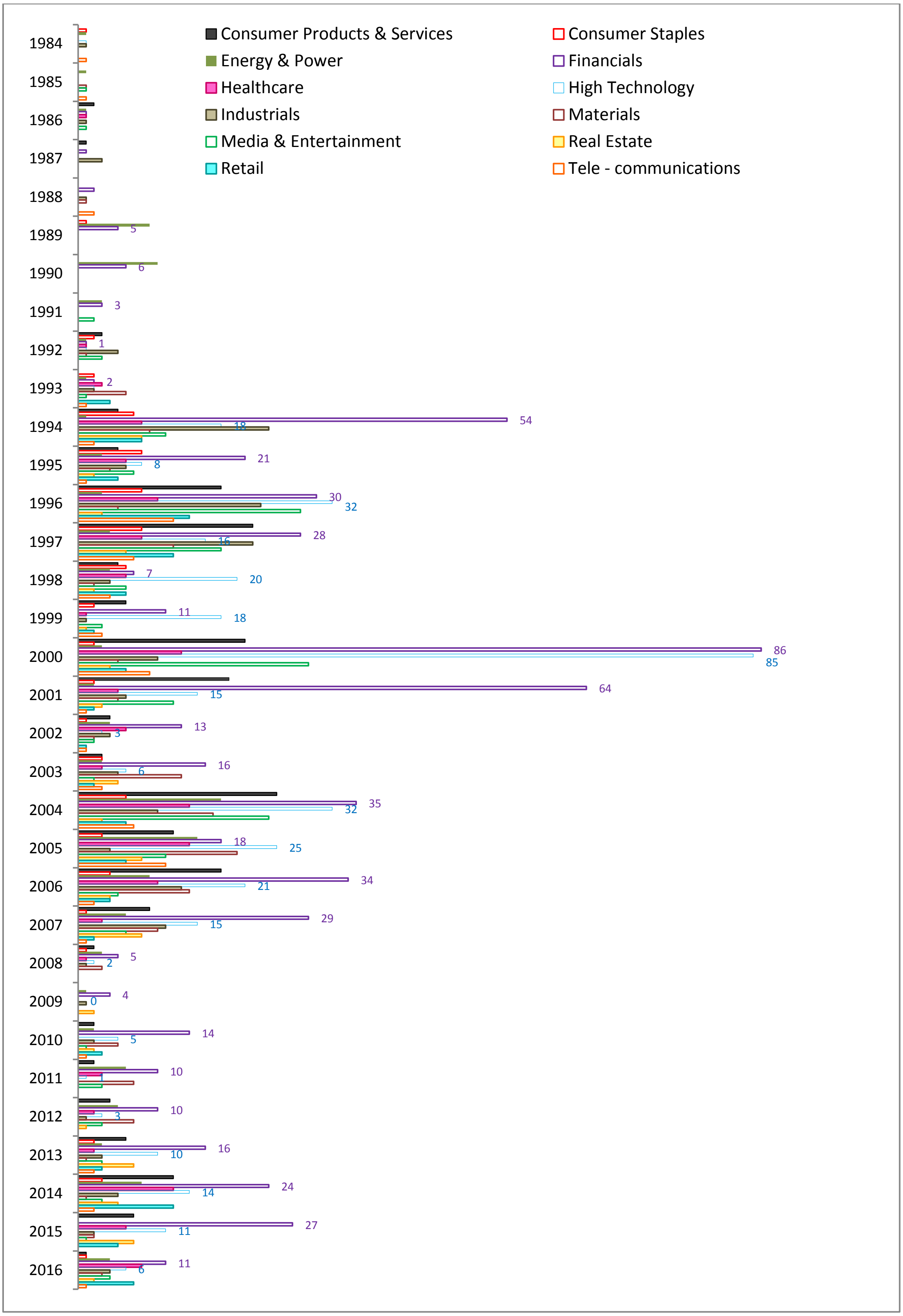


Table 5.21: Total and average number of IPOs by industry sectors in the UK in 1984 – 2016
The table presents the total and the average number of IPOs for different industry sectors for the sample of 2317 IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

Industry	Total	Average
Financials	*588*	*18*
High Technology	*370*	*11*
Consumer Products & Services	*214*	*6*
Media & Entertainment	190	6
Industrials	175	5
Materials	156	5
Healthcare	146	4
Energy & Power	134	4
Retail	110	3
Real Estate	83	3
Telecommunications	75	2
Consumer Staples	74	2

The 'Financials' sector, as mentioned earlier, displays the highest IPO activity (588 IPOs), followed by the 'High Technology' sector (370 IPOs), and the 'Consumer Product and Services' sector (214 IPOs). These sectors have been looked at individually to get a more detailed picture of the IPO activity in those industries. The overview of the IPO waves for the remaining industries (sectors with the total number of IPOs higher than 100) is presented in Appendix D.

Figure 5.31presents the overview of the IPO activity in the 'Financials' sector. The number of IPO transactions in the financial industry prior to 1994 is extremely low. The activity in the sector, however, increases substantially in 1994 (54 IPOs) and the subsequent growth in the numbers of IPOs in the sector is quite dramatic. The 'Financials' sector displays four IPO waves, two waves with complete cycles, one overlapping wave and one wave with an incomplete cycle. The summary of the yearly IPO waves in the industry is presented in table 5.22.

Following the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008), the first wave is four years in duration, it begins with a sharp increase in the number of transactions that peaks in the first year at 54 IPOs. The second wave lasts for eight years; it also begins with sharp increase in the number of IPOs and starts with a peak of 86 IPOs in 2000. The activity displays two sharp declines (that indicate ends of the waves) in 1998 and 2008 - 2009. There is a gradual increase in the IPO activity from the 2010 throughout to the 2016 that forms a new wave with an incomplete cycle (the decline in the number of IPOs following a peak of 27 IPOs in 2015 is not substantial to indicate a clear end to the wave).

Figure 5.31: IPO waves in the 'Financials' sector in the UK in 1984-2016
The figure presents an overview of the yearly IPO waves in the 'Financials' sector for the IPOs of the UK-based companies issued during the period from January 1984 to December 2016.

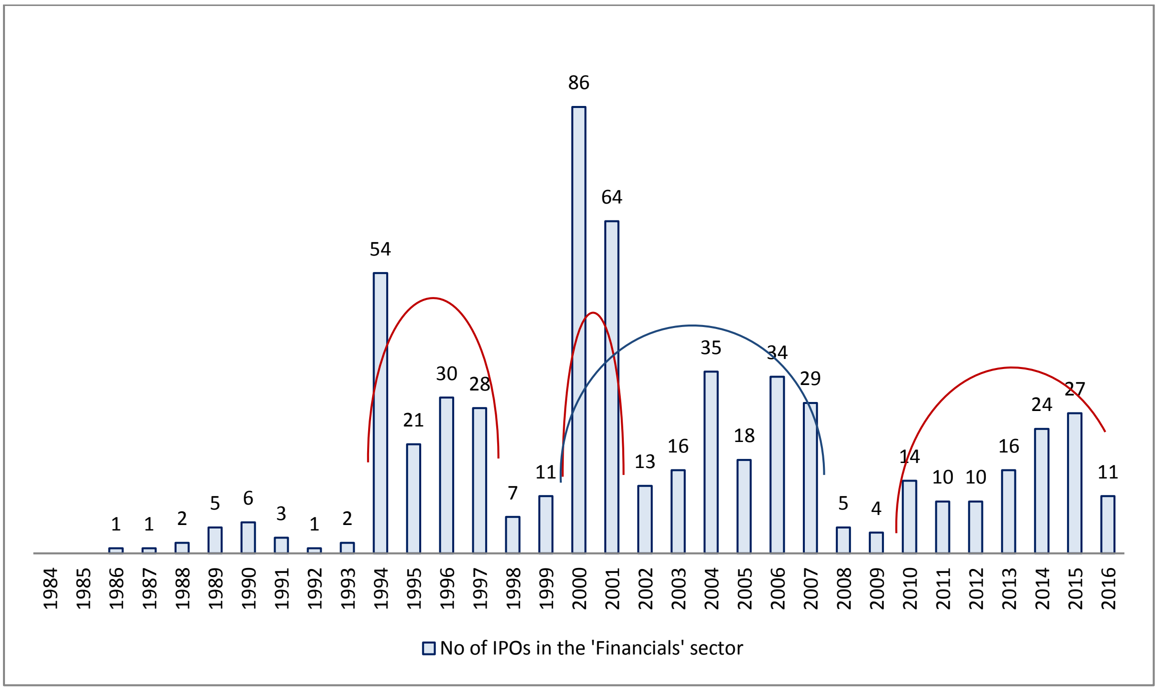


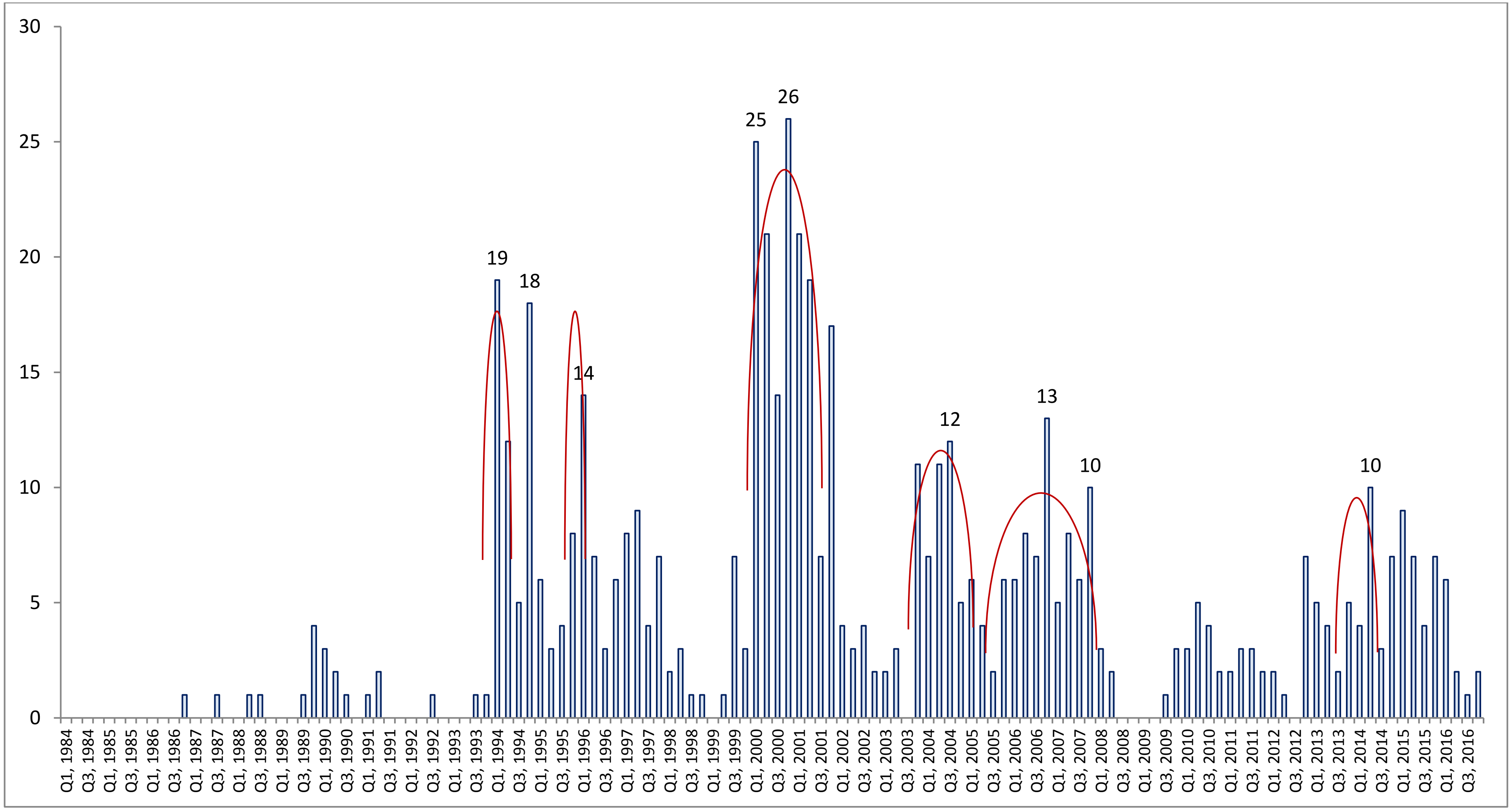
Table 5.22: IPO waves in the 'Financials' sector
The table presents the yearly IPO waves for the sample of 588 IPOs of the UK-based companies in the 'Financials' sector issued during the period from January 1984 to December 2016. *Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak	Date	Description	Duration, years
1	1994 - 1997	54	1994	Complete	4
2	2000 - 2007	86	2000	Complete, Extended	8
4	2010 - (2016)*	12	2014	Incomplete	3

Due to the high number of transactions in the sector it is worth looking at the IPO dynamics in detail. Figure 5.32 presents an overview of the quarterly IPO waves in the 'Financials' sector in the specified period.

Figure 5.32: Quarterly IPO wave in the 'Financials' sector in the UK in 1984-2016

The figure presents an overview of the quarterly IPO waves for the sample of 588 IPOs of the UK-based companies in the 'Financials' sector issued during the period from January 1984 to December 2016. Only peaks of at least 10 IPOs and only waves of at least 2 quarters in duration are considered.



The summary of waves is presented in the table 5.23.There are six identifiable waves in the sector. All of the waves have complete cycles. The three biggest waves happen in the period between 2000 and 2007 (two waves of six quarters and one wave of nine quarters in duration). Most of the waves start in quarter four (four waves out of six) and the majority of the waves end in quarter two (four out of six waves).

Table 5.23: Quarterly IPO waves in the 'Financials' sector in the UK in 1984-2016
The table presents a summary of the quarterly IPO waves for the sample of 588 IPOs of the UK-based companies in the 'Financials' sector issued during the period from January 1984 to December 2016. Only peaks of at least 10 IPOs and only waves of at least 2 quarters in duration are considered.

No	Wave	Peak	Date	Description	Duration, quarters
1	Q1 1994 - Q2 1994	19	Q1 1994	Complete	2
2	Q4 1995 - Q2 1996	14	Q1 1996	Complete	3
3	Q1 2000 - Q2 2001	26	Q4 2000	Complete	6
4	Q4 2003 - Q1 2005	12	Q3 2004	Complete	6
5	Q4 2005 - Q4 2007	13	Q4 2006	Complete	9
6	Q4 2013 - Q2 2014	10	Q2 2014	Complete	3

The IPO activity in the 'High Technology' sector, second sector with the highest number of IPOs in the UK in the specified period, is quite different to the developments of the 'Financials' sector. Figure 5.33 presents an overview of the IPO activity in the 'High Technology' sector in 1984 – 2016.The number of transactions in the industry prior to 1994 is almost at zero. The activity increases more gradually compared to the 'Financials' sector and displays two waves with complete cycles, one overlapping wave, starting on the back of the first wave and caused by a very dramatic increase in the IPO activity in 2000, and one wave with an incomplete cycle.

Summarised yearly IPO waves in the 'High Technology' sector are presented in table 5.24. The industry experienced a long trough period after the decline after 2007 and the activity did not increase until 2013.The increase in 2013 is substantial enough to mark the start of another wave, there is a definite beginning and a clear peak, but the decrease in the number of IPOs in 2016 is not significant enough to mark an end of the cycle. Therefore, the increase in activity 2013 – 2016 is coded as an incomplete wave.

Figure 5.33: IPO waves in the 'High Technology' sector in the UK in 1984-2016
The figure presents the yearly IPO waves for the sample of 370 IPOs of the UK-based companies in the 'High Technology' sector issued during the period from January 1984 to December 2016.

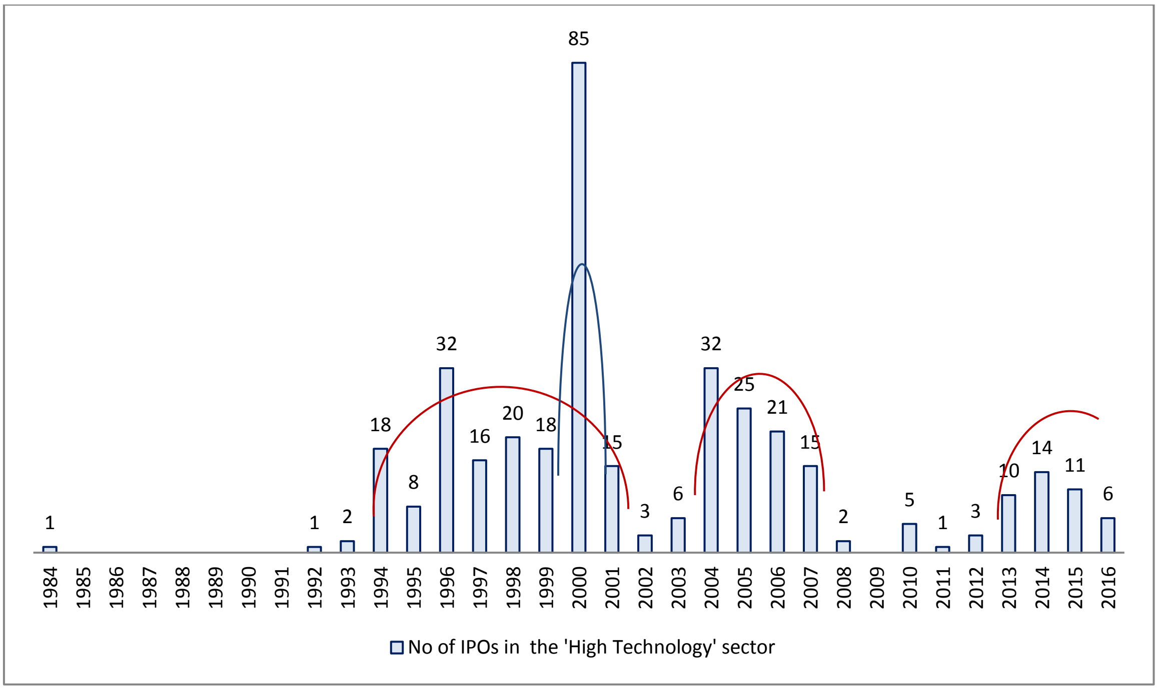


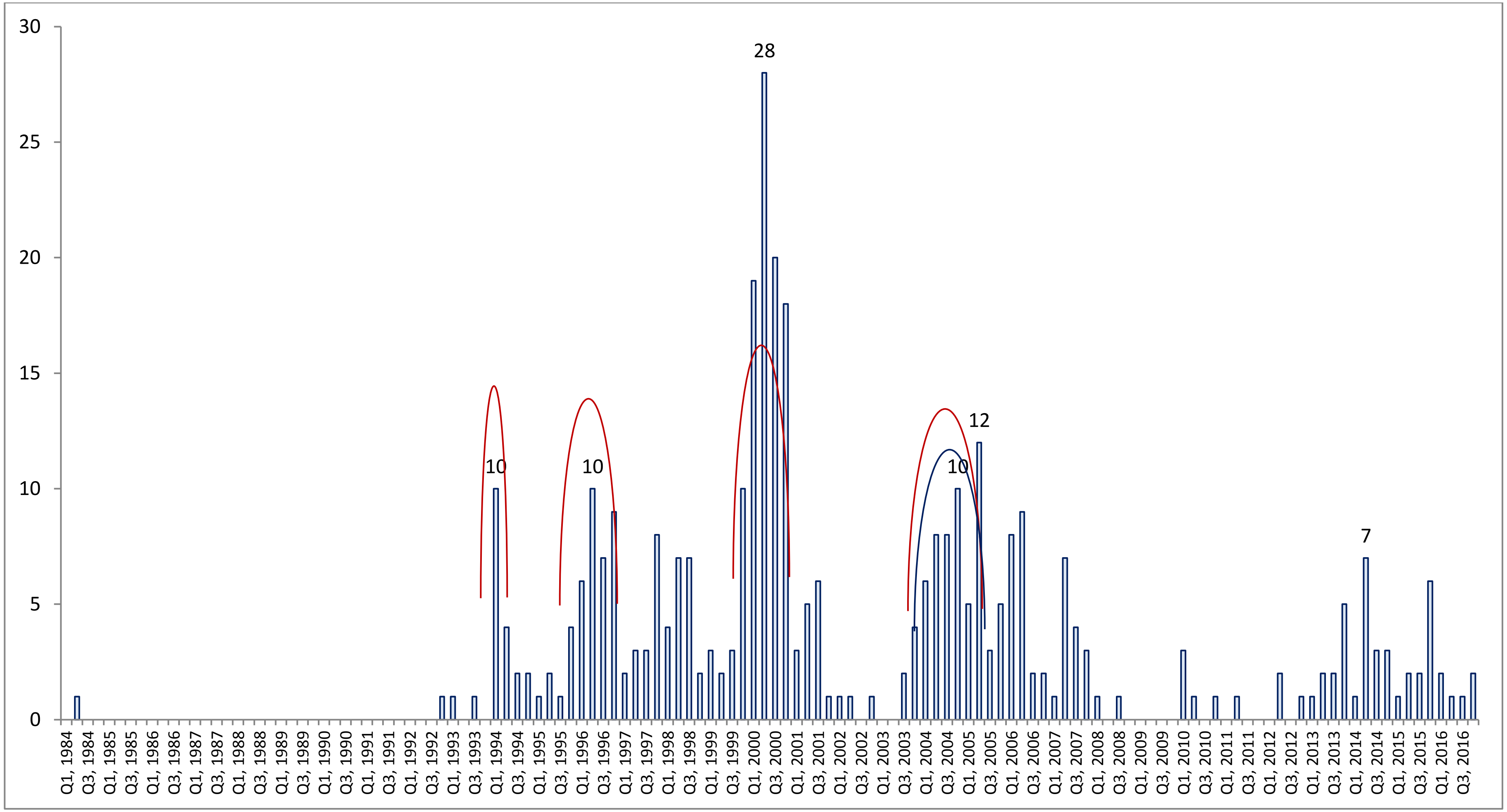
Table 5.24: IPO waves in the 'High Technology' sector
The table presents a summary of the yearly IPO waves for the sample of 370 IPOs of the UK-based companies in the 'High Technology' sector issued during the period from January 1984 to December 2016. *Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak	Date	Description	Duration, years
1	1994 - 2001	85	2000	Complete, Extended	8
2	2004 - 2007	32	2004	Complete	4
3	2013 - *(2016)**	14	2014	Incomplete	4

Figure 5.34 present the quarterly IPO dynamic in the 'High Technology' sector in the specified period. It displays four periods of heightened IPO activity corresponding to five quarterly waves in the sector. Four of the waves have a complete cycle and one wave is an overlapping wave. The highest wave in the 'High Technology' sector happens between quarter four, 1999 and quarter four, 2000, with the peak of 28 IPOs in second quarter of 2000. The longest wave occurs between quarter four, 2003 and quarter two, 2005.

Figure 5.34: Quarterly IPO wave in the 'High Technology' sector in the UK in 1984-2016

The figure presents an overview of the quarterly IPO waves for the sample of 370 IPOs of the UK-based companies in the 'High Technology' sector issued during the period from January 1984 to December 2016. Only peaks of at least 10 IPOs and only waves of at least 2 quarters in duration are considered.



Summarised quarterly IPO waves in the 'High Technology' sector are presented in table 5.25.Most of the waves begin in quarter four of the relevant year; two of the waves also finish in quarter four and the remaining two waves finish in quarter two. Following the specified methodology, the increases in the numbers of transactions in the surges after 2013 are too low to form a wave when measured quarterly.

Table 5.25: Quarterly IPO waves in the 'High Technology' sector in the UK in 1984-2016
The table presents a summary of the quarterly IPO waves for the sample of 370 IPOs of the UK-based companies in the 'High Technology' sector issued during the period from January 1984 to December 2016. *Italics indicate suggested end of the wave for the purpose of this investigation.

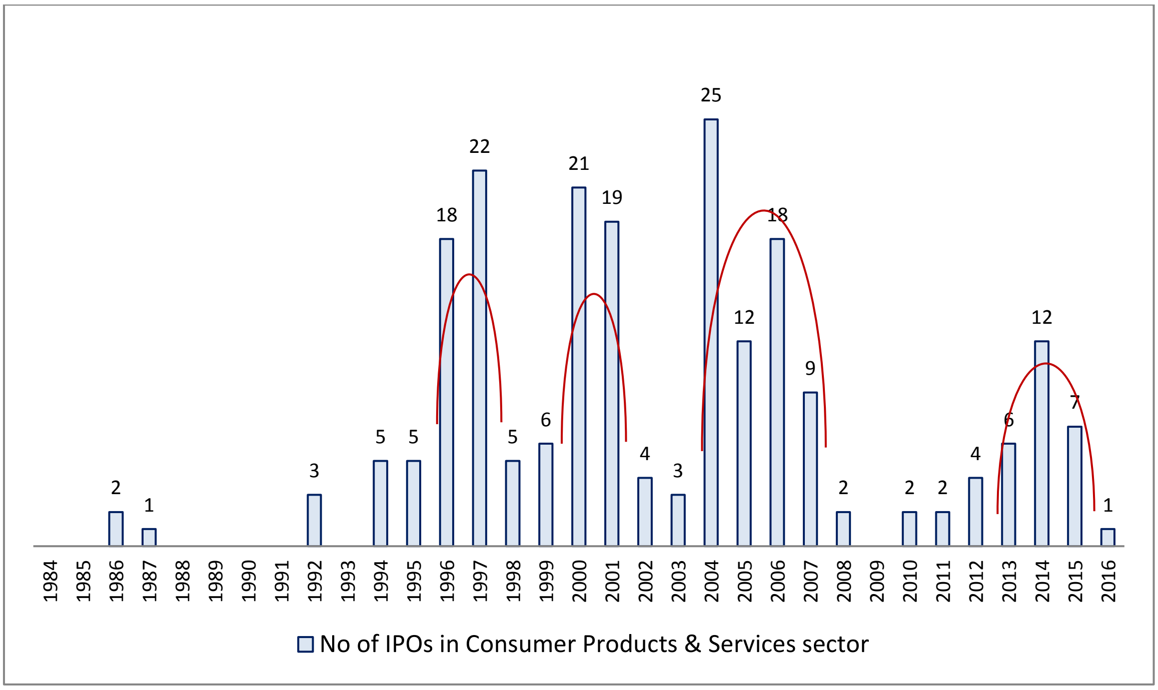
No	Wave	Peak	Date	Description	Duration, quarters
1	Q1 1994 - Q2 1994	10	Q1 1994	Complete	2
2	Q4 1995 - Q4 1996	10	Q2 1996	Complete	5
3	Q4 1999 - Q4 2000	28	Q2 2000	Complete	5
4	Q4 2003 - Q2 2005	12	Q2 2005	Complete, Extended	7

Figure 5.35 presents an overview of the IPO activity in the 'Consumer Product and Services' sector in 1984 – 2016. As before, the activity in this industry is slow to pick up and does not increase until 1996. The sector displays four complete waves, 1996 – 1997, 200-2001, 2004 – 2007, and 2013-2015. The first three waves start with a significant increase in the number of IPO transactions, the first wave also finishes with quite a dramatic decline. The activity slows down after 2007 and does not pick up until 2010. Table 5.26summarises the IPO waves in the sector.

Table 5.26: IPO waves in the 'Consumer Product & Services' sector
The table presents the yearly IPO waves for the sample of 214 IPOs of the UK-based companies in the 'Consumer Product & Services' sector issued during the period from January 1984 to December 2016.

No	Wave	Peak	Dates	Description	Duration, years
1	1996 - 1997	22	1997	Complete	2
2	2000-2001	21	2000	Complete	2
3	2004 - 2007	25	2004	Complete	4
4	2013 - 2015	12	2014	Complete	3

Figure 5.35: IPO waves in the 'Consumer Products & Services' sector in the UK in 1984-2016
The figure presents the yearly IPO waves for the sample of 214 IPOs of the UK-based companies in the 'Consumer Product & Services' sector issued during the period from January 1984 to December 2016.



To understand the difference in the dynamics of IPO activity in different industry sectors it is useful to look at different industries in comparison. Figure 5.36 shows the IPO activity in the ‘Financials’ and the ‘Consumer Staples’ sectors in comparison to each other. While the former is characterised by a very irregular IPO activity with many ups and downs, the latter displays a more stable, regular dynamic with gradual changes without any dramatic raises or declines. Also, the IPO activity in the ‘Consumer Staples’ industry is not significantly different around the 2008 – 2009 years mark (global crisis) comparing to the preceding years.

Similarly, comparing the ‘High Technology’ and the ‘Consumer Staples’ sectors, figure 5.37, reveals the differences in the dynamic of the IPO activity in these industries. The stability and gradual developments in the ‘Consumer Staples’ are contrasted by the irregularities in the number of IPOs in the ‘Technology’ sector.

Figure 5.36: IPO activity in the 'Financials' and the 'Consumer Staples' sectors
The figure presents comparative dynamics of the IPO activity in the 'Financials' and the 'Consumer Staples' sectors for the IPOs of the UK-based companies issued from January 1984 to December 2016. The 2-year moving averages are included to highlight the difference in the IPO activity of the sectors.

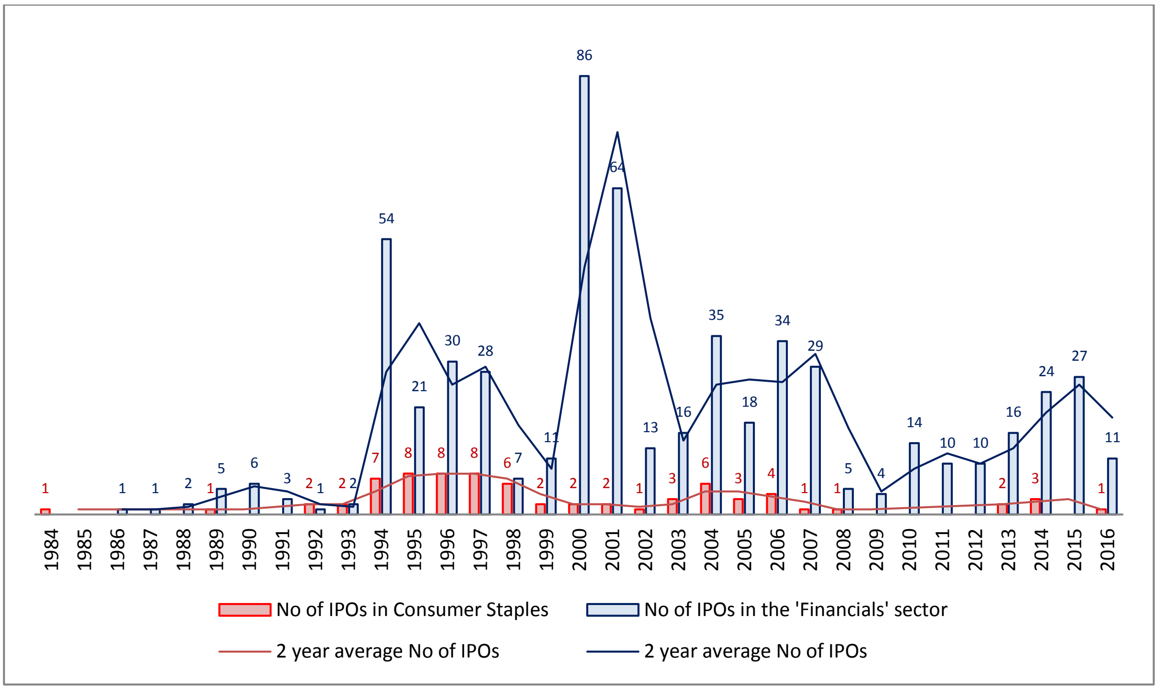
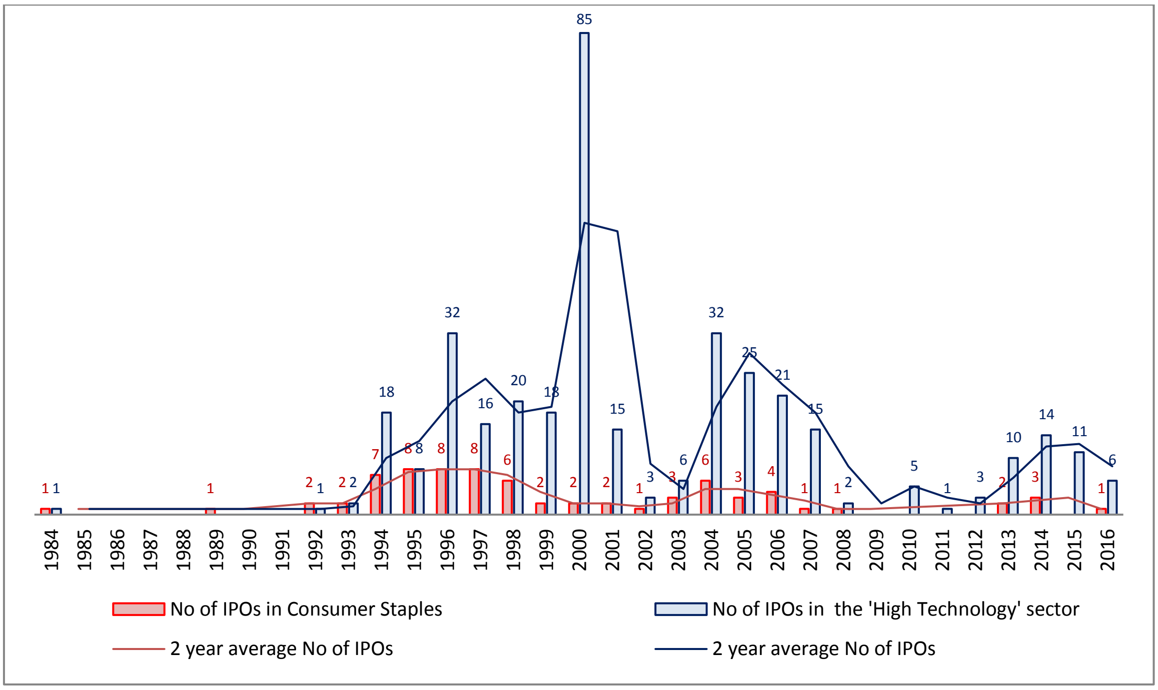


Figure 5.37: IPO activity in the 'High Technology' and the 'Consumer Staples' sectors
The figure presents comparative dynamics of the IPO activity in the 'High Technology' and the 'Consumer Staples' sectors for the IPOs of the UK-based companies issued from January 1984 to December 2016. The 2-year moving averages are included to highlight the difference in the IPO activity of the sectors.



On the other hand, comparing industry sectors that are related to each other demonstrates similar patterns in the dynamics of the IPO activity in these sectors. Figure 5.38 compares the 'Consumer Product and Services' and the 'Media and Entertainment' sectors. According to the data, the increases and decreases in the number of IPOs in both sectors are highly correlated; they also follow the same time periods.

Figure 5.38: IPO activity in the 'Consumer Product & Services' and the 'Media & Entertainment' sectors

The figure presents comparative dynamics of the IPO activity in the 'Consumer Product & Services' and the 'Media & Entertainment' sectors for the IPOs of the UK-based companies issued during the period from January 1984 to December 2016. The 2-year moving averages are included to highlight the similarities in the IPO activity of the sectors.

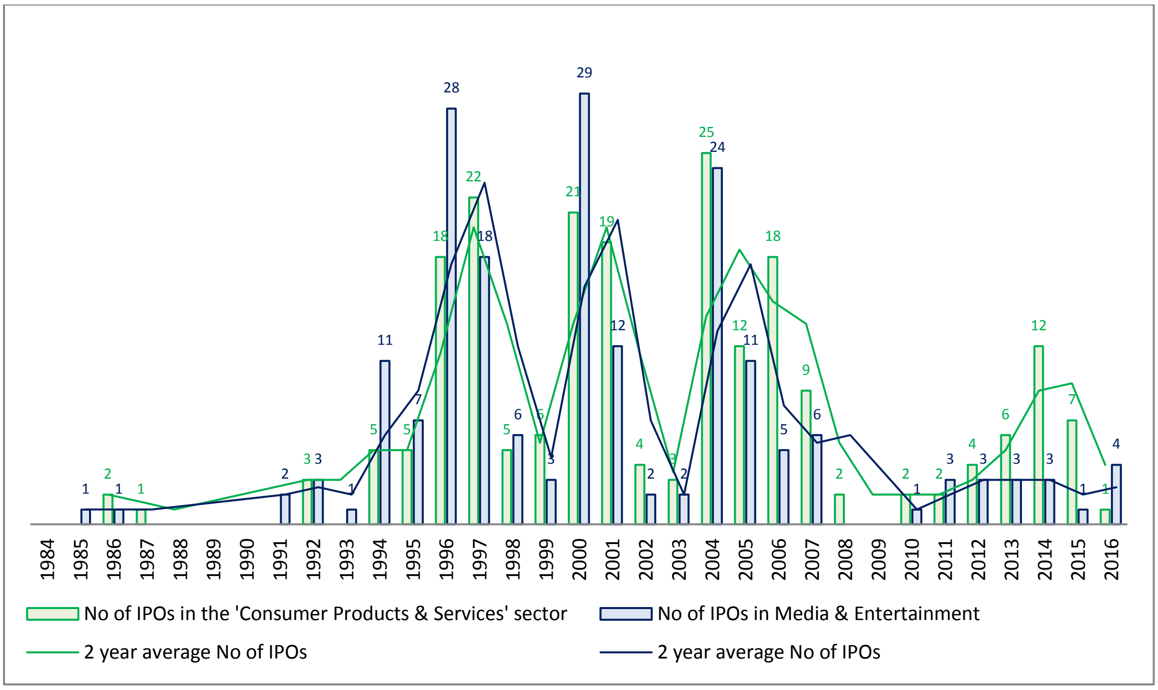


Figure 5.39 comparesthe 'Healthcare' industry to the 'Consumer Product and Services' sector and presents an interesting observation. As previously, the dynamic of the IPO activity in the industries exhibits many similarities and follows the same patterns of ups and downs. The volumes of the increases and the decreases in the sectors are also closely related.

Figure 5.39: IPO activity in the 'Consumer Product and Services' and the 'Healthcare' sectors
The figure presents comparative dynamics of the IPO activity in the 'Consumer Product and Services' and the 'Healthcare' sectors for the IPOs of the UK-based companies issued during the period from January 1984 to December 2016. The 2-year moving average is included to highlight the similarities in the IPO activity of the sectors.

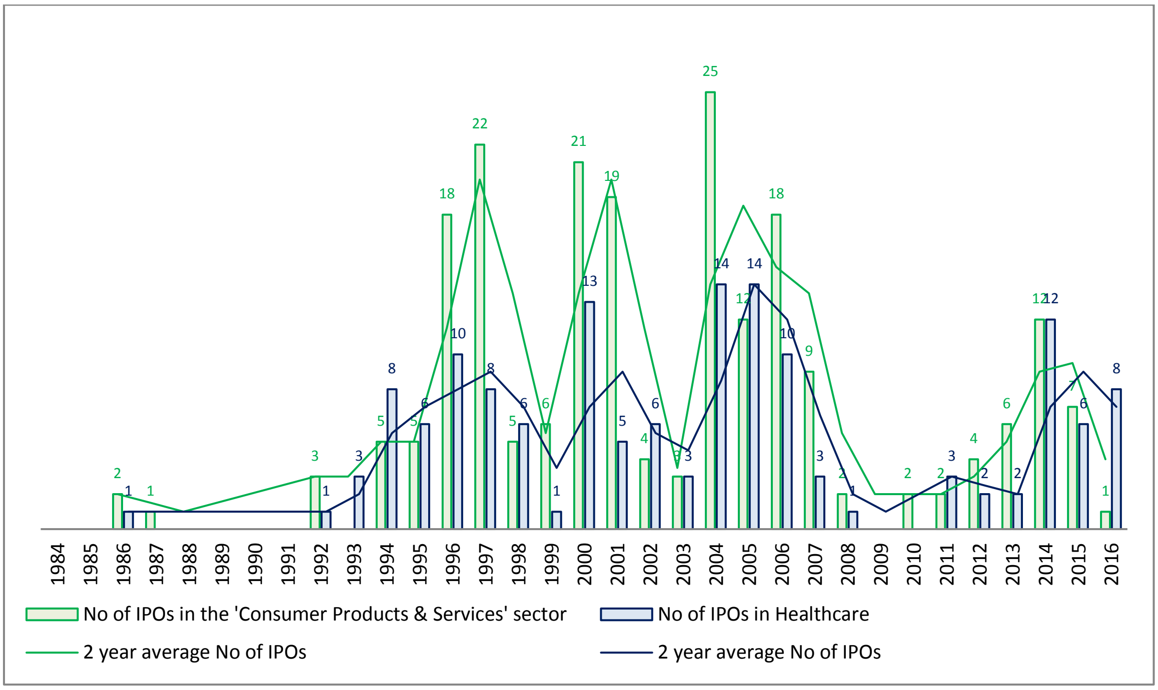
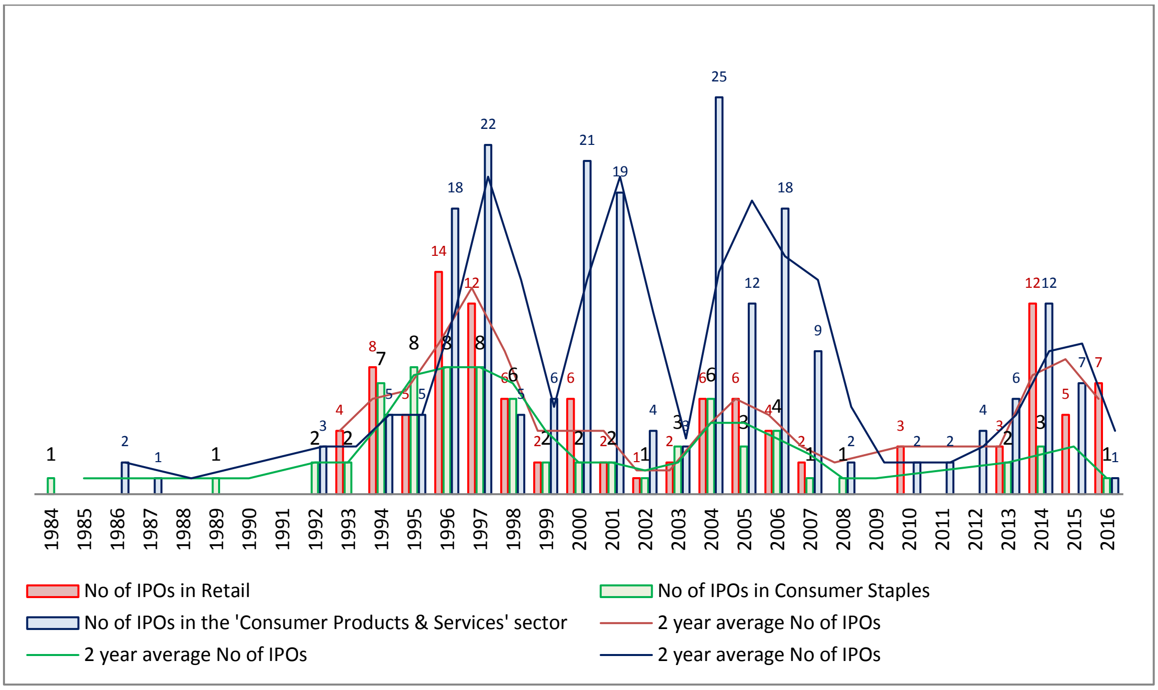


Figure 5.40 presents a comparison between the IPO dynamics in the three seemingly related sectors. The ‘Retail’ sector relates both to the ‘Consumer Product and Services’ and the ‘Consumer Staples’ sector by the nature of the composing businesses. However, comparing the three sectors gives a contradicting picture. While the ‘Retail’ (in red) and the ‘Consumer Staples’ (in green) sectors show similarities in the development of the IPO dynamic and the direction of change, the IPO activity of the ‘Consumer Product and Services’ (in blue) sector differs significantly to the IPO activity of the ‘Retail’ and the ‘Consumer Staples’ sectors. The former is characterised by periods of high and low activity, and the activity of the latter two, while displaying some fluctuations, is not prone to very sudden changes. Furthermore, the change in the number of transactions in the two sectors sometimes goes in different directions during the specified period.

Figure 5.40: IPO activity in 'Retail', 'Consumer Product & Services' and 'Consumer Staples' sectors
The figure presents comparative dynamics of the IPO activity in 'Retail', 'Consumer Product & Services' and 'Consumer Staples' sectors for the IPOs of the UK-based companies issued during the period from January 1984 to December 2016. The 2-year moving averages are included to highlight the differences and similarities in the IPO activity of the sectors.



IPO proceeds in relation to the IPO waves according to the industry sectors are presented in the Appendix D.

5.3 Research Question 3: How IPO waves are formed?

This section reports the findings for the IPO waves in the UK for a subset of data covering the period from January 2002 to December 2016. Section 5.3.1 reports the evidence on the market timing for IPO issuance; section 5.3.2 examines the evidence on the factors influencing the formation of an IPO wave, and section 5.3.3 evaluates potential characteristics of the pioneering firms within the IPO waves in the UK market.

5.3.1 Research Question 3a: Is there evidence of market timing in the UK?

Table 5.27 provides a summary of the descriptive statistics and the independent sample t-test for the number of IPOs per month (dependent variable) for the period of 2002-2016. The table shows statistical significance for the variable at 0.01 level of significance.

Table 5.27: Independent sample t-test for and descriptive statistics for the number of IPOs.

Number of IPOs per month (No IPO)	
Sample size	180
t-stat	-13.594242
Degrees of freedom	179
sig. (2-tailed)	0.0000*
Mean	5.6
Standard error	0.425272
Median	4
Mode	0
Standard deviation	5.705628
Sample Variance	32.55419
min	0
max	27

Table 5.28 present the summary statistics for the selected explanatory variables and table 5.29 shows their correlation matrix. Results of the anova test for the explanatory variables show statistical significance (*F-ratio* value of 486.04 with critical *F-ratio* of 3.01).

Table 5.28: Descriptive statistics for the explanatory variables for market timing.

Variable	*Sample size*	*Mean*	*St.err*	*Median*	*Std. Dev*	*Min*	*Max*
IPO underpricing (UP)	180	0.17	0.01	0.15	0.18	-0.44	1.11
Market Returns (MR_{FTSE})	180	0.29	0.01	0.24	0.16	0.11	1.14
Market Volatility (ΔMV_{FTSE})	180	6.16	0.26	4.93	3.47	2.49	23.28

Table 5.29: Correlation matrix for the explanatory variables for market timing.

	IPO underpricing (UP)	*Market Returns (MR_{FTSE})*	*Market Volatility (ΔMV_{FTSE})*
IPO underpricing (UP)	1		
Market Returns (MR_{FTSE})	-0.18	1	
Market Volatility (ΔMV_{FTSE})	-0.16	0.94	1

The results of the multivariate regression analysis presented in table 5.30 indicate statistical significance for the level of IPO underpricing and marginal significance for the market volatility variables. The level of IPO underpricing is positively related to the number of IPOs in the subsequent month, suggesting that the increase in the number of IPOs is influenced by the level of previously observed underpricing on the market. Market volatility variable has a negative relationship with the level of underpricing indicating that higher market volatility leads to lower number of IPOs. Market returns seem to have no impact on the number of IPO transactions.

Table 5.30: Regression Results for Market Timing (R sq. = 0.23, adjusted R sq. = 0.22)

Dependent Variable - Number of IPOs (No IPO)					
	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Significance****
Intercept	8.718	0.924	9.434	0.000	
IPO underpricing (UP)	6.120	2.151	2.846	0.005	**significant**
Market Returns (MR_{FTSE})	-2.327	6.917	-0.336	0.737	insignificant
Market Volatility (ΔMV_{FTSE})	-0.539	0.323	-1.666	0.098	**significant**

*The results are significant at the 0.05 level of significance

Therefore, for the specified sample and the time period for the UK based IPOs , the number of IPO transactions on the market tends to be influenced by the previously observed level of IPO underpricing and the change in the market conditions. The summary of the results for the hypothesis testing is presented in the table 5.31.

Table 5.31: Results of the hypotheses testing for market timing.

H	Hypothesis	Statistical Relationship	Result
H_8:	There is a positive relationship between the stock market index returns and the number of IPOs.	Negative, insignificant	Not accepted
H_9:	There is a negative relationship between the market volatility and the number of IPOs.	Negative, significant	Accepted
H_{11}:	There is a positive relationship between IPO underpricing and the number of IPOs.	Positive, significant	Accepted

5.3.2 Research Question 3b: What are the potential factors initiating an IPO wave?

Research question 3b examines the evidence in relation to the formation of a wave and the development of its cycle. Eight factors potentially influencing the formation of a wave have been identified. They are: (i) size of the company at the time of IPO (SIZE), (ii) offer price (PENNY), (iii) level of the first day IPO mispricing (UP), (iv) use of an underwriter (UW), and (v) reputation of the employed underwriter (UWrank), (vi) offer type (OT), (vii) market type (MT), (viii) industry sector (SECTOR).

Table 5.32 provides the descriptive statistics for the probability of an IPO being in or out of a wave (dependent variable). For the descriptive statistics for the explanatory variables see section 5.1.3 RQ 1c, (table 5.9 and 5.10).

Table 5.32: Descriptive statistics for the probability of an IPO being in a wave.

IPOs being in or out of a wave (WAVE)	
Sample size	1031
Mean	0.84
Standard error	0.01
Median	1
Mode	1
Standard deviation	0.37
Sample Variance	0.14
min	0
max	1

Table 5.33 present the correlation matrix. As the table indicates, the selected variables are uncorrelated with each other. Results of the anova test for the explanatory variables show statistical significance (*F-ratio* value of 261.81 with critical *F-ratio* 2.1).

Table 5.34 and 5.35 present the results of the multivariate probit regression analysis for the factors influencing the probability of an IPO being in or out of a wave. Table 5.8 shows results for all IPOs in the sample, while table 5.9 shows the results for the multivariate regression with the underwritten IPOs only.

Table 5.33: Explanatory variables correlation matrix for the probability of an IPO being in a wave.

	Underpricing (UP)	Use of an Underwriter (UW)	Company Size (VALUE)	Offer Price (PENNY)	Market Type (MT)	Offer Type OT MIXED	Offer Type OT INTERNATIONAL	*Consumer Products & Services*	*Consumer Staples*	*Energy & Power*	*Healthcare*	*High Technology*	*Industrials*	*Materials*	*Media & Entertainment*	*Real Estate*	*Retail*	*Telecommunications*
Underpricing (UP)	1																	
Use of an Underwriter (UW)	-0.13	1																
Company Size (VALUE)	-0.27	0.12	1															
Offer Price (PENNY)	0.10	-0.06	-0.34	1														
Market Type (MT)	-0.07	-0.10	0.55	-0.34	1													
Offer Type OT MIXED	-0.06	0.04	0.12	0.00	0.12	1												
Offer Type OT INTERNATIONAL	-0.10	0.05	0.47	-0.28	0.46	-0.09	1											
Consumer Products & Services	0.05	0.07	-0.08	0.07	-0.07	-0.04	-0.06	1										
Consumer Staples	0.06	-0.02	-0.02	0.04	-0.01	0.09	0.00	-0.05	1									
Energy & Power	-0.02	0.00	0.03	-0.07	-0.02	0.03	-0.01	-0.10	-0.05	1								
Healthcare	-0.02	0.04	0.00	0.02	-0.02	-0.03	-0.02	-0.10	-0.04	-0.08	1							
High Technology	-0.01	0.02	-0.02	0.01	-0.05	0.02	-0.03	-0.13	-0.06	-0.12	-0.12	1						
Industrials	-0.05	0.00	0.00	-0.01	-0.02	-0.03	0.01	-0.09	-0.04	-0.08	-0.07	-0.11	1					
Materials	-0.02	-0.06	-0.11	0.01	-0.09	-0.04	-0.06	-0.11	-0.05	-0.09	-0.09	-0.13	-0.08	1				
Media & Entertainment	0.01	0.05	-0.04	0.01	-0.07	0.00	-0.06	-0.09	-0.04	-0.08	-0.08	-0.11	-0.07	-0.08	1			
Real Estate	-0.01	0.01	0.05	0.02	0.04	-0.03	0.05	-0.07	-0.03	-0.07	-0.06	-0.09	-0.06	-0.07	-0.06	1		
Retail	-0.01	0.06	0.12	-0.01	0.07	0.01	0.10	-0.07	-0.03	-0.07	-0.07	-0.09	-0.06	-0.07	-0.06	-0.05	1	
Telecommunications	-0.02	-0.01	-0.04	0.05	-0.02	0.03	-0.08	-0.06	-0.03	-0.05	-0.05	-0.07	-0.04	-0.06	-0.05	-0.04	-0.04	1

Table 5.34: Regression results for the probability of an IPO being in a wave (all IPOs).

WAVE = $\alpha + \beta_1(UP) + \beta_2(UW) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(International) + \gamma_2(Mixed) + \rho_1(Consumer\ Product\ \&\ Services) + \rho_2(Energy\ \&\ Power) + \rho_3(Financials) + \rho_4(Healthcare) + \rho_5(High\ Technology) + \rho_6(Industrials) + \rho_7(Materials) + \rho_8(Media\ \&\ Entertainment) + \rho_9(Real\ Estate) + \rho_{10}(Retail) + \rho_{11}(Telecommunications) + \varepsilon$

Underpricing (UP) – abnormal first day returns. There is a positive relationship between UP and WAVE, i.e. probability of an IPO being within a wave increases with higher underpricing.
Use of an Underwriter (UW) - firms that employ an underwriter are coded as 1, others 0. There is a positive relationship between UW and WAVE, i.e. probability of an IPO being within a wave increases for the underwritten IPOs.
Company Size (VALUE) - log of the total number of shares offered at the IPO multiplied by the offering price. There is a negative relationship between VALUE and WAVE, i.e. probability of an IPO being within a wave decreases as the company size increases.
Offer Price (PENNY) - stock with offer price less than 3.00 are coded as penny stocks equal to 1, others are coded as 0. There is a positive relationship between PENNY and WAVE, i.e. probability of an IPO being within a wave increases for penny socks, companies with lower offer price.
Market Type (MT) - AIM IPOs are coded as 0, MM as 1. There is a negative relationship between MT and WAVE, i.e. probability of an IPO being within a wave decreases for Main Market IPOs.
Offer Type (OT) - national IPOs are coded as the base/reference group. There is a positive relationship between OT and WAVE, i.e. probability of an IPO being within a wave increases for the international and mixed IPOs.
Industry (SECTOR) - IPOs in 'Consumer Staples' sector are coded as the base/reference group. There is a negative relationship between SECTOR and WAVE, i.e. probability of an IPO being within a wave decreases for IPOs in sectors other than the 'Financials'.

Variable code	*Coefficients*	*St. err*	*t-stat*	*P-value*	*Significance**
Intercept	-0.918	0.572	-1.610	0.108	
Underpricing (UP)	0.005	0.002	2.830	**0.005**	**significant**
Use of an Underwriter (UW)	0.016	0.174	0.090	0.928	insignificant
Company Size (VALUE)	0.282	0.073	3.880	**0.000**	**significant**
Offer Price (PENNY)	0.019	0.195	0.100	0.923	insignificant
Market Type (MT)	-0.456	0.133	-3.420	**0.001**	**significant**
Offer Type (OT Mixed)	-0.667	0.396	-1.680	**0.092**	**marginally significant**
Offer Type (OT International)	-0.380	0.120	-3.150	**0.002**	**significant**
Consumer Products & Services	0.227	0.192	1.180	0.238	insignificant
Consumer Staples	0.804	0.456	1.760	**0.078**	**marginally significant**
Energy & Power	-0.274	0.182	-1.510	0.132	insignificant
Healthcare	0.026	0.197	0.130	0.894	insignificant
High Technology	0.454	0.178	2.550	**0.011**	**significant**
Industrials	0.050	0.210	0.240	0.813	insignificant
Materials	-0.216	0.174	-1.240	0.216	insignificant
Media & Entertainment	0.157	0.221	0.710	0.477	insignificant
Real Estate	0.319	0.255	1.250	0.212	insignificant
Retail	0.332	0.255	1.300	0.193	insignificant
Telecommunications	1.007	0.470	2.140	**0.032**	**significant**

*The results are significant at the 0.05 level of significance

Table 5.35: Regression results for the probability of an IPO being in a wave (underwritten IPOs only).

WAVE = $\alpha + \beta_1(UP) + \beta_2(UWrank) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(Mixed) + \gamma_2(International) + \rho_1(Consumer\ Product\ \&\ Services) + \rho_2(Energy\ \&\ Power) + \rho_3(Financials) + \rho_4(Healthcare) + \rho_5(High\ Technology) + \rho_6(Industrials) + \rho_7(Materials) + \rho_8(Media\ \&\ Entertainment) + \rho_9(Real\ Estate) + \rho_{10}(Retail) + \rho_{11}(Telecommunications) + \varepsilon$

Underwriter reputation (UW rank) - prestigious underwriters (who subscribed 16 and more IPOs) are coded as 1, other s are 0. There is a positive relationship between UWrank and WAVE, i.e. probability of an IPO being within a wave increases for the IPOs with prestigious underwriters.

Variable code	*Coefficients*	*St. err*	*t-stat*	*P-value*	*Significance**
Intercept	-0.993	0.614	-1.620	0.106	
Underpricing (UP)	0.004	0.002	2.220	0.026	**significant**
Underwriter Reputation (UW rank)	0.146	0.107	1.360	0.174	insignificant
Company Size (VALUE)	0.294	0.081	3.620	0.000	**significant**
Offer Price (PENNY)	0.047	0.200	0.240	0.813	insignificant
Market Type (MT)	-0.410	0.145	-2.830	0.005	**significant**
Offer Type (OT Mixed)	-0.815	0.396	-2.060	0.039	**significant**
Offer Type (OT International)	-0.491	0.129	-3.820	0.000	**significant**
Consumer Products & Services	0.162	0.198	0.820	0.415	insignificant
Consumer Staples	0.667	0.484	1.380	0.168	insignificant
Energy & Power	-0.310	0.193	-1.610	0.108	insignificant
Healthcare	-0.058	0.205	-0.280	0.777	insignificant
High Technology	0.464	0.192	2.410	0.016	**significant**
Industrials	-0.096	0.220	-0.440	0.663	insignificant
Materials	-0.340	0.188	-1.810	0.070	**marginally significant**
Media & Entertainment	0.071	0.226	0.310	0.754	insignificant
Real Estate	0.179	0.264	0.680	0.499	insignificant
Retail	0.266	0.260	1.020	0.306	insignificant
Telecommunications	0.856	0.491	1.740	0.081	**marginally significant**

*The results are significant at the 0.05 level of significance

Results of the probit regression for the full sample show statistical significance for the level of IPO underpricing, company size, type of IPO offer, type of IPO market, and for the certain industry sector variables. The company size variable shows positive relationship with the probability of an IPO being in a wave. This contradicts the expected relationship (and the hypothesis that bigger companies have their IPOs outside of an IPO wave) for this variable. This result is similar for the underwritten IPOs. Offer price variable shows insignificant relationship for both cases (all IPOs and underwritten only IPOs) suggesting that penny stocks are as likely to be outside of a wave as within it. However, the level of IPO underpricing is a significant factor for all IPOs as well as for the underwritten only IPOs. The relationship is positive in both cases, as ecpected, indicating that higher underpricing happens within IPO waves. .

‘Use of an underwriter’ and ‘reputation of the employed underwriter’ variables (for the underwritten IPOs) display insignificant relationship for all IPOs. This suggests that probability of an IPO being within a wave does not depend on hiring an underwriter. Offer type variables show significant influence on the probability of an IPO being within a wave in both cases. The relationship with the dependent variable is negative indicating that more IPO waves tend to happen in national type of offers rather than in international and mixed IPO offers. The type of market variable shows statistical significance in both cases. The relationship is negative indicating strong evidence that more IPO waves tend to happen on the AIM. Industry variable shows statistical significance in both cases for certain industries. For all IPOs ‘Consumer Staples’, ‘High Technology’ and ‘Telecommunications’ sectors show statistical significance and indicate a positive relationship. For the underwritten IPOs only, ‘High Technology’, ‘Materials’ and the ‘Telecommunications’ sectors show statistical significance with positive relationship for the ‘High Technology’ and the ‘Telecommunications’ sectors and negative for the ‘Materials’ sector. As argued earlier, the nature of the industry and the industry specific characteristics can be the determining factors for an IPO being within a wave.

Therefore, for the specified sample and the time period for the UK based IPOs, factors influencing the probability of an IPO being within a wave are IPO underpricing, company size, market type, type of IPO offer and the industry of an IPO. IPO waves pertain to national type of offers, compared to mixed and international IPOs and tend to happen more often on the AIM, compared to the Main Market. The summary of the results for the hypothesis testing is presented in the table 5.36

Table 5.36: Results of the Hypotheses testing for the probability of an IPO being within a wave.

H	Hypothesis	Statistical Relationship	Result
H_{11}:	There is a negative relationship between company size and the probability of an IPO being within a wave.	Positive, significant	Not accepted
H_{12}:	There is a positive relationship between offer price and the probability of an IPO being within a wave.	Positive, insignificant	Not accepted
H_{13}:	There is a positive relationship between IPO underpricing and the probability of an IPO being within a wave.	Positive, significant	Accepted
H_{14}:	There is a positive relationship between use of an underwriter and the probability of an IPO being within a wave.	Positive, insignificant	Not accepted
H_{15}:	There is a positive relationship between UWrank and the probability of an IPO being within a wave.	Positive, insignificant	Not accepted
H_{16}:	There is a positive relationship between offer type and the probability of an IPO being within a wave.	Negative, significant	Not accepted
H_{17}:	There is a negative relationship between market type and the probability of an IPO being within a wave.	Negative, significant	Accepted
H_{18}:	There is a negative relationship between industry sector and the probability of an IPO being within a wave.	Negative, insignificant	Not Accepted

5.3.3 Research Question 3c: What are the characteristics of pioneering IPOs?

Question 3c looks at the characteristics of the pioneering IPOs. The probability of an IPO being a pioneering IPO (early mover) has been examined through the influence of the same potential factors. Table 5.37 provides the descriptive statistics for the IPO being a pioneering IPO (dependent variable).For the descriptive statistics for the explanatory variables see section 5.1.3 RQ 1c**,** (table 5.9 and 5.10). For correlation matrix and anova see section 5.3.2 (table 5.33).

Table 5.37: Descriptive statistics for the probability of an IPO being a pioneering IPO.

Probability of an IPO being a pioneering IPO	
Sample size	1031
Mean	0.17
Standard error	0.01
Median	0
Mode	0
Standard deviation	0.37
Sample Variance	0.14
min	0
max	1

Table 5.38 and 5.39 present the results of the multivariate probit regression analysis for the factors influencing the probability of an IPO being a pioneering IPO. Table 5.38 shows results for all IPOs in the sample, while table 5.39 shows the results for the multivariate probit regression for the underwritten IPOs only.

Table 5.38: Regression Results for the probability of an IPO being a pioneering IPO (all IPOs)

PIONEER = $\alpha + \beta_1(UP) + \beta_2(UW) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(International) + \gamma_2(Mixed) + \rho_1$(Consumer Product & Services) + ρ_2(Energy & Power) + ρ_3(Financials) + ρ_4(Healthcare) + ρ_5(High Technology) + ρ_6(Industrials) + ρ_7(Materials) + ρ_8(Media & Entertainment) + ρ_9(Real Estate) + ρ_{10}(Retail) + ρ_{11}(Telecommunications) + ε

Underpricing (UP) – abnormal first day returns. There is a negative relation between UP and PIONEER, i.e. early movers have lower underpricing.
Use of an Underwriter (UW) - firms that employ an underwriter are coded as 1, others 0. There is a positive relationship between UW and PIONEER, i.e. early movers employ an underwriter.
Company Size (VALUE) - log of the total number of shares offered at the IPO multiplied by the offering price. There is a positive relationship between VALUE and PIONEER, i.e. early movers are larger firms.
Offer Price (PENNY) - stock with offer price less than 3.00 are coded as penny stocks equal to 1, others are coded as 0. There is a negative relationship between PENNY and PIONEER, i.e. early movers have higher offer price.
Market Type (MT) - AIM IPOs are coded as 0, MM as 1. There is a positive relationship between MT and PIONEER, i.e. early movers are Main Market IPOs.
Offer Type (OT) - national IPOs are coded as the base/reference group. There is a negative relationship between OT and PIONEER, i.e. early movers are national IPOs.
Industry (SECTOR) - IPOs in 'Consumer Staples' sector are coded as the base/reference group. There is a negative relationship between SECTOR and PIONEER, i.e. early movers are more often 'Financials' sector's IPOs.

Variable code	***Coefficients***	***St. err***	***t-stat***	***P-value***	***Significance****
Intercept	-0.047	0.574	-0.080	0.935	
Underpricing (UP)	-0.001	0.001	-0.710	0.480	insignificant
Use of an Underwriter (UW)	0.142	0.176	0.810	0.419	insignificant
Company Size (VALUE)	-0.072	0.071	-1.020	0.310	insignificant
Offer Price (PENNY)	-0.302	0.219	-1.380	0.168	insignificant
Market Type (MT)	0.134	0.142	0.940	0.346	insignificant
Offer Type (OT Mixed)	0.522	0.360	1.450	0.147	insignificant
Offer Type (OT International)	-0.667	0.139	-4.810	**0.000**	**significant**
Consumer Products & Services	-0.274	0.189	-1.450	0.148	insignificant
Consumer Staples	0.427	0.293	1.460	0.145	insignificant
Energy & Power	-0.467	0.220	-2.120	**0.034**	**significant**
Healthcare	-0.370	0.216	-1.710	**0.088**	**marginally significant**
High Technology	-0.042	0.158	-0.260	0.791	insignificant
Industrials	-0.293	0.229	-1.280	0.202	insignificant
Materials	0.002	0.180	0.010	0.991	insignificant
Media & Entertainment	-0.049	0.207	-0.240	0.812	insignificant
Real Estate	0.279	0.222	1.260	0.208	insignificant
Retail	-0.310	0.270	-1.150	0.250	insignificant
Telecommunications	-0.079	0.280	-0.280	0.776	insignificant

*The results are significant at the 0.05 level of significance

The results for the probit regression for all IPOs indicate statistical significance for the type of offer for international IPOs and for two industries, 'Healthcare' and 'Energy and Power'.

The relationships with the dependent variable is negative suggesting that early movers are more often national type of IPO offers compared to international and pertain more often to ‘Energy and Power’ and ‘Healthcare’ industries compared to ‘Financials’ for the specified sample and time period. The rest of the identified variables have no influence on the probability of an IPO being a pioneering IPO.

Table 5.39: Regression Results for the probability of an IPO being a pioneering IPO (underwritten IPOs).

PIONEER = $\alpha + \beta_1(UP) + \beta_2(UWrank) + \beta_3(VALUE) + \beta_4(PENNY) + \beta_5(MT) + \gamma_1(Mixed) + \gamma_2(International) + \rho_1(Consumer\ Product\ \&\ Services) + \rho_2(Energy\ \&\ Power) + \rho_3(Financials) + \rho_4(Healthcare) + \rho_5(High\ Technology) + \rho_6(Industrials) + \rho_7(Materials) + \rho_8(Media\ \&\ Entertainment) + \rho_9(Real\ Estate) + \rho_{10}(Retail) + \rho_{11}(Telecommunications) + \varepsilon$

Underwriter reputation (UW rank) - prestigious underwriters (who subscribed 16 and more IPOs) are coded as 1, other s are 0. There is a positive relationship between UWrank and PIONEER, i.e. early movers have underwriters with higher ranking.

Variable code	*Coefficients*	*St. err*	*t-stat*	*P-value*	*Significance**
Intercept	0.684	0.594	1.150	0.249	
Underpricing (UP)	-0.002	0.002	-1.090	0.274	insignificant
Underwriter Reputation (UWrank)	0.262	0.106	2.460	**0.014**	**significant**
Company Size (VALUE)	-0.173	0.078	-2.240	**0.025**	**significant**
Offer Price (PENNY)	-0.336	0.223	-1.510	0.132	insignificant
Market Type (MT)	0.210	0.153	1.370	0.170	insignificant
Offer Type (OT Mixed)	0.557	0.363	1.530	0.125	insignificant
Offer Type (OT International)	-0.579	0.145	-4.000	**0.000**	**significant**
Consumer Products & Services	-0.276	0.193	-1.430	0.152	insignificant
Consumer Staples	0.348	0.317	1.100	0.273	insignificant
Energy & Power	-0.605	0.243	-2.490	**0.013**	**significant**
Healthcare	-0.374	0.220	-1.700	**0.090**	**marginally significant**
High Technology	-0.112	0.167	-0.670	0.501	insignificant
Industrials	-0.284	0.237	-1.200	0.231	insignificant
Materials	-0.036	0.194	-0.180	0.854	insignificant
Media & Entertainment	-0.050	0.212	-0.230	0.814	insignificant
Real Estate	0.226	0.232	0.970	0.330	insignificant
Retail	-0.336	0.273	-1.230	0.219	insignificant
Telecommunications	-0.184	0.299	-0.620	0.538	insignificant

*The results are significant at the 0.05 level of significance.

The results are different, however, when the use of an underwriter is considered. For the underwriter only IPOs, company size, reputation of the employed underwriter, international type of offer and certain industries show statistical significance. The variable for the company size, however, displays a negative relationship with the probability of being a pioneering IPO suggesting that smaller companies tend to be among early movers in an IPO wave. The international type of offer variable shows negative relationship with the dependent variable indicating that for the underwritten IPOs early movers pertain to national type of IPO offers compared to international. Reputation of the employed underwriter shows positive relationship with the probability of being an early mover as was previously expected. This suggests that once the decision to employ an underwriter has been made, the reputation of the employed underwriter and the choice between the type offers plays a significant role. Pioneering IPOs tend to employ underwriters with higher reputation and pertain to national type of offer (offering shares to local investors) and certain industries. The summary of the results for the hypothesis testing for the probability of an IPO being a pioneering IPO is presented in the table 5.40.

Table 5.40: Results of the Hypotheses testing for the probability of an IPO being a pioneering IPO.

H	Hypothesis	Statistical Relationship	Result
H_{19}:	Probability of an IPO being a pioneering IPO is positively related to company size, i.e. early movers are larger firms.	Negative, significant	Not accepted
H_{20}:	Probability of an IPO being a pioneering IPO is negatively related to offer price, i.e. early movers have higher offer price.	Negative, insignificant	Not accepted
H_{21}:	Probability of an IPO being a pioneering IPO is negatively related to underpricing, i.e. early movers have lower underpricing.	Negative, insignificant	Not accepted
H_{22}:	Probability of an IPO being a pioneering IPO is positively related to underwriter, i.e. early movers employ an underwriter.	Negative, insignificant	Not accepted
H_{23}:	Probability of an IPO being a pioneering IPO is positively related to the reputation of the employed underwriter, i.e. early movers have underwriters with higher ranking.	Positive, significant	Accepted
H_{24}:	Probability of an IPO being a pioneering IPO is negatively related to offer type, i.e. early movers are national IPOs.	Negative, significant	Accepted
H_{25}:	Probability of an IPO being a pioneering IPO is positively related to market type, i.e. early movers are Main Market IPOs.	Positive, insignificant	Not accepted
H_{26}:	Probability of an IPO being a pioneering IPO is negatively related to industry sector, i.e. early movers are more often 'Financials' sector's IPOs.	Negative, insignificant	Not accepted

5.4 Chapter Summary

Chapter five outlines the key results of this study pertaining to the performance of IPOs in the UK during the period from January 1984 to December 2016. The short-term IPO mispricing, the aftermarket performance, and the potential factors influencing the initial mispricing, are examined on the sub-sample of 1008 UK-based companies that had their IPO during the period from January 2002 to December 2016.

The levels of IPO mispricing are examined according to the different types of market used for an IPO (AIM versus MM) and in relation to the type of offer, national only, mixed, and international offers. The total average level of underpricing is 19 percent and is mainly due to the performance of IPOs on the AIM market with average underpricing of 21 percent. The aftermarket performance of IPOs is measured as CAR and is presented for different types of offers. The abnormal aftermarket returns are measures for one, three and six months following the date of the IPO. Both the short-term and the aftermarket performance are reported for different industry sectors.

The potential factors influencing the levels of initial mispricing are the size of the company, the use of an underwriter, the market type and the industry sector. The factors are examined through multivariate regression analysis for the first day.

The investigation of the IPO waves in the UK is based on the full sample and follows the methodology of Carow *et al.* (2004) and McNamara and Haleblian (2008), adopted from the mergers and acquisition markets. The waves are presented in relation to the different types of offers and for different time periods, yearly, quarterly and monthly. The dynamic in the IPO activity is also examined in different industry sectors. The industries more prone to IPO waves are also presented. The seasonality in the formation of IPO waves is highlighted.

The formation of IPO waves has been studied through the market timing argument and also in relation to the potential factors facilitating its formation. The possible characteristics of the early movers or pioneering IPOs have also been addressed. According to the findings, IPO volumes show a positive lead-lag relationship with the level of IPO underpricing and are negatively related to past changes in market volatility.

The potential factors facilitating the formation of an IPO wave investigated in this research are the size of the company at the time of IPO, the level of IPO underpricing, the type of offer, the type of market used for the IPO, and the industry sector..

The characteristics of pioneering IPOs include the type of offer, the size of a firm at the time of IPO, and the reputation of the employed underwriter. Pioneering IPOs tend to employ underwriters with higher reputation and pertain to national type of offer. The variable for the firm size, however, suggests that smaller companies tend to be among the early movers in an IPO wave. The influence of the identified factors is examined though probit multivariate regression analysis.

Overall the chapter presents the changing nature of IPO performance and draws attention to the differences in IPO performance for different types of offers depending on the overall prevailing market conditions in the country of origin. It also points to the seasonality present in the formation and dislodgement of IPO waves and highlights the role of industry characteristics, IPO mispricing, type of offer and type of market used for the IPO, and the reputation of the employed underwriter in facilitating a wave.

Chapter 6

DISCUSSION

> "Bull markets are born on pessimism, grow on scepticism, mature on optimism and die of euphoria."
>
> John Templeton

CHAPTER SIX – DISCUSSION

The chapter presents the discussion of the empirical findings of the research. The layout of the chapter follows the research questions. Section 6.1 provides a discussion of IPO mispricing in the UK. It also discusses the aftermarket performance of IPOs and the findings of the regression analysis used to investigate the possible factors influencing IPO mispricing. Section 6.2 discusses the evidence of IPO waves in UK, the time of their occurrence and seasonal patterns. It also looks at the industry conditions that facilitate the creation of IPO waves. Section 6.3 focuses on the potential factors initiating an IPO wave and the influence of pioneering IPOs on later movers.

6.1 Research Question 1: What is the performance of IPOs in the UK and what are the potential factors influencing it?

The first question of the research examines the short-term and aftermarket performance of IPOs in the UK market. It looks initially at the existing levels of IPO underpricing in the UK, followed by the examination of the aftermarket performance of IPOs and concludes with the investigation of the potential factors affecting the level of IPO underpricing.

6.1.1 Research question 1a: Is there evidence of IPOs underpricing in the UK?

Question 1a examines the levels of IPO underpricing in the UK in 2002-2016, a period including the pre-financial crisis, the crisis, and the post-crisis years. The total average level of underpricing is 19 percent. This finding is line with the previous research. For example, Ritter (2011) reports that initial underpricing of IPOs in USA for 1960-2011 average level was 16.8 per cent, in the UK in 1959-2010 the levels were at 16.2 per cent, and in France had 10.5 per cent on average for 1983-2010. In general, the evidence of underpricing in the UK is supported by robust evidence (Keasey and McGuinness, 1992; Byrne and Rees, 1994; Dewenter and Malatesta, 1997) and confirmed by the findings of this study. The high overall average level of underpricing is mainly due to the performance of IPOs on the AIM market with average underpricing of 21 percent. The AIM market is a more active compared to the Main Market; 69 percent of the companies in the sample had their IPOs on the AIM market while only 21 percent of companies chose to have their IPO on the Main Market.

The underpricing in the pre-crisis and early post-crisis years is driven primarily by the AIM IPOs; the levels of IPO underpricing on the Main Market show a gradual increase between 2002 and 2008 and a sharp decline during the early post-crisis years before increasing again by 2014. The highest level of IPO underpricing is seen in the crisis years of 2008-2009. This level is substantially higher than in other periods and the increase is significant for both UK markets.

There is significant difference in the overall average levels of IPO mispricing between the different types of offer. The overall average level of IPO underpricing for national offers is 22 percent, while for international offers it is 14 percent and only eight percent for the mixed offer. This difference is even more evident for different periods. The level of IPO underpricing is quite high for national offers throughout the period with the highest underpricing of 99 percent in 2008. It remains quite high through the rest of the period, except for 2015 when national IPOs show overpricing of 15 percent. The international offers experience high underpricing in 2006-2008 the years immediately preceding the crisis, while during the crisis years and in the post-crisis period it drops significantly and remains relatively low for this type of offer. This suggests that independently of the offer type the pricing of an IPO is largely driven by the existing market conditions and the prevailing investor sentiment.

The findings indicate that the highest level of IPO underpricing is seen in the national only type of offering and even during the economic boom years, when all three types of IPO offerings are being used by the companies and the underwriters, the levels of IPO mispricing for the local offering are substantially higher than for the mixed offers and the international offers. This suggests that underpricing is potentially used as an incentive to attract investors, especially for the local issues. Since the national only offers are distributed locally to investors that find it easier to communicate with each other and gather information than investors on wider international markets, underpricing can entice investors to buy into the issue. This finding also explains the lower level of IPO underpricing for the mixed and the international only offerings, as the need for an incentive is greatly reduced with the geographical dispersion of the investor base.

According to the findings, underpricing is different in different industry sectors. Two sectors stand out from the rest showing the highest underpricing during the specified period, the ‘Consumer Staples’ and the ‘Financials’ sectors. The high levels of underpricing in the

‘Consumer Staples’ sector may be explained by the noncyclical nature of the demand for the products of this sector. The sector is composed of companies whose primary lines of business are food, beverages, tobacco and other household items. Unlike other areas of the economy, even during economically slow times, the demand for the products made by ‘Consumer Staples’ companies does not slow down. Some staples, like discount foods, liquor and tobacco see increased demand during slow economic times.

As for the ‘Financials’ sector, the deregulation of the sector can potentially explain the high levels of underpricing. Following the deregulation of the sector, a lot of innovative products and new financial instruments were introduced to the market. Some of these products were not of the high standard and quality traditionally required by the industry. As a result, the introduction of these products and instruments and their subsequent sale to the investors required some incentive to encourage the confidence of investors and their interest. Hence, the underpricing has played substantial role in promoting the firm and creating the high demand for its shares.

One of the reasons for changing levels of IPO underpricing may be due to the global financial crisis. The effects of the crisis have been also reflected in the number of IPOs. Another reason for the reduced level of IPO underpricing may be the fact that investors are becoming more selective in their investment choices. Investors’ perceptions of the valuation of IPOs are also changing. The financial industry could serve as one example of the changing investor perceptions. The findings suggest that investors are becoming more realistic in their valuations of IPOs. They are focusing more on the future perspectives that the company has to offer rather than a ‘great investment story’.

Another reason that IPO underpricing is changing is the fact that investors are becoming disenchanted with IPO markets. The argument brought forward by Kay (2012) states that larger companies are becoming more and more self-financing and do not view equity markets as an important source of capital. They raise money through internal financing or through mergers and acquisitions rather than IPOs. The IPO market is increasingly used by smaller firms to raise finance.

Thus, there is an apparent reduction in the levels of mispricing in the UK meaning that the use of underpricing as an initial discount offered to motivate investors is not as efficient as it used to be.

6.1.2 Research question 1b: What is the aftermarket performance of IPOs in the UK and what are the potential factors influencing it?

Question 1b examines the immediate aftermarket performance of IPOs in the UK in 2002-2016. Aftermarket performance of IPOs in the UK is measured as CARs for the share price at the end of the first, third, and the sixth month of trading. The high volatility in the share price following the IPO is associated with information asymmetry between issuers and investors. As the share price adjusts according to investors' perceptions of the firm, the IPO either outperforms or underperforms the market.

The findings suggest that on average IPOs outperform the market by 56 percent at the end of the first month of trading, 54 percent at the end of the third month and by 46 percent at the end of the sixth month. The average level of outperformance is similar and consistent across all three types of offers. However, the spread in abnormal returns depends on the type of the IPO offer. The results for the abnormal returns show IPO underperformance for the international offers in 2009 for the third and the sixth months of trading and for the national offers in 2015 for all three periods. This underperformance for both offers increases by the sixth month of trading.

An interesting observation is that the three months' abnormal returns generally follow the trend of the first month without much deviation in the levels; while the sixth month's abnormal returns develop their own pattern. This finding confirms that the biggest adjustment in the price of an IPO happens around the sixth month of trading or around the 180 days mark.

This difference in the abnormal returns between the first and the sixth months is even more obvious for the international type of offers, suggesting higher information asymmetry between the issuers/underwriters and the investors. This geographical dispersion of the investor base is deliberately pursued by the underwriters (Welch, 1992). This suggestion is in line with the findings of the previous section indicating that during the crisis and post-crisis periods the prevailing type of offering is the international type of offering indicating the move by the issuers and the underwriters from the local market to the larger international market, where investors are geographically too far away from each other to be able to gather information quickly and accurately.

The highest outperforming sector is the ‘High Technology’ sector for all three periods, followed by the ‘Consumer Staples’ and the ‘Consumer Product and Services’ sectors for the first and the third months of trading. The ‘High Technology’ sector is an innovative and research driven industry, the investment in this sector is not driven mainly by the fundamentals as by the opportunity, excitement and entrepreneurialism. The latter two sectors are characterised by the stable demand for their products ensuring higher abnormal returns.

Abnormal returns broken by the industry sectors show the same trend for the highest adjustment of the share price around the sixth month of trading. For the majority of industries the sixth month returns follow a different pattern when compared to the returns of the first and the third month of trading that generally coincide with each other. Two interesting cases are presented by the ‘Financials’ and the ‘Energy and Power’ sectors.

In the ‘Financials’ sector, unlike in other sectors, the six months’ abnormal returns do not deviate substantially from the first and the third months’ trends and there is no drop in he returns during the crisis years observed in other industries. Does this suggest fair pricing or more trust in the products and the new financial instruments introduced in the sector following the deregulation? Or maybe investor confidence comes from the “too big to fail” belief, knowing that governments’ bailing out of banks and guaranteeing the deposits across Europe (as opposed to the USA, for example) secured the investments in the sector?

The abnormal returns in the ‘Energy and Power’ sector follow different unpredictable and uncorrelated with each other patterns for the first, the third and the sixth months. This poses a question of pricing of new offers in the industry. It seems that the pricing of the shares is completely unrelated to their true value. Such irregular dynamic of the returns in the ‘Energy and Power’ sector can be explained by the changing nature of the sector. The UK’s power is generated by a number of different sources, from oil, gas and nuclear power stations to renewable wind, solar and hydro energy sources and biomass and micro-renewable technologies. There is high uncertainty about the future development of the sector as several changes are occurring simultaneously. Besides the global trends of decarbonisation, decentralisation, vehicle electrification and energy access that affect the sector, the interaction between technological, economic and political forces is also catalysing its transformation (Deloitte, 2016).

Aftermarket performance of IPOs also shows a trend different to the findings of previous research. The fact that in the first six months following the IPO date new issues continue to outperform the market suggests that the initial pricing is correct in the sense that it incorporates all the available information about the firm. It indicates high demand for the stock and little change in investors’ perception of IPO during the first trading month. However, the decrease in the level of outperformance over the six months is significant (from 56 to 46 percent) suggesting higher volatility in the share price and a significant change in investors’ perception of the IPOs. This result is particularly evident in the international IPOs where information asymmetry is prominent. This trend to the reduction in the level of outperformance points to the idea that the offer price adjusts in the long run and new issues will potentially underperform the market in the long term. Further research is required to determine this. As suggested by previous research, probability of underperformance increases with firms that have the short operating histories, low sales, low-prestige underwriters, low institutional ownership, high volatility, high underpricing at the time of issuance, listing on regional exchanges, and operate in certain newer industries.

6.1.3 Research question 1c: What are the factors influencing IPO mispricing in the UK?

Research question 1c examines the potential factors influencing IPO mispricing in the UK. The factors include: (i) company size at the time of the IPO (VALUE), (ii) offer price (PENNY), (iii) use of an underwriter, (vi) reputation of the employed underwriter (UWrank), (v) type of offer (OT): national, international or mixed IPO, (vi) type of market (MT): AIM or Main Market, and (vii) industry sector (SECTOR). The chosen factors refer to information asymmetry and signalling theories of IPO underpricing.

The use of an underwriter, the size of the company, the type of IPO market and the industry sector of the IPO are important factors for the level of IPO underpricing. The offer price and the type of offer, on the other hand, have no influence on the underpricing.

According to the literature review, the signalling theory of underpricing implies the use of signalling mechanisms, such as size, age, and the status of the issuing firm, to inform investors of the quality of the issue and to increase the demand for the IPO (Willenborg, 1999; Karlis, 2000). The theory assumes a linear relationship between the level of underpricing and the firm’s demographic variables (i.e. change in size, age or status of the issuer directly leads to the change in the level of underpricing). In this sense, the type of the IPO market (Main Market or AIM) used for the issue can act as a certification instrument. Having an IPO on the Main Market, therefore, send a signal about the status and the quality of the firm and its issue. Main Market IPOs are viewed as companies with more established reputation and solid fundamentals as the legal and regulatory framework of MM is more traditional in nature and imposes additional costs and compliance requirements.

Comparing the underpricing of IPOs in different sectors indicates that the level of underpricing for companies of similar size and status is different in different sectors. The ‘Consumer Staples’ sector, exhibiting the highest and most constant level of underpricing, includes manufacturers and distributors of food, beverages and tobacco and producers of non-durable household goods and personal products. It also includes food & drug retailing companies as well as hypermarkets and consumer super centres. These goods are those products that people are unable or unwilling to cut out of their budgets regardless of their financial situation. As such, consumer staples sector comprises companies whose businesses are impervious to economic cycles and benefit from constant and stable demand. The nature of the industry can explain the reason for higher underpricing in this sector when compared to other industries and also the more stable level of underpricing throughout the time period.

The observation of the significance of the ‘use of an underwriter’ and the ‘reputation of the employed underwriter’ variables is quite interesting. While the decision to hire an underwriter has as significant impact on the level of IPO underpricing, the reputation of the employed underwriter (for the underwritten IPOs) shows no statistical significance. Therefore, once the decision to employ an underwriter is made, his reputation is of lesser importance.

The adverse selection theory argues that underwriters intentionally underprice their IPOs to increase the demand for the issue (Rock, 1986). Issuers in turn use an underwriter as a signalling mechanism and as a security against failure of an IPO. From the agency-based point of view, issuing firms leave some money for the underwriters to ensure that they act in the firm’s best interest (Baron, 1982). Therefore, hiring an underwriters reduces the need to underprice as these underwriters are concerned with their own reputation (Welch and

Ritter, 2002). Therefore, issuers hire underwriters to signal the quality of an IPO (to ensure the confidence of investors in the issue), and underwriters use pricing as an incentive to induce investors to buy into the new issue.

It is worth mentioning, however, that according to the results, the specified variables combined have somewhat poor explanatory power over the levels of mispricing in the UK. There is a number of additional variables that may be included into the regression model. This is often the approach used by previous researchers to improve the explanatory power of the specified model. The review of potential variables that could be included into the model is presented in Appendix A. Chan *et al.* (2004) and Guo and Brooks (2008) argue that inclusion of proxies for economic indicators or country-specific characteristics of IPO markets can help better understand the IPO mispricing.

Based on the findings of this research, behavioural theories of underpricing may be the ones that can explain underpricing in the UK. From the behavioural perspective, perhaps the most obvious reason that underwriters choose to systematically underprice new issues is to make it easier for them to market the IPO. Empirical studies have demonstrated that underwriters are risk averse. Without the ability to hedge the risk of holding the issuing firm's stock, it is difficult to shift the risk to another party. Therefore, there is a strong incentive for the underwriter to underprice IPOs (Loughran and Ritter, 2002).

6.2 Research Question 2: Are there IPO waves in the UK market?

The second research question investigates the evidence of IPO waves in the UK market during the 1984-2016 period. It looks at the existing patterns of IPO activity in the UK, examines the periods of the higher number of IPO transactions and looks at the potential factors that can initiate the creation of an IPO wave.

As discussed in the previous section, the IPO activity throughout the examined period goes through a number of wave-like patterns (see sections 5.1 and 6.1) that depend on the type of IPO offer (national, international or mixed offers). The findings of this research suggest that companies tend to offer shares locally when the IPO activity (market sentiment) is high and on a wider geographical scale when the IPO activity (market sentiment) is low.

6.2.1 Research question 2a: Is there evidence of IPO waves in the UK?

Question 2a examines the evidence of IPO waves in the UK market in 1984-2016. The findings suggest that IPO activity throughout the examined period goes through periods of high and low IPO activity. This highly irregular IPO activity differs depending on the type of offer. The national only type of offering is the prevalent type of an IPO offer throughout the period. However, it subsides dramatically at the time of financial crisis and gives way to the international only type of offering that dominates the IPO activity after the financial crisis and until 2016. Thus, the periods of high IPO activity of the pre-financial crisis period are driven by the local IPOs taking place on the national markets, while the ones after the crisis period happen mainly due to the IPOs being offered on a wider geographical scale taking place on the international markets. The mixed type of offering covers only one decade (1994-2004) during the pre-crisis period. This is the time with the biggest number of IPO waves and also the period of the highest IPO activity within the sample.

This finding suggests that companies tend to offer shares locally during the times of high market sentiment, when the IPO activity is increased and offer shares to investors on a wider geographical scale who have less chance to communicate with each other when the situation is in reverse. This goes in line with the Welch (1992) argument stating that an important role of an underwriter may be to provide issuers with investor base that cannot communicate with each other easily. In addition, when market conditions are favourable companies are more prone to use the mixed type of offers, distributing shares through local and international markets. Therefore, the geography of IPO offering (local versus international offers) is an important indicator and depends on the general market conditions and the prevalent investor sentiment. When issuers/underwriters get alarmed, they tend to go wider.

The waves are measured according to the methodology of Carow *et al.* (2004) and Harford (2005) used to measure waves in the mergers and acquisition markets. The number of waves is measured according to monthly, quarterly and yearly cycles. As the findings suggest, the biggest IPO waves happen during the pre-crisis period, from 1994 till 2007. This period contains the waves with the highest number of transactions. The waves of the pre-crisis period are predominately driven by the local IPOs, while the investor base in the post-crisis period is geographically wider and the waves are driven by the international type of offering. This indicates the change of focus of the underwriters in marketing IPOs depending on the prevailing market conditions in the country of origin.

Looking at the IPO proceeds, the results indicate that in the pre-crisis period the IPO proceeds are facilitated mainly by the national and to a great extent by the mixed type of offers, while in the post-crisis era both the IPO waves and the IPO proceeds are due to the international offers. However, the IPO proceeds are the highest in 1994 and in 2014 and are around similar values. Thus, while the highest IPO proceeds do happen within the waves, their occurrence is outside of the period of the highest IPO activity. This is despite the fact that the highest IPO underpricing happens within the periods of high number of IPO waves (between 2004 and 2008). Therefore, having an IPO within a wave requires a high degree of underpricing but does not necessarily bring the highest potential proceeds.

Lowery and Schwert (2002) and Benveniste *et al.* (2003) find that if the offer prices in a given month exceed initial expectations the IPO volume in the subsequent month increases dramatically. If, on the other hand, the offer prices turn out to be lower than expected, the IPO market dries out. In short, the number of IPO transactions increases when stock is overvalued. Initial post IPO yields play the role of indicator for firms seeking to find out if the time is right for them to carry out an IPO and upon detecting overvalued IPO prices, they speed up their own IPO in order to profit from the opportunity and raise larger amount of funds than had been initially planned (Batnini and Hammami, 2015).

This suggests that the reason for IPOs is not in raising money as such but in catching the good market. This confirms the argument of Pastor and Veronesi (2005) stating that IPO waves develop naturally as a result of optimal IPO timing and are caused by a 'backlog' of private firms waiting for sufficiently large improvement in market conditions.

The evidence suggests high sensitivity of IPO offer prices to market conditions and institutional demand; therefore, it is logical to assume that underwriters price new issues with the view of incentivising and awarding the key investors through the offer price and share allocation[38]. This results in IPO market valuation (and not necessarily the immediate

[38] According to Aggarwal, Prabhala, and Puri (2002), when investors indicate demand for issues priced at the upper end of the filing range they are awarded with more shares. Cornelli and Goldreich (2001, 2003) show

financing needs of a firm) becoming the driver of a firm's decision to IPO. Consequently, the question arises whether issuers attempt to time the market conditions in order maximise the proceeds of an IPO and whether underwriters do in fact deliberately bundle IPOs together. Our findings suggest that it is not the actual level of the offer price but the information spillover it produces that triggers subsequent issue activity.

6.2.2 Research question 2b: When do IPO waves occur in the UK?

Research question 2b examines the evidence of IPO activity according to different time intervals. The methodology for the wave identification is adopted from the merger and acquisition analysis of Carow *et al.* (2004) and Duchin and Schmidt (2013) in order to allow for more accurate analyses of the pioneering IPO as opposed to the later movers.

The findings display seasonal patterns in monthly levels of IPO transactions with January and the end of summer periods displaying lower number of IPOs transactions and spring and the end of a calendar year periods showing an increase in IPO activity. The pattern that emerges from the analyses indicates that the IPO waves follow a seasonal pattern. More than half of the monthly IPO waves begin in February (14 waves out of 26), another 30 percent of the waves begin in October, this means that the absolute majority of the waves begin in just two periods. Similarly, the lowest IPO activity happens in the preceding periods, in January and in August-September. These periods of the lowest IPO activity is presented by sudden drops in the number of IPOs in the specified months[39].

The seasonal pattern of IPO waves remains even when the seasonality issue has been accounted for through measuring the waves by quarterly intervals. The majority of the quarterly IPO waves begin in either quarter one or quarter four and half of the quarterly IPO waves finish in quarter two, while the other half finishes in quarter four.

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that only a small number of bids is used as a base in setting the offer price and investors who submit larger bids are awarded with more shares.

[39]The author is unaware of any other research confirming the seasonality in IPO waves. The only other mentioning of IPO seasonality is in Yung *et al.* (2007) footnote stating that approximately 40% more IPOs are issued in quarter four than in quarter one.

One potential explanation for the seasonality of IPO waves is offered by Kamstra *et al.* (2003) and Kramer and Weber (2012) who examine the role of Seasonal Affective Disorder (SAD) in the seasonal time-variation of stock market returns and the effects of SAD on individuals' financial decisions. SAD is a medical condition that causes depression and heightened risk aversion during the autumn and winter months when the amount of daylight is the lowest. The authors find evidence consistent with lower demand for risky stock in depression-prone autumn and winter seasons. They also indicate that general market returns are, on average, lower in autumn and winter and that the SAD-sufferers have significantly stronger preferences for safer choices during the winter months.

The findings presented in this study indicate similar decline in the IPO activity during the months of January and August and September. Following the logic of Kamstra *et al.* (2003) and Kramer and Weber (2012), the reduction in the number of IPO transactions is due to the seasonal effect of the SAD. In the months following January and September the IPO activity increases quite significantly and reaches its peak on average in March and December. While the January to March increase might be explained through the increase in the amount of the daylight and the arrival of spring, the September to December increase still falls onto the SAD period (autumn to winter months). As suggested by Kamstra *et al.* (2003) and Kramer and Weber (2012), the heightened risk aversion during the autumn and winter months should lead to lower demand for stock. One explanation for the increased activity in the autumn and winter months is provided by Dolvin and Pyles (2007), who examined the possible effects of seasonal affective disorder on IPO underpricing.

According to Dolvin and Pyles (2007), there is a direct connection between investor emotions and issuer pricing; investors influenced by SAD are more risk averse and are less willing to invest. In response to this, issuers reduce offer prices and increase underpricing to induce investment, i.e. they offset the higher degree of risk aversion and lower demand by investors. The increased risk aversion escalates the uncertainty that issuers face in coming to market. This results in issues going public at a lower price than during non-SAD months and also in increased offer price revisions during the SAD months. The study suggests that behavioural aspects (such as the emotions of buyers) may affect IPO pricing as much as more traditional characteristics and confirms that the characteristics of an offer are dictated, at least in part, by the demands of investors.

Comparing the quarterly levels of IPO mispricing in relation to the IPO waves show that prior to the financial crisis the levels of underpricing are the highest during the IPO wave, while during the post-crisis period the IPO underpricing is relatively low and does not differ much between the in- and out- of the wave periods. However, generalising this conclusion is somewhat problematic due to the limited sample for measuring the IPO mispricing (IPO mispricing is measured only for a sub-set of the full data, for the period of 2002-2016 due to the limited data availability).

Looking at the quarterly IPO proceeds reveals an inconclusive picture. While the IPO proceeds are significantly higher within the identified waves, they are highly irregular. For the earlier waves (1994-1997) and for the post crisis wave (2012-2016) the IPO proceeds are significantly higher than for the waves of 2000-2007, the immediate pre-crisis period.

6.2.3 Research question 2c: What industries are more prone to IPO waves?

Research question 2c examines the evidence of IPO waves according to the industry sectors in order to understand whether hot IPO markets in the UK are industry specific. Findings of the earlier research state that IPO clusters are more likely to happen in high-growth and fragmented industry with higher investment in research and development. These sectors are characterised by strong investment opportunities and favourable investor sentiment (Jain and Kini, 2006).

The results of this research indicate that, while the majority of industries of the pre-crisis period are characterised by the heightened IPO activity, two sectors stand out throughout the examined period. They are the ‘Financials’ and the ‘High technology’ sectors. Both sectors outperform every other sector for the majority of the specified periods and peak in 2000 with the number of IPOs in that year at least three times higher than the yearly average for 2000. The identified IPO waves in these two sectors are the highest compared to other industries. However, the timing of the waves is different in the two sectors. In the ‘Financials’ sector, the pre-crisis waves happen in 1994-1997 and in 2000-2007, while in the ‘High Technology’ sector they happen in 1994-2001 and 2004-2007. Comparing different industry sectors, it is possible to conclude that the overall IPO waves of the pre-crisis period are driven mainly by the two sectors and the initiation of a wave is influenced by the nature of the industry and the specific industry characteristics.

The seasonality of the IPO waves discussed in the previous section is observed in the two industries. The majority of IPO waves in both sectors begin in quarter four, and finish in quarter two.

The heightened IPO activity and the waves of the 'High technology' sector are easily explained through the nature of the sector and the finding is in line with the argument of Jain and Kini (2006) who state that high-growth and fragmented industries are more prone to IPO clustering. The sector is characterised by high growth and innovation and bigger requirement for investment in research and development, and therefore, is more prone to cascades due to the favourable investor sentiment and investment opportunities.

The 'Financials' sectors, however, is not traditionally an industry that requires innovation and high investment in R&D. It is viewed as a more stable and 'traditional' industry, yet it shows the highest IPO activity and the longest and highest IPO waves. This can be explained through the deregulation of the sector. Following the deregulation the industry has seen an introduction of many innovative products. This invention of the new financial instruments continued for some time (until the finical crisis) and thus, fulfilled the 'innovation' criteria of the cascades prone industry. It is possible to conclude that the 'Financials' sector from around 1994 became an innovation-prone industry. This surge in innovative products, instruments and procedures led to formation of informational cascades in the industry.

Innovation and technological change are among the most influential factors in creation of an IPO wave[40]. The arrival of a new technology or the introduction of an innovative product demand a fast development and requires considerable investment (Lowry, 2003; Batnini and Hammami, 2015). These innovations create a positive shock to the economy creating significant capital needs and driving several companies to launch an IPO with an aim to raise funds. At the same time, the improvement in investment opportunities raises the price at which firms can sell securities. Higher prices increase the temptation for bad firms to pool. This increase in the number of firms going public creates a wave (facilitated by an informational cascade). In addition, marginal firms entering the market given improved

[40]Other factors discussed by the literature are the data asymmetry and the capital market yields (Batnini and Hammami, 2015).

market conditions (and higher capital yields) are of relatively lower quality. This implies that the dispersion in quality of the IPO firms is higher during the wave.

Once a wave is initiated, the information asymmetry is increased. This higher information asymmetry leads to more underpricing. Therefore, the positive shocks to the economy (through innovation and introduction of new technologies) lead to more firms going public creating an IPO wave (informational cascade) characterised by high information asymmetry, more underpricing and higher dispersion in the quality of the issuing firms.

6.3 Research Question 3: How IPO waves are formed?

The third research question investigates how IPO waves are formed. It looks initially at the evidence on market timing on the UK market, followed by investigation of the potential factors influencing formation of a wave and concludes with the overview of the potential characteristics of the pioneering IPOs.

6.3.1 Research question 3a: Is there evidence of market timing in the UK?

Question 3a examines the evidence of market timing on the UK market. The lead-lag relationship between IPO initial returns and volume documented by Ljungqvist (1995) and Lowry and Schwert (2002) is confirmed by the findings of the current research as well. In overall, the results also match those obtained by Pastor and Veronesi (2005) and Banerjee *et al.* (2013). The UK IPO volume increases following periods of low market volatility and extensive IPO underpricing. In particular, IPO volumes show a positive lead-lag relationship with the level of IPO underpricing and are negatively related to past changes in market volatility as predicted. However, in contrast to Pastor and Veronesi (2005) and Banerjee *et al.* (2013) the prediction of positive relationship between market returns and IPO volume is not confirmed by the empirical findings of this study.

There is ample evidence on the positive relationship between market conditions and IPO activity. However, there are disagreements in the literature as to whether this relationship is due to rational or behavioural reasons. Pagano *et al.* (1998) provides evidence for a behavioural explanation, such that firms time their IPOs to go public when the stocks in their industries are overvalued. Many researchers attribute time variation in IPO volume to market inefficiency, arguing that IPO volume is high when shares are 'overvalued' (Ritter, 1991; Loughran, Ritter, and Rydqvist, 1994; Loughran and Ritter, 1995; Rajan and Servaes, 1997, 2003; Pagano, Panetta, and Zingales, 1998; Baker and Wurgler, 2000; and Lowry, 2003). Such an argument assumes that the periodic market mispricing can somehow be detected by the owners of the firms going public, but not by the investors providing IPO funds.

In contrast, Pastor and Veronesi (2005) offer a rational explanation based on a model of optimal IPO timing in which IPO waves emerge following improvements in market conditions. The basic idea is that when market conditions improve, many private firms that have been waiting to go public exercise their options around the same time, causing IPOs to cluster in time and form an IPO wave.

Overall, the results of this study provide strong evidence that the activity in the UK IPO market is highly sensitive to the market conditions. IPO volume increases following periods of low market volatility and tends to follow phases of extensive IPO underpricing.

6.3.2 Research question 3b: What are the potential factors initiating an IPO wave?

Research question 3b examines the formation of a wave and investigates the factors potentially initiating it. As the findings indicate, IPO underpricing, company size, type of offer, market type and the industry of an IPO are important factors in facilitating a wave.

The empirical findings of this research do not confirm the predictions that bigger companies have IPOs outside of a wave and that firms with lower offer price tend to have IPOs within a wave. The level of IPOs underpricing, however shows statistical significance suggesting that observing higher underpricing induces more companies to go public because issuers learn from the experience of previous issuers. This finding confirms the argument of Lowry and Schwert (2002).

Based on the findings of this research, the type of offer is an important factor for timing an IPO. IPOs within a wave tend to be national rather than international and mixed offers. This findings contradicts the argument of (Welch, 1992) in that the issuers hire underwriters to distribute an offering widely, to investors who find it difficult to communicate with each other. 'Use of an underwriter' and 'reputation of the employed underwriter' variables (for the underwritten IPOs) display insignificant relationship for all IPOs suggesting that probability of an IPO being within a wave does not depend on hiring an underwriter.

The type of market variable shows statistical significance in both cases indicating strong evidence that more IPO waves tend to happen on the AIM. The reason for this choice could be due to the AIM's relaxed regulatory regime, making it easier for smaller companies and companies of lower quality to comply with the requirements, while MM is a viewed as a more traditional IPO market more attractive to well established and confident firms. It is important to note that when only the underwritten IPOs are considered the choice of market becomes insignificant while the reputation of the employed underwriter is an important factor. This suggests that the choice of the Main Market for an IPO by the issuers can be used as a certification signalling mechanism for the quality of the firm and the offer, especially in the cases where an underwriter is not used.

The findings of this study show that IPO waves are more often formed by the companies in the 'Telecommunications', 'High Technology' and the 'Consumer Staples' sectors. The tendency of IPO waves to pertain to the 'Consumer Staples' sector is an interesting observation is in that this sectors comprises companies whose businesses are less sensitive to economic cycles and benefit from constant and stable demand. The companies of this sector produce goods that people are unable or unwilling to cut out of their budgets regardless of their financial situation. The nature of the industry can provide an explanation for the higher number of IPO waves in this sector when compared to other industries

The heightened IPO activity and the waves of the 'High technology' sector are easily explained through the nature of the sector. It is characterised by high growth and innovation and bigger requirement for investment in research and development, and therefore, is more prone to cascades due to the favourable investor sentiment and investment opportunities. This finding is in line with the argument of Jain and Kini (2006) who state that high-growth and fragmented industries are more prone to IPO clustering.

Overall, the results of this study indicate the significance of IPO underpricing, company size, type of offer, market type, and the industry of an IPO for formation of an IPO wave.

6.3.3 Research question 3c: What are the characteristics of pioneering IPOs?

Research question 3c examines the characteristics of the pioneering IPOs by analysing the observable firm characteristics in relation to the place of the IPO in a wave. Based on the findings of this research, the type of offer is an important indicator for pioneering IPOs. The relationship with the dependent variable is negative indicating that early movers are companies that offer shares locally. This suggests that pioneering IPOs are established confident firms that do not depend on information asymmetry between issuers and investors and can benefit from the early movers advantage. The rest of the identified variables have no influence on the probability of an IPO being a pioneering IPO. The results are different, however, when the use of an underwriter is considered. For the underwritten IPOs, firm size, reputation of the employed underwriter and the type of offer show statistical significance.

The observation of the company size variable in relation to an IPO wave provides interesting insights. While, the prediction that bigger companies have IPOs outside of a wave is not confirmed, the size of a company is a significant factor when the characteristics of the pioneering IPOs are investigated. The 'company size' variable shows statistical significance for the underwritten IPOs. The variable for the firm size, however, displays a negative relationship with the probability of a firm being a pioneering IPO suggesting that smaller companies tend to be among the early movers in an IPO wave. This result, while confirming the importance of the factor, does not support the prediction that early movers are bigger companies. This may be due to the measurement of the variable itself. The 'VALUE' variable is measured as the size of the company at the time of an IPO (the total number of shares offered by the offering price of these shares). A different specification for the variable measuring the size of a company capturing fundamental valuation and history of the company's profits might provide further insights.

According to Willenborg (1999) and Karlis (2000), demand for IPO shares is a function of information and insurance signalling. For the underwritten IPOs, hiring a more reputable underwriter is a signal that the firm will benefit from having its financials more accurately analysed. This also acts as an insurance signalling against possible overpricing of an IPO and future securities litigations. The use of a higher ranking underwriter signals the confidence of the issuer in timing of an IPO inducing other firms to perceive market conditions as favourable and proceed with their IPO. This suggests that the reputation of an underwriter used by the pioneering firms can induce the formation of a cascade, i.e. the underwriter with higher reputation hired by the pioneering firms (usually the firms that are confident in their issue and do not need to wait for an opportune moment as do firms of poorer quality) facilitate the formation of a cascade.

An innovation or an introduction of a new technology creates a positive exogenous shock to the economy. A strong and confident firm decides to proceed with an IPO because it needs to raise finance; it hires a reputable underwriter to signal its quality and to ensure the success of an IPO. The underwriter then, in search of bigger profits and in pursuit of an opportunity to raise more finance through other IPOs, bundles IPOs together, high quality firms and lower quality firms, and uses underpricing and share allotment to induce key investors to buy into the issue, creating the demand for the shares and also signalling the opportunity to invest. Thus, a cascade starts, information stops accumulating and an IPO wave facilitated by informational cascade is created.

Issuers hire underwriter to manage an IPO, to attract sufficient investor base and to ensure the success of an issue. Some of these underwriters are more reputable than others. Underwriters with high reputation attract more investors than underwriters with low reputation. Therefore, the reputation of an underwriter is used as a signal about the quality of an issue and acts as a signal of an opportunity to invest. The choice of an underwriter then serves as a product endorsement marketing technique and induces a cascade.

According to the model of observational learning and the argument of Welch (2000), combining the reputation of the underwriter with the decisions of the approached investors can lead to the formation of an UP or DOWN cascade. Underwriters approach well-known ('celebrity') investors and use incentives to make the issue attractive for them to invest (such as underpricing and share allocation). *Other investors* in the market that have not been approached or incentivised base their decisions on observing the decision and/or actions of the *incentivised investors*. There is a number of scenarios for the formation of an informational cascade that can develop under these conditions. They are as follows:

- If a firm hires an underwriter with a high reputation ensuring that the 'celebrity' investors *(incentivised investors)* **invest**, *other investors* should herd and **invest** as well, forming an ***UP* cascade** almost immediately.

- If a firm hires an underwriter with a low reputation and the ‘celebrity’ investors *(incentivised investors)* **invest**, then *other investors* are indifferent between investing or abstaining, and should follow their own private signal. A cascade should not form. However, intuitively, *other investors* will not be indifferent between the choices and will choose to follow the *incentivised investors* because of their ‘celebrity’ status (that can still act as product endorsement) and **invest** forming an ***UP*** **cascade**.
- If a firm hires an underwriter with a low reputation and the ‘celebrity’ investors *(incentivised investors)* **abstain**, *other investors* should herd and **abstain** as well, forming a ***DOWN*** **cascade**.
- If a firm hires an underwriter with a high reputation and the ‘celebrity’ investors *(incentivised investors)* **abstain,** *other investors* are indifferent between investing or abstaining, and should follow their own private signal. Cascade should not form. However, intuitively, *other investors* will herd and **abstain** as well as the ‘celebrity’ investors because of their ‘celebrity’ status endorsement, forming a ***DOWN*** **cascade**.

The question that arises is how much does the reputation of the underwriter actually matter? Based on the discussion above, the underwriter’s reputation plays little role as *other investors* follow ‘celebrity’ (*incentivised*) investors. The underwriter’s reputation serves only as a security measure against the DOWN cascade scenario.

6.4 Chapter Summary

In this chapter the main findings of this study are discussed in detail. The discussion follows the general layout of the research questions. First section discusses the findings relating to the performance of IPOs in the UK and the potential factors influencing it. The average level of IPO mispricing in the UK for the specified sample is19 percent and it is primarily driven by the AIM market with the average IPO underpricing of 21 percent. The finding is in line with the previous research. The highest underpricing pertains to the national only offers suggesting that in situations where information asymmetry is reduced (as compared to, for example, the international IPOs where the potential investors are geographically far away from each other), underpricing is potentially used to incentivise investors. Looking at the IPO mispricing by industry sectors reveals that the levels of IPO underpricing is the highest in two sectors: the 'financials' and the 'consumer product and services'. The high underpricing in the former can be explained by the deregulation of the sector and the introduction of new innovative products, while in the latter by the stable demand for its products unaffected by the economic cycles. The results of the study indicate that IPO mispricing can act as an indicator of the changing market conditions. Analysing the factors that potentially influence IPO underpricing show that price is an important factor and can act as an incentive to invest. The use of an underwriter is significant and is used by the issuers as a signalling mechanism and a security measure to ensure success of the issue.

The aftermarket performance of IPOs is investigated through one month's three months' and six months' CARs. The findings reveal that new issues continue to outperform the market in the first six months following an IPO. This outperformance is, however, significantly reduced by the end of the 180 days period, the time of the expiration of the lock-in period. This trend is particularly evident with higher information asymmetry (international offers) indicating change in the investors' perception of the IPOs and price adjustment of the offer price in the long run.

Second section of the chapter discusses the findings relating to the evidence of IPO waves in the UK market. While the national only offers are the prevalent type of IPO offers, the highly irregular IPO activity is different for different types of issues. The pre-crisis IPO waves are driven predominantly by the local IPOs, while during the financial crisis and in the post crisis years the waves are mainly due to the international IPOs. This finding reveals that issuers and underwriters carefully select the investor base depending on the market conditions in the home country, offering shares locally in 'hot' markets and on a wider geographical scale in 'cold' markets. This result confirms the theoretical argument of Welch (1992).

The study highlights the seasonality in the IPO waves. More than half of the monthly IPO waves begin in February with another 30 percent of the waves in October, this means that the absolute majority of the waves begin in just two periods. This pattern is persistent even when the seasonality is accounted for by measuring the waves quarterly. The majority of the quarterly IPO waves begin in either quarter one or quarter four. One of the possible explanations for the seasonality of IPO waves is offered by Kamstra *et al.* (2003) and

Kramer and Weber (2012). The occurring patterns can be attributed to the role of Seasonal Affective Disorder (SAD).

Analysing IPO waves by industry sectors shows that wave formation often follows the introduction of a new technology or an innovative product, creating a positive shock and driving several companies to launch an IPO. This in turn creates an improvement in the investment opportunities leading to the temptation of many firms to pool and, thus, facilitate formation of a wave through inducing an informational cascade.

The last section of the chapter analyses formation of an IPO wave and the potential factors initiating an IPO wave and the characteristics of the early movers. The findings confirm the lead-lag relationship between IPO initial returns and volume and the positive relationship between market conditions and IPO activity documented by earlier research. In particular, IPO volumes show a positive lead-lag relationship with the level of IPO underpricing and are negatively related to past changes in market volatility as predicted.

Based on the findings of this research, the level of IPO underpricing and the type of offer are important factors for the probability of an IPO being in a wave. The results show the importance of the industry of an IPO, and the choices of the UK IPO market by the issuers. IPOs within a wave tend to be AIM IPOs.

As the findings indicate, IPOs waves tend to pertain to sectors which comprise companies whose businesses are less sensitive to economic cycles and to industries characterised by high growth and innovation and bigger requirement for investment in research and development. The type of offer is an important indicator for early movers. Pioneering IPOs tend to offer shares locally suggesting that pioneering IPOs are established confident firms that do not depend on information asymmetry between issuers and investors and can benefit from the early movers advantage. For the underwritten IPOs, company size, reputation of the employed underwriter and the type of offer show statistical significance. The use of an underwriter with higher reputation by the pioneering firms can potentially facilitate the formation of a cascade. Following the model of observational learning of Welch (2000), a few scenarios leading to creation of an UP or DOWN cascade are possible and the use of an underwriter with higher reputation serves as a security measure against the DOWN cascade.

Chapter 7

CONCLUSIONS

"Markets can remain irrational longer than you can remain solvent."

John Maynard Keynes

CHAPTER SEVEN – CONCLUSIONS

The chapter provides the summary of the research findings and draws the conclusions suggested by the current research. It discusses the theoretical and practical implications of the study, followed by the limitations of the current work and the recommendations for the future research.

7.1 Research objectives

The overarching aim of the study was to investigate the clusters in IPO markets through examining the initial and the aftermarket performance of IPOs and the role of informational cascades in IPO waves in the UK during the period of 1984-2016. To address this, the research objective had been broken into three main research questions examining the performance of IPOs and the evidence of IPO waves and investigating the potential factors initiating a wave in the UK market. The questions are:

1. What is the performance of IPOs in the UK market and what are the potential factors influencing it?
2. Are there IPO waves in the UK market?
3. How IPO waves are formed?

7.2 Key findings

A purely quantitative approach had been adopted to address the research objective. IPO performance was examined through abnormal returns measured at different time intervals. Evidence of IPO waves was studied through the methodology adopted from the mergers and acquisitions literature that allowed for the identification of the periods of high and low IPO activity, as well as for the investigation of the dynamics of IPO activity within a wave. Formation of a wave and the potential factors influencing it were presented through descriptive statistics, independent samples tests, univariate analysis and multiple regressions.

7.2.1 Research Question 1: What is the performance of IPOs in the UK and what are the potential factors influencing it?

The findings of the research show that the performance of IPOs in the UK is changing. There is a significant difference in the IPO performance between the two UK markets, the AIM and the Main Market. The IPO trends of the Main Market are a better indicator for the change in the market conditions. This may be due to the quality of companies that choose to have their IPO on the Main Market. These companies are usually well-established firms with solid fundamentals and growth perspectives, while the AIM with a more flexible regulatory system attracts smaller companies to float shares. The exceptionally high level of IPO underpricing in 2008-2009 on both markets is expected due to the financial crisis and the higher need to encourage investment.

There is significant difference in the average levels of IPO mispricing between the different types of offer. However, the findings indicate that independently of the offer type, the pricing of IPOs is largely driven by the prevailing market conditions. The levels of mispricing differ significantly for different stages of economic cycles. The pre-crisis and crisis years show the highest levels of IPO underpricing, while during the post-crisis period underpricing drops significantly and remains relatively low for the rest of the period. Interestingly, the findings indicate that during the economic boom years, when all three types of IPO offerings are used, the levels of IPO underpricing for the local offerings are substantially higher than for the mixed and the international offers. In line with the previous studies, the findings of this research reveal that underpricing is potentially used as an incentive to entice investors to buy into the issue. Underpricing becomes lower as the need for an incentive is reduced with the geographical dispersion of the investor base. According to the findings of this study, international offers require less underpricing as investors are at a larger geographical distance from each other, information gathering is more difficult and the need to incentivise investment is, therefore, reduced (as opposed to local IPOs offers (national offers). An important finding, especially from the issuers' standpoint, states that having an IPO within a wave requires higher underpricing but does not bring higher proceeds.

The level of mispricing is different in different industry sectors. The industries prone to high levels of underpricing are the ones characterised by the noncyclical nature of the demand for its products or the tendency for the introduction of innovations and, therefore, external shocks to the industry. Therefore, underpricing is used as an incentive in sectors with noncyclical demand that is stable even during the low times or to encourage the confidence of investors. However, there is an apparent reduction in the levels of mispricing in the UK meaning that the use of underpricing as an initial discount offered to motivate investors is not as efficient as it used to be.

The average level of abnormal returns is consistent across all three types of offers. The initial aftermarket outperformance suggests that the initial pricing is correct indicating high demand for the shares. However, the decrease in the level of outperformance over the six months reveals a significant change in investors' perception of the IPOs. This trend is particularly evident for the IPOs offered to the international investor base with higher information asymmetry suggesting that the offer price adjusts in the long run. The findings confirm that the biggest adjustment in the price of an IPO happens around the sixth month of trading. However, the spread in abnormal returns is different depending on the offer type. The difference in abnormal returns between the first and the sixth month is the highest in the international offers, suggesting higher information asymmetry between the issuers/underwriters and the investors. The move from the local to the larger international market during the times of low market sentiment (the crisis and post-crisis periods in this research) suggests the premeditated exploit of the informational asymmetries caused by the geographical dispersion of the investor base in pursuit of profit maximisation by issuers and underwriters.

The analyses of the possible factors influencing IPO underpricing reveal that traditional theories based on EMH and information asymmetry no longer provide the explanation for the levels of IPO underpricing. The findings of this study show that the proxies for ex-ante uncertainty based on traditional theories show statistically insignificant relationship with the level of IPO underpricing in the UK. The research argues that including additional variables will not increase the explanatory power of the model because the assumption of the linear relationship between firms' demographic variables and the level of underpricing is fundamentally wrong. The role of underwriters, however, as well as the signalling effects of the type of IPO market used for the new issue remain important. Underpricing of IPOs is influenced to a great extent by the behavioural aspect of investors' decision-making process rather than a number of explanatory variables measuring size and status. In a certain sense, size and status do not matter unless investors decide that they matter. Following the financial crisis many investors are becoming reluctant to invest in the new issues. This suggests that the new IPOs will show the tendency for smaller issues in sizes with larger SEOs following and the issuers will shift their focus of profit making through these SEOs.

7.2.2 Research Question 2: Are there IPO waves in the UK market?

The findings of the research illustrate that it is not sufficient to divide the IPO markets simply into ‘cold’ and ‘hot’ periods in order to understand the dynamics of IPO transactions. The waves in IPO market are an evident occurrence and the overall IPO activity follows a highly seasonal pattern. The findings of the research indicate that the absolute majority of the waves begin in just two periods (months of February and October). Furthermore, the IPO waves differ within themselves according to the wave cycle.

IPO waves of the pre-crisis period are predominantly caused by the local offers while post-crisis waves are due to the international types of IPOs. IPO proceeds follow the same pattern. This indicates the change of focus of the underwriters in marketing IPOs depending on the prevailing market conditions in the country of origin. However, having an IPO within a wave requires a high degree of underpricing but does not necessarily bring the highest potential proceeds, suggesting that the reason for IPOs is not in raising money for investment as such but in catching the good market. This is in line with the market timing arguments of Lowry and Schwert (2002), Benveniste *et al.* (2003), Pastor and Veronesi (2005), and Batnini and Hammami (2015). The logical conclusion of the research is that it is not uncommon for the underwriters to price new issues with the view of incentivising and awarding the key investors through the offer price and share allocation. However, it is the information and the information spillovers that the offer price produces rather than the actual level of the offer price itself that triggers the subsequent issuing activity.

Furthermore, in line with Jain and Kini (2006) and Banerjee *et al.* (2013), the research indicates that industry clustering contributes to the occurrence of IPO waves. Industries characterised by high-growth and higher investment in research and development are more prone to IPO clusters and the subsequent IPO waves. The most influential factors in facilitating a wave are innovations and technological change. As a consequence of the arrival of new technologies or following the introductions of innovative products the economy experiences an exogenous shock leading to requirements for new investment. In order to meet the new financial demands several companies proceed with an IPO which in itself results in improvement in investment opportunities and in higher market sentiment. The number of firms going public increases but so does the temptation for bad firms to pool. As a result (given improved market conditions and higher capital yields), marginal firms of relatively lower quality enter the market. It is, therefore, logical to conclude that the positive shocks to the economy lead to more firms going public creating an IPO wave (informational cascade) characterised by high information asymmetry, high underpricing and higher dispersion in the quality of the issuing firms.

7.2.3 Research Question 3: How IPO waves are formed?

The UK IPO volume increases following periods of low market volatility and extensive IPO underpricing. The basic idea is that when market conditions improve, many private firms that have been waiting to go public exercise their options around the same time, causing IPOs to cluster in time and form an IPO wave.

According to the findings of this research, IPO underpricing, firm size, the type of offer, market type and the industry of an IPO are important factors in facilitating a wave. Observing higher underpricing induces more companies to go public because issuers learn from the experience of previous issuers. IPOs within a wave tend to be local (national) offerings, rather than international and mixed offers and choice of market type is used as a certification for the quality of a firm and the offer (MM is a viewed as a more traditional IPO market more attractive to well established and confident firms).

Based on the findings of this research, the type of offer is an important indicator for pioneering IPOs. This suggests that early movers are companies that offer shares locally and the pioneering IPOs tend to be established confident firms that do not depend on information asymmetry between issuers and investors and can benefit from the early movers advantage.

The observation of the company size variable in relation to an IPO is interesting. While, the prediction that bigger companies have IPOs outside of a wave is not confirmed, the size of a company is a significant factor when the characteristics of the pioneering IPOs are investigated. The variable for the firm size, however, displays a negative relationship with the probability of a firm being a pioneering IPO suggesting that smaller companies tend to be among the early movers in an IPO wave. This result, while confirming the importance of the factor, does not support the prediction that early movers are bigger companies.

The role of underwriters in the IPO process and also their underlying motives pose an interesting question. Underwriters in response to positive exogenous shocks to the economy seek to profit from the arising opportunity and bundle together high and low quality firms. Bundling and selling IPOs together allows them to raise higher IPO proceeds and to spread the costs associated with underwriting IPOs. To ensure the success of the issues, underwriters use underpricing and share allotment to induce key investors to buy into the IPO, creating the demand for the shares thus, creating an informational cascade. Information stops accumulating and an IPO wave is created.

The findings of this research suggest that the reputation of an underwriter in the early stages of an IPO wave can facilitate the formation of a cascade. It acts as a signal about the quality of an issue and an opportunity to invest. The choice of an underwriter then serves as a product endorsement marketing technique in order to induce a cascade. The conclusion that stems from this research is that the underwriter's reputation in itself plays little role as investors follow the 'celebrity' (incentivised) investors. The underwriter's reputation serves only as a security measure against the DOWN (no-investment) cascade scenario. In this case, who in fact needs (and facilitates) a cascade? Does an issuer who hires an underwriter with higher reputation in order to signal the quality of an IPO facilitate a cascade? Or is it induced by the underwriter who bundles different companies together in order to profit from the high market sentiment?

7.3 Implications

Findings of this research have implications for issuers, investors, regulators, and academics. The research implications for the academics are set out in a number of areas. There is a number of variables potentially influencing the level of IPO mispricing that could be included into the model. They are, for example, retained equity that signals to investors the management's confidence in the future prospects of the firm; auditor reputation; venture capital equity, the age of the firm, the number of uses referring to the allocation of the proceeds of an IPO. Also, Chan *et al.* (2004) and Guo and Brooks (2008) argue that inclusion of proxies for economic indicators or country-specific characteristics of IPO markets can help better understanding of the IPO mispricing. Clearly, an investigation of the behavioural explanations of IPO mispricing merits further research.

Furthermore, the distinguishing empirical implications of the research relate to the issues of uncertainty and informational asymmetry among market participants. The role of underwriters in this is of particular importance. The investigation of marketing strategy for a new issue in relation to the prevailing market conditions in the country of origin, as well as the use of the offer price and the share allocation as an incentive and reward for the key investors is an interesting avenue for future investigation.

Additionally, the further analyses of the lead-lag relationships between the level of IPO mispricing and an IPO wave may represent a direction for future research. A critical element in this analysis is the speed-to-market of lower quality issues as opposed to high quality issues as this reflects the extent to which low quality firms can mimic good quality firms.

From the issuers point of view, having an IPO within a wave requires higher underpricing but does not necessarily bring higher proceeds. Timing the market and/or the investor sentiment in order to proceed with an IPO provides a strategy that has the potential to ensure the success of an IPO, i.e. having an IPO within a wave has higher chance of the success of an issue. The seasonal patterns in IPO issuance in the UK suggest that the first and the fourth quarters are potentially the best time for considering a new issue. At the same time, for the firms that are well established, mature and have an industry advantage, waiting to launch an IPO does not prove to be the best strategy. These firms already have good investment prospective and delay before launching an IPO could act as a negative signal to investors and reduce the profitability of the issue.

From the investors' point of view, the best IPO investment strategy is investing in early movers, firms that are usually characterised by solid fundamentals. As argued by Coakley *et al.* (2008), evidence relating to fundamentals such as pre-issue earnings growth and turnover are particularly useful during hot markets to identify issues that are less likely to underperform in the long run. As innovation and technological change are among the most influential exogenous factors in creating an IPO wave, the companies launching an IPO early are the ones who are more likely to use the IPO proceeds to invest in the near future, whereas the later joiners are more likely to be simply timing the market in search for profitable opportunities. Also, marginal firms are of lower quality than the average pre-shock firms. Because these marginal firms in the wave (joining later) are of poorer quality they will be more likely to delist.

Another implication of the research is that investors need to pay special attention to the marketing strategy of an IPO and the geography of the offer that often depend on the prevailing market conditions in the country of origin. Also, depending on the investment strategy, the seasonality of IPO waves and the industry characteristics should be taken into consideration. High-growth innovative industries requiring higher investment in R&D and industries that have recently experienced positive exogenous shocks (through innovation and introduction of new technologies) are more prone to informational cascade and IPO waves.

There are several issues in the IPO process that have implications for regulators and policy-makers. Firstly, the use of underpricing by the issuers/underwriters to incentivise investors is of great importance. The research suggests that industries characterised by the noncyclical demand for its products or the tendency for introduction of innovations are prone to higher levels of underpricing suggesting the use of underpricing as a reward or an encouragement of the confidence of investors. Underpricing becomes lower as the need for an incentive is reduced with the increase in the geographical distance between investors.

Secondly, the quality of the issuing firms becomes questionable as the waves form. On one hand, issuers of the firms of poorer quality are timing the market, on the other hand, underwriters bundle high quality and lower quality IPOs together in pursuit of an opportunity for bigger profits. The waves then often develop as a result of a 'backlog' of private firms waiting for sufficient improvement in the market conditions. The value of these lower quality firms joining later in the wave is dubious after the IPO and, as a result, IPOs issued during a wave are much more likely to delist or bankrupt than the pioneering IPOs or IPOs issued out of the wave. Alti (2005) suggests that followers in the IPO process are more likely to hold onto IPO proceeds for extended periods of time relative to IPO pioneers who use IPO proceeds for investment. The seasonality of the IPO patterns, the use of IPO proceeds, and the industry characteristics should provide the necessary guidelines in designing the regulatory requirements for the IPO process.

Thirdly, despite many changes in the regulation of the IPO process and the availability of information, the issues of uncertainty, informational asymmetry among market participants, and the role of underwriters in the IPO process still remain critical. From a practical point of view, the change in the IPO markets indicates the change in investment practices. Investors are becoming more selective and realistic in their valuations of IPOs. Also, demand for improved corporate governance and better practices in financial reporting are making issuers focus not just on the initial returns of an IPO but more on the long-term performance. This, in turn, leads to the changing role of underwriters in IPOs. They have a large say in setting the offer price and also influence the timing of the issue. The quality of the disclosed information, the IPO marketing strategy, as well as the geography of an IPO offer in relation to the prevailing market conditions in the home country and the use of price as an incentive and/or award should be the focus of further regulation.

7.4 Limitations

The conclusions of this study are constrained by a number of limitations relevant to various aspects of this study and thus, should be interpreted accordingly. First, a number of IPOs in the datasets for the UK were excluded due to the limited availability of information. To analyse the IPO mispricing and the aftermarket performance a subset of the full dataset (IPOs in 2002-2016) is used for the UK market due to the limited information for earlier periods. Every attempt is made to minimise the amount of data excluded from the study due to incomplete or unavailable historical data; however, no systematic survivorship bias is presented.

Second, the research uses proxies for some of the variables as there are no direct measures reflecting them. The use of proxies for the underwriter's reputation in the regression model was limited to the underwriters' ranking based on the number of IPOs underwritten by a particular bank in the specified period and the country. Prior studies have used underwriters' reputation based on the underwriters' size and/or underwriters' reputation based on the international ranking of the underwriter. However, the internationally accepted underwriters' rankings are available only for the later years and using the underwriters' size as a proxy for underwriters' reputation is not feasible due to the limited financial data available for the examined period.

Third, share allocation according to investor type could offer greater insights in examining the role of underwriters and the use of the offer price as an incentive. However, the information on share allocation for the UK market is not accessible.

Fourth, some of the implications of the model of observational learning explaining informational cascades are not directly testable due to the restrictions on data availability.

Fifth, psychological forces influencing the behaviour of maker participants are not measurable and therefore could not be incorporated into an empirical research.

In addition, this study is purely a quantitative research and although this allows for the in-depth analyses of a broad ranging dataset from a number of perspectives, the inclusion of a qualitative element may add to the study, particularly with regard to behavioural biases of managers and investors.

7.5 Recommendations for future research

The findings of this study suggest several channels for further research. The examination of the quality of the issuing firms throughout the development of the wave and also in and out of the wave may contribute to the understanding of the market timing argument highlighted by the current research. The use of IPO proceeds may provide an avenue for investigating the IPO quality.

Another issue brought forward by the research is related to survival rates. Firms with IPOs issued during later stages of an IPO wave are more likely to become worthless, delist or bankrupt, which is consistent with the argument of Yung *et al.* (2008). Testing for delisting and/or bankruptcy following an IPO may provide better insight into the quality of issuing firms, as well as contribute to the understanding of the role of underwriters in facilitating and exploiting an IPO wave through bundling high and low quality issues together.

Additional investigation of IPO waves by industry with focus on the quality of marginal firms merits further research. Argument brought forward by Yung *et al*. (2007) states that issuer quality deteriorates faster through time in the case of the high growth industries, while mature industries that lack growth opportunities exhibit a less pronounced time-series variation in this regard.

Also, the distinctive finding of this research is the seasonality in the IPO waves. The pattern that emerges from the analyses shows that the absolute majority of the monthly IPO waves begin in just two periods: February and October. The seasonality of IPO waves persists even when the seasonality issue is accounted for through measuring the waves by quarters. The Seasonal Affective Disorder is offered as one of the potential explanations of this development by Kamstra *et al.* (2003), Dolvin and Pyles (2007), and Kramer and Weber (2012) suggesting that the general market returns are lower in autumn and winter as the SAD-sufferers have significantly stronger preferences for safer choices during the winter months. Following their logic, issuers reduce offer prices and increase underpricing to induce investment in response to lesser willingness to invest for the investors influenced by SAD. Additional research into the seasonal patterns of IPO waves, especially with regard to industry characteristics and in relation to the maturity of an industry (younger versus more mature industries) may provide a good comparison between the emerging seasonal patterns of IPO waves.

Furthermore, the type of investor (large versus small, institutional versus individual) participating in new issues with regard to the stage of an IPO wave development could provide interesting insights into the issue of the key or incentivised investors. Study of the type of investor approached by the underwriters in different stages of an IPO wave, the amount of shares allotted to each group of investors and also the overall amount of shares allotted prior to IPO in and out of the wave would facilitate better analyses of the role of underwriters in IPO. Ofek and Richardson (2002) argue that a significantly larger proportion of investors in internet stock consisted of individuals rather than institutions, making the market prone to behavioural biases based on overly optimistic beliefs. Behavioural theories have been brought forward to explain the behaviours of market participants, i.e. IPO issuers and investors. Generally, investigation of these theories involves qualitative analysis. Research of behavioural theories would provide a more complex and detailed understanding of the IPO process, underpricing, after-market performance, IPO clustering and IPO wave formation and development.

Finally, an intriguing avenue for future research is the characteristics of the firms underwritten by banks during different stages of an IPO wave. Even among IPOs underwritten by high-prestige banks, early movers experience high levels of underpricing. Banerjee *et al.* (2015) states that the client base of high-prestige underwriters is not limited to high-growth firms. This is consistent with Loughran and Ritter (2004) who state that with time prestigious underwriters relax their underwriting standards and take public an increasing number of very young and unprofitable companies. It would be interesting to see who underwriters underwrite during different stages of an IPO wave.

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APPENDICES

Appendix A: Factors influencing IPO underpricing

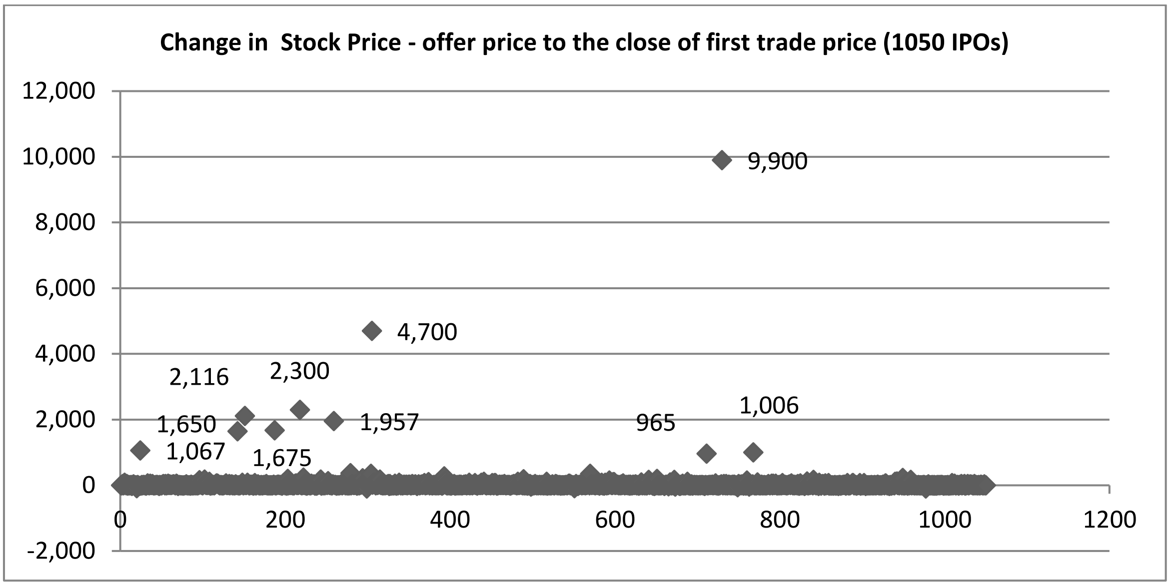
Indicator	Description	Studies
Retained Equity	Firm owners are free to decide how much equity to relinquish at the time of IPO. This information, disclosed in the firm's prospectus, is an observable signal known in advance and difficult to imitate (pre-IPO ownership of a firm is unlikely to change immediately prior to IPO as such change would draw the interest of regulators and dampen enthusiasm for the IPO). The level of retained equity signals to investors the management's confidence in the future prospects of the firm (i.e., higher levels of retained equity signalling greater confidence). Investors view high levels of managerial ownership as an indication that the goals of firms' managers are effectively aligned with those of potential investors in the IPO firm.	Jensen and Meckling, 1976; Ritter, 1984; Beatty, 1989; Kim, Krinsky, & Lee, 1995; Klein, 1996; Van der Goot, 1997
Auditor Reputation	Entrepreneurs with favourable inside information to present to investors will hire high-quality auditors. This is a powerful signal to potential investors, as high-quality auditors will be less subject to pressures from firm management and more discriminating in their audits. The reputational capital of a high-quality auditor may suffer should the auditing firm fail to reveal potentially negative IPO firm information. More important, failure to disclose negative information may subject the auditor to shareholder lawsuits. IPO firm owners, however, risk significantly diminished investor interest in the IPO should potential investors lose interest in the offering as a function of negative firm-specific information. As a result, entrepreneurs who believe that unfavourable information about the firm and its prospects will negatively impact investors' perceptions are unlikely to hire high-quality auditors.	Titman &Trueman, 1986; Beatty, 1989; Feltham, Hughes, &Simunic, 1991; Michaely& Shaw, 1995
Number of Uses	Number of uses refers to how the proceeds of an IPO will be allocated. The reporting of these uses, required by the SEC for IPO filings, is subject to some interpretation. Firms are often understandably reluctant to provide full disclosure because the information is proprietary and may constitute a competitive advantage. At the same time, potential investors are entitled to some briefing on how the IPO-generated funds will be used.	Beatty & Ritter, 1986; Rasheed, Datta, &Chinta, 1997

Indicator	Description	Studies
Risk Factors	The lead underwriter is required by law to file a registration statement, which includes a section of the prospectus detailing the relevant risk factors (e.g., new product, few or limited products, inexperienced management, technical risk, seasonality, customer dependence, supplier dependence, competition, legal proceedings pending against company, government regulation) pertaining to the company. The purpose in requiring the firm to detail the relevant risk factors is to provide potential investors the opportunity to fairly assess the ex-ante uncertainty facing the IPO firm. Firms with greater numbers of risk factors are associated with higher uncertainty. This increased uncertainty is likely to be associated with higher levels of underpricing.	Beatty &Zajac, 1994; Welbourne& Cyr, 1999
Venture Capital Equity	Venture capitalists are frequently active shareholders, often occupying seats on the board of directors. They have also offer firm management, especially CEOs, advice regarding firm strategy and assistance in providing access to key stakeholders such as financiers, customers, and suppliers. This historically active role in the firms in which they invest suggests that venture capitalists are both concerned with these firms' future performance and are willing to assist in the achievement of high performance. An additional factor is that venture capitalists typically invest in firms that have strong management teams. Additionally, venture capitalists are instrumental in recruiting high-quality managers into the firm (which is critical post IPO as the firm employs the generated funds to pursue growth opportunities).	MacMillan *et al.*, 1988; Gorman &Sahlman, 1989; Barry *et al.*, 1990; Keeley &Roure, 1990; Rosenstein *et al.*, 1993; Fried &Hisrich, 1995; Cyr *et al.*, 2000
Firm Age	The age of the firm has served as a proxy for risk in previous IPO research, i.e., more established firms are less risky. Less-seasoned firms will have fewer years of published financial data and are less likely to have been assessed by financial analysts.	Ritter, 1984, 1991; 1998; Megginson & Weiss, 1991; Rasheed, Datta, &Chinta, 1997; Mikkelson, Partch, & Shah, 1997; Carter, Dark, & Singh, 1998

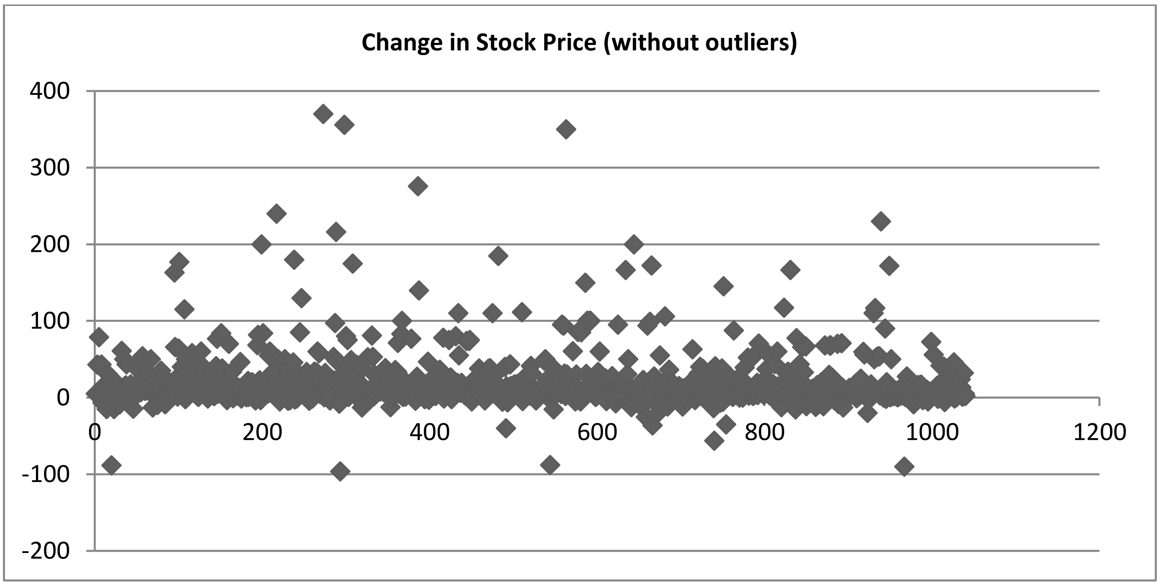
Indicator	Description	Studies
Underwriter Prestige	Prestigious underwriters will have prior experience in taking firms public and will also have reputations as effective underwriters to protect. The relationship between underwriter prestige and IPO underpricing, is not straightforward. Underwriters are dual agents in the IPO process. They act on behalf of the firm whose securities they represent, but as the vast majority of IPO shares are not initially sold on the open market but to key clients of the underwriters (e.g., institutional shareholders), underwriters also have the interests of these clients to protect. These two constituent groups will have very different preferences with regard to a performance indicator such as underpricing. The IPO firm's initial shareholders will, in general, want to reduce underpricing, as it represents money left on the table. Underwriter's institutional clients, however, realise a potentially lucrative benefit from underpricing. Moreover, the underwriters (investment bankers) maintain ongoing relationships with their institutional clients, but are unlikely to have repeated contact with the IPO firm. Previous research has found that IPO firms seldom rely on their lead underwriter for seasoned equity offerings following the IPO.	Carter &Manaster, 1990; Megginson & Weiss, 1991; Gordon &Jin, 1993; Beatty & Welch, 1996; Spiess& Pettway, 1997; Carter, Dark, & Singh, 1998; Lange *et al.*, 2001
Firm Size	Larger firms, as compared to smaller firms, present less uncertainty for potential investors. Larger organisations have greater access to resources essential for firm survival and profitability. Consistent with this, several studies have found a negative association between firm size and underpricing. Another factor suggestive of a correlation between firm size and IPO firm performance is that larger firms tend to attract more prestigious underwriters. Smaller firms may be perceived as offering lower performance potential, leading prestigious underwriters to avoid these issues so that they do not directly bear any loss through undersubscribed issues. Underwriters will also be concerned about passing on a riskier issue to their clients, thereby jeopardising future client business.	Ibbotson *et al.*, 1988; Megginson & Weiss, 1991; Ibbotson *et al.*, 1994; Carter, Dark, & Singh, 1998; Finkle, 1998; Carter, Dark, & Singh, 1998.

Appendix B: Outliers for the subset of data for the UK IPOs in 2002-2016.

Scatter plot for the subset of data for the UK IPOs in 2002-2016 removing outliers:



The entries with exceptionally high level of the change in price have been removed. The next high value after the 965 is 370; the gap between the two values is more than 2.5 which justifies the removal of observations with values over 370. Scatter plot after removing outliers:



The IPOs have also been classified into AIM IPOs and Main Market IPOs (using data from LSE) in order to be able to check if the AIM IPOs are the ones driving the underpricing up. The results show that it underpricing is higher for the AIM IPOs.

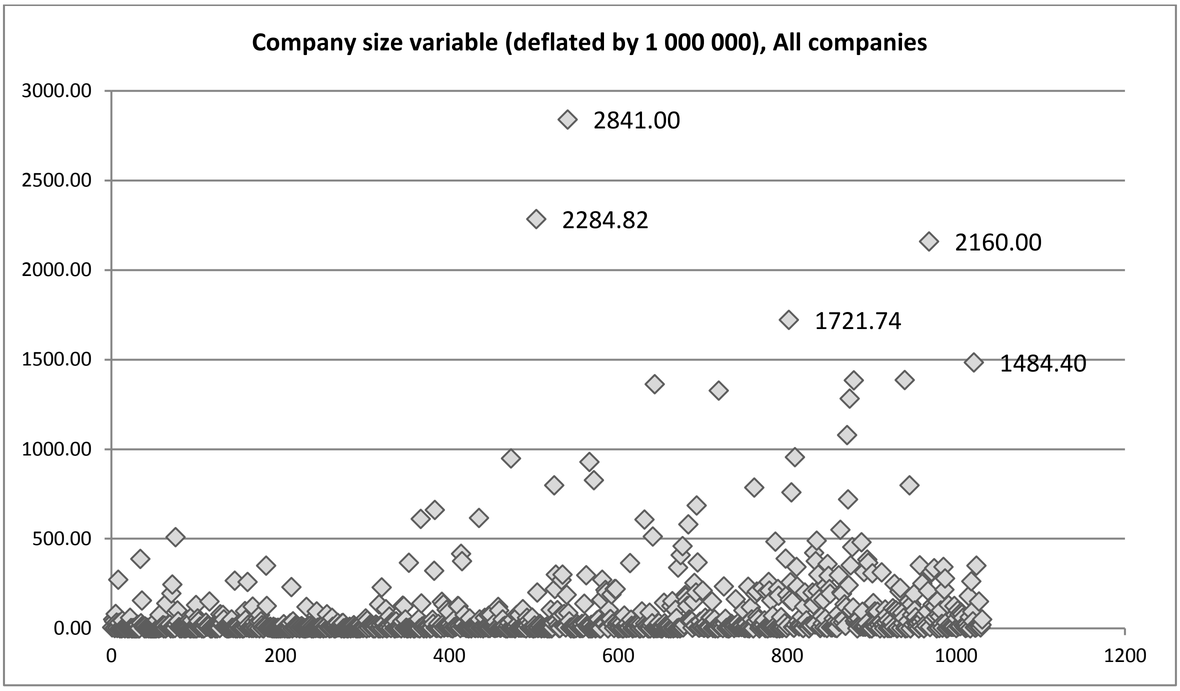
Additionally, the mean levels of underpricing for IPOs with different offer prices have been checked in order to identify the influence of the penny stocks on the level of IPO underpricing (majority of penny stocks are from the AIM market). The results show that IPOs with the offer price less than 0.50 (and especially less than 0.20) are underpriced substantially higher than IPOs with the offer price, for example, over 1.00. The table below shows the results.

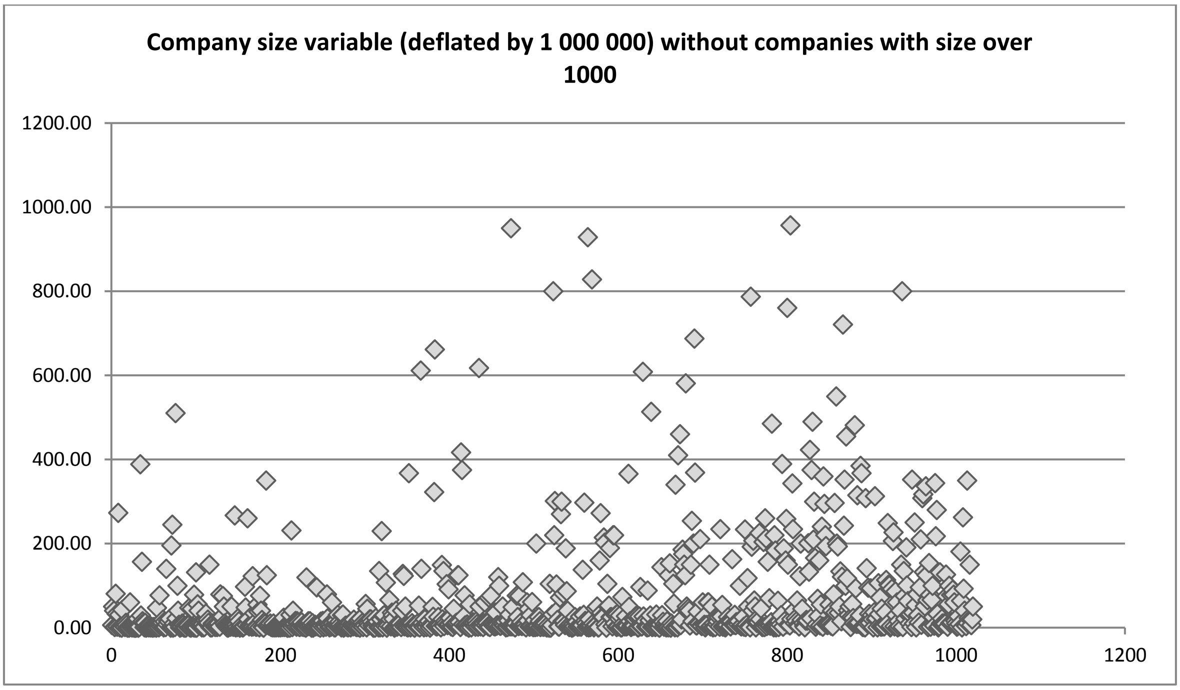
Mean IPO underpricing	% Change Stock Price – offer price to close of first trade price (without outliers)	% Change Stock - offer price to close of first trade price (all data)
Mean	19%	45%
AIM only	21%	42%
Main Market (MM) only	14%	15%
less than or equal to 0.20	48%	154%
less than or equal to 0.50 and greater than 0.20	18%	18%
less than or equal to 0.50	35%	98%
less than or equal to 1.00	**25%**	62%
less than or equal to 1.00 and greater than 0.50	13%	16%
greater than or equal to 1.00	11%	18%
greater than 1.00	10%	17%
greater than or equal to 2.00	8%	8%
greater than or equal to 3.00	6%	6%
greater than or equal to 4.00	3%	3%
greater than or equal to 5.00	3%	3%
greater than or equal to 10.00	5%	5

Appendix C: Process for variables specification.

Firm size logged (VALUE)*

The data for the firm size variable is highly uneven. However, the distance between the observations and the layout of the scatter plot are not sufficient to consider the very high size companies as outliers.



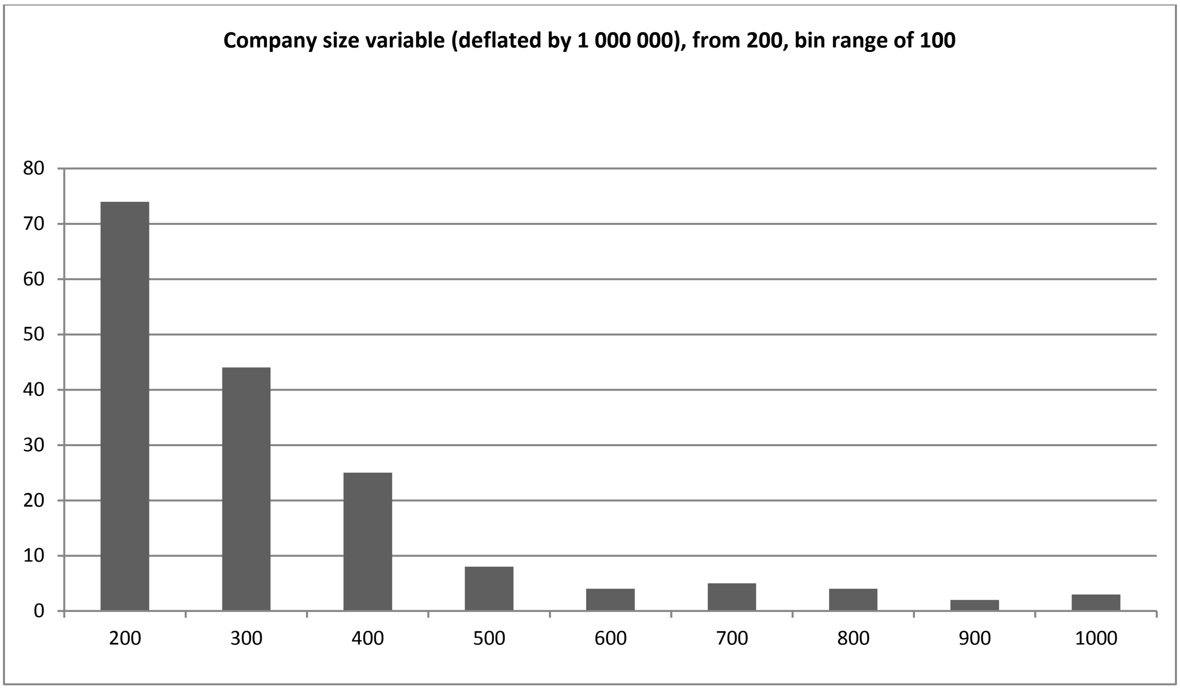


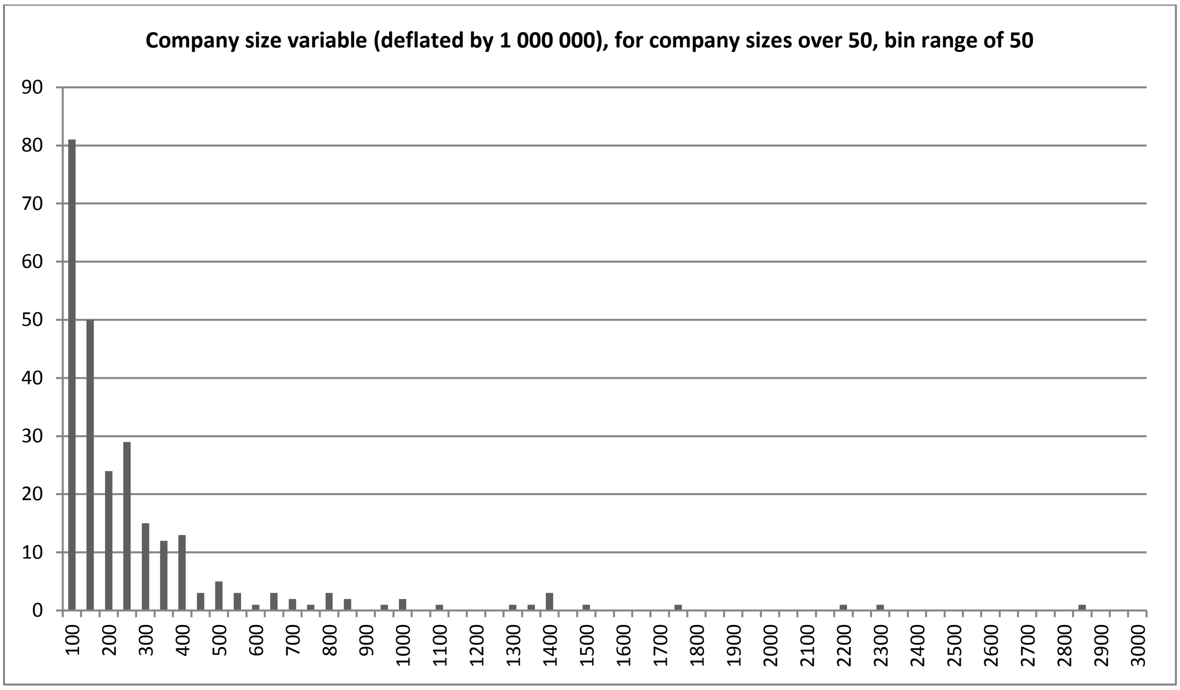
Checking for normal distribution[41] to determine the cut off point for the large firms shows that the data is highly skewed to the right. Removing the very small companies (that are majority of the data – companies with firm size less than $100 m represent 83% of the dataset) eliminates too many observations. Keeping the observations and breaking the dataset into smaller bin sizes renders the data abnormally distributed and highly skewed[42]to the right. Using the 100 mln as a cut off point for creating a binary indicator for small/large company size, still leaves the data for the bigger companies skewed to the right. (Data becomes somewhat normally distributed for companies over $600 m, but that leaves only 14 companies to be considered large).

Firm size variable (deflated by 1 000 000)	
Mean	76.24009
Standard Error	6.614437
Median	10.06817
Mode	1
Standard Deviation	212.3842
Sample Variance	45107.06
Kurtosis	**59.79543**
Skewness	**6.692957**
Range	2840.995
Minimum	0.005
Maximum	2841
Sum	78603.54
Count	1031

[41]Normally distributed data facilitates more accurate predictions.

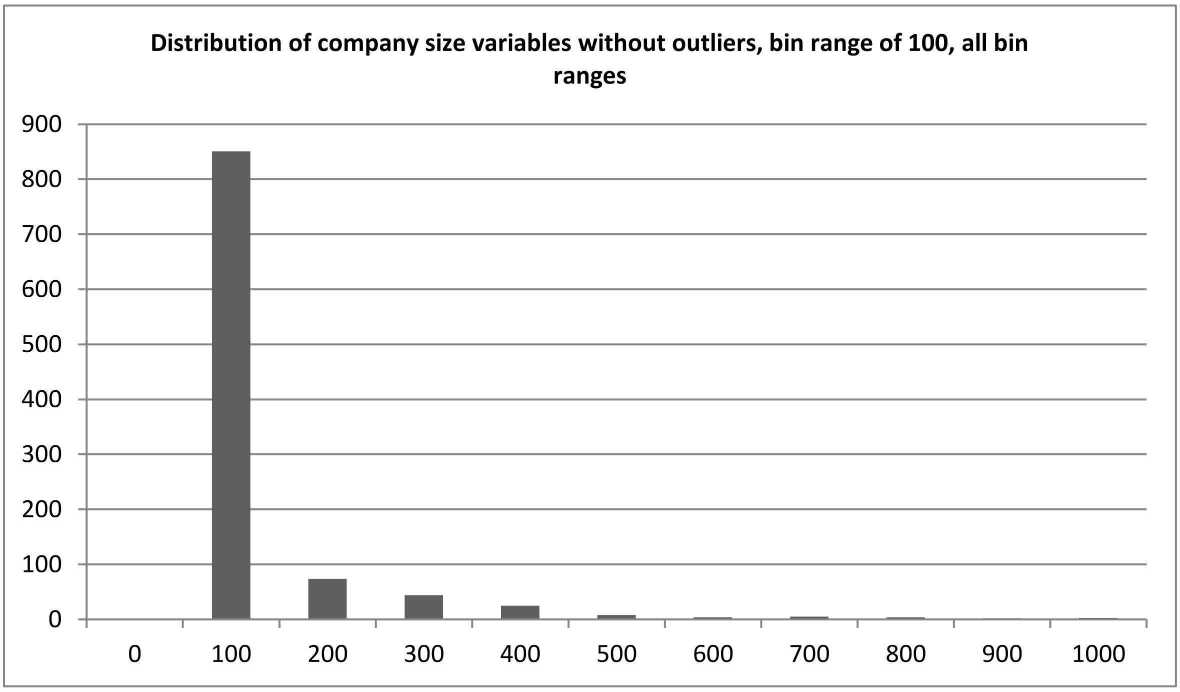
[42] Skewness measures how symmetrical the data is around the mid-point. Kurtosis indicates how quickly the data tails off (-2 and +2 means that data is consistent with the normally distributed dataset, for perfectly distributed data the value should be 0).





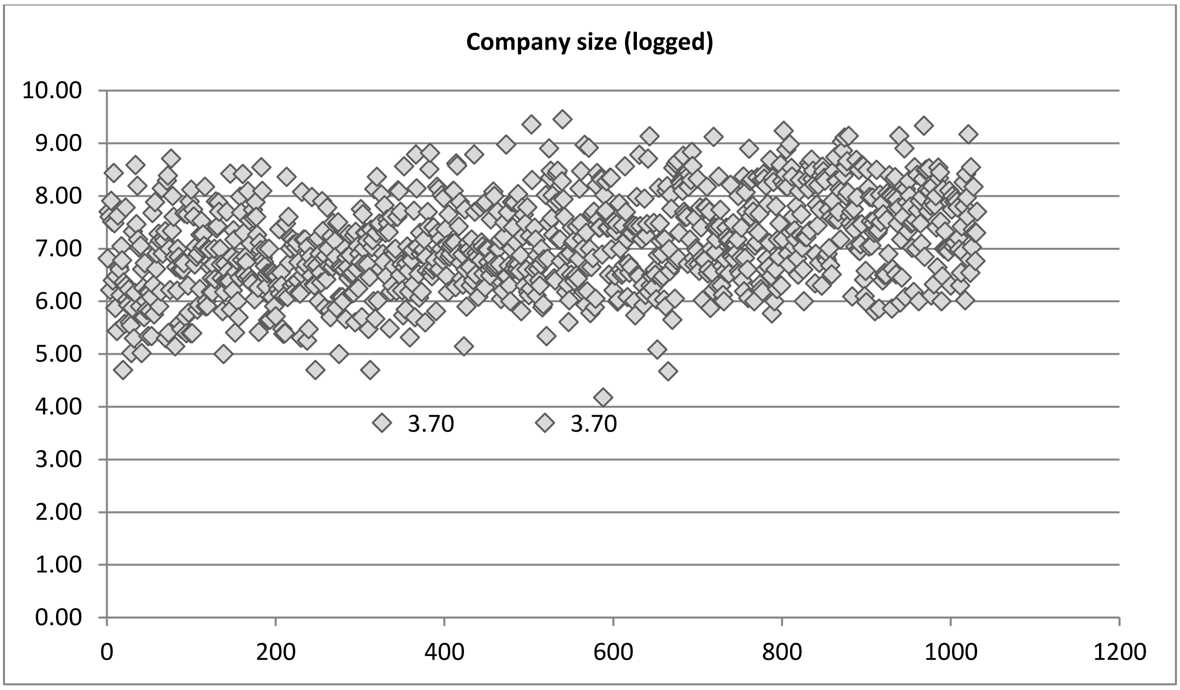
Removing outliers (companies with size over $1000 m) does not change the results for the normality of the distribution, i.e. the data remains highly skewed to the right.

Company size variable (deflated by 1 000 000)	
Mean	59.10278
Standard Error	3.8601
Median	10
Mode	1
Standard Deviation	123.2817
Sample Variance	15198.38
Kurtosis	**17.30687**
Skewness	**3.755249**
Range	956.991
Minimum	0.005
Maximum	956.996
Sum	60284.84
Count	1020

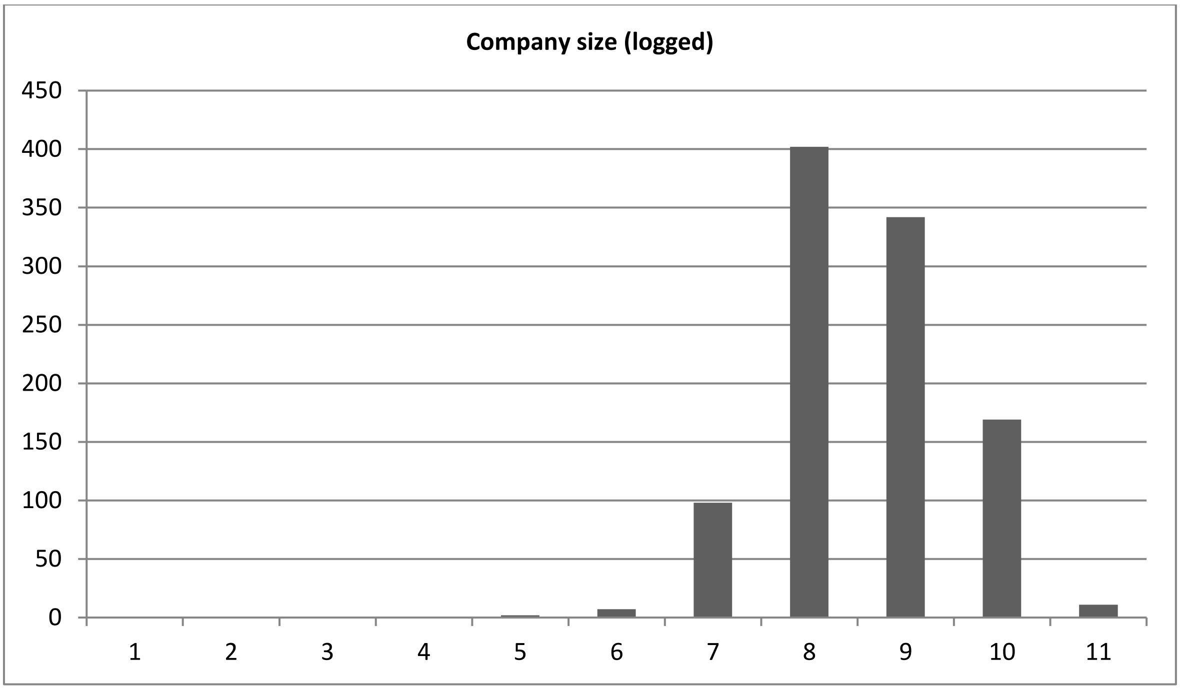


Logging the Firm Size variable[43] allows keeping the number of observations (without the need to remove outliers) while making the distribution of the transformed variable more symmetrical (more normal, with skewness very close to 0):

43 The log transformation can be used to make highly skewed distributions less skewed. Statistically if the variables are right-skew then a measure such as correlation or regression can be influenced significantly by a few cases at the high end (outliers, leverage points, influential points). Taking the log can help this by reducing or eliminating skew.



Company size (logged)	
Mean	7.077782
Standard Error	0.027701
Median	7.00295
Mode	6
Standard Deviation	0.889471
Sample Variance	0.791158
Kurtosis	**-0.09278**
Skewness	**-0.0185**
Range	5.754501
Minimum	3.69897
Maximum	9.453471
Sum	7297.193
Count	1031

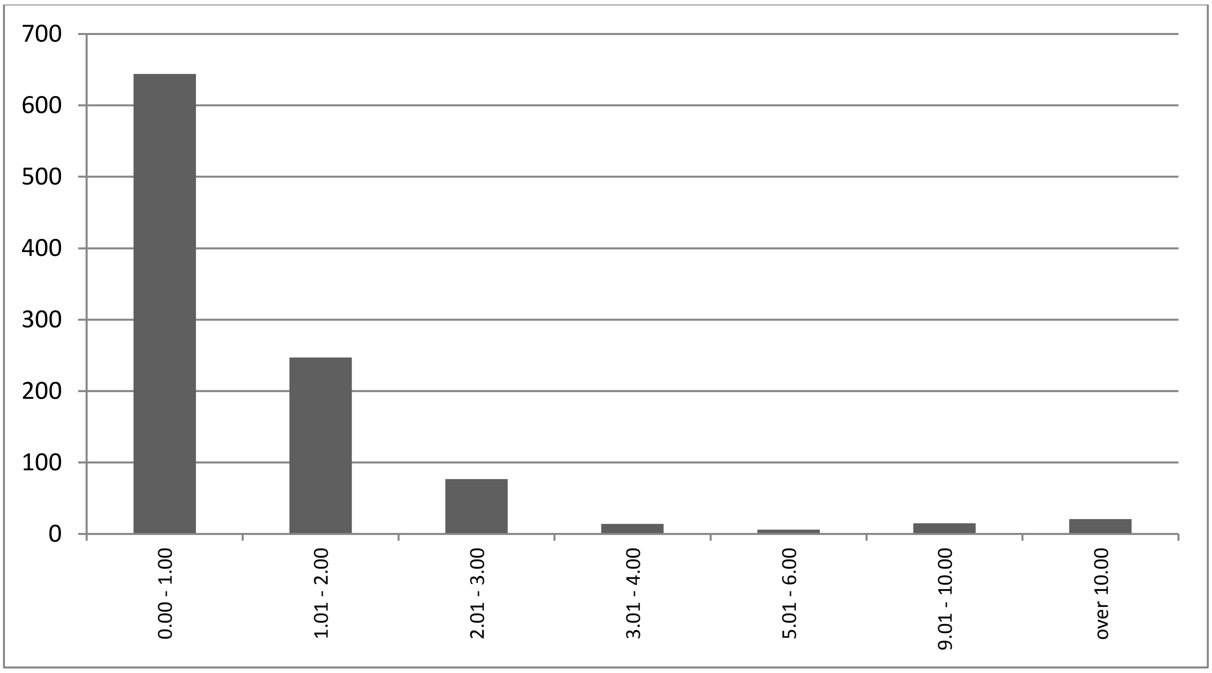


Therefore, based on the analysis of the Company Size variable, coding it as a binary dummy variable for an alternative specification for the model will require elimination of too many observations. However, as the data is highly skewed, logging the variable deflates it, eliminates the need to remove outliers, and renders the data normally distributed. The log of Company Size variable is used in the regression.

Offer Price (PENNY)*

Analysis of the data for the offer price variable shows that 63% of the data have offer price below or equal to $1.00 and the absolute majority of IPOs (87%) have offer prices below $2.00

Price range	frequency for the No of observations	% of the dataset 2002-2016
0.00 - 1.00	644	63%
1.01 - 2.00	247	24%
2.01 -3 .00	77	7%
3.01 - 4.00	14	1%
4.01 - 5.00	3	0%
5.01 - 6.00	6	1%
6.01 - 7.00	0	0%
7.01 - 8.00	2	0%
8.01 - 9.00	1	0%
9.01 - 10.00	15	1%
over 10.00	21	2%



Checking for the normality of the data distribution shows that kurtosis and skewness is the lowest for the stocks priced below $3.00. The ‘penny’ stocks account for the majority of the IPOs in the sample due to the predominance of AIM stocks in the given sample.

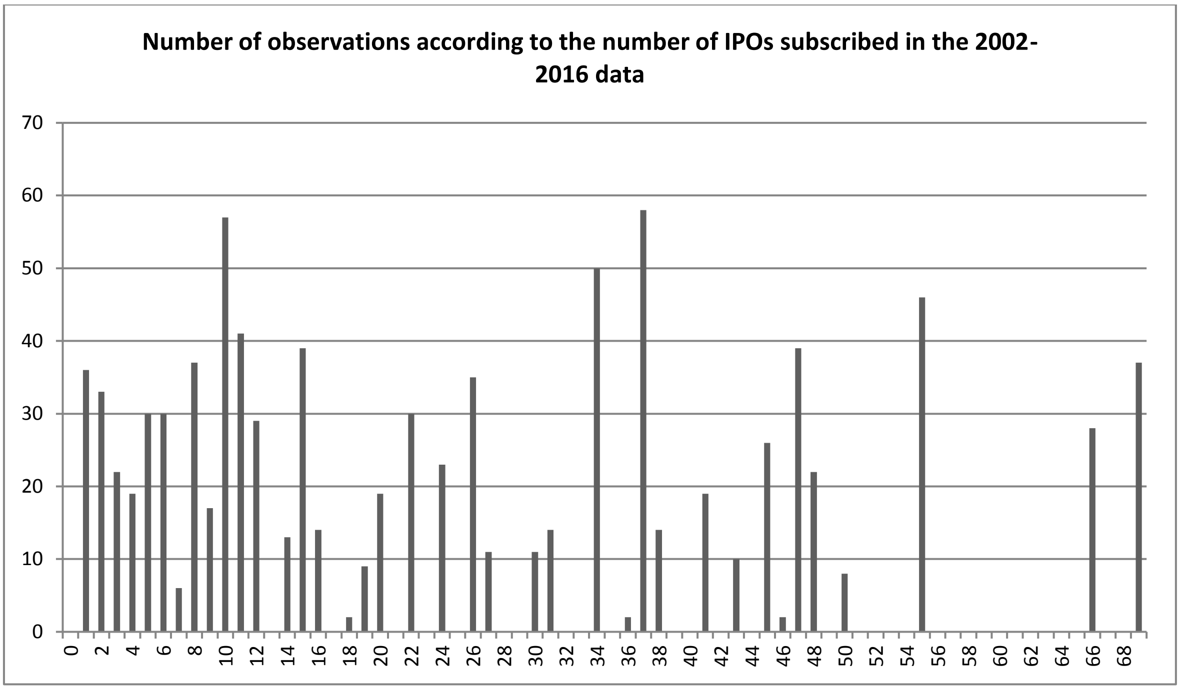
	offer p <1.00	offer p ≥ 1.00	offer p <3.00	offer p ≤4.00	offer p ≤ 5.00
Mean	0.368041	2.750173	0.888908	0.936098	0.948374
Standard Error	0.012704	0.231712	0.022126	0.024237	0.025179
Median	0.3	1.5	0.85	0.9	0.9
Mode	0.05	1	1	1	1
Standard Deviation	0.288583	5.253265	0.686605	0.759509	0.790241
Sample Variance	0.08328	27.59679	0.471426	0.576854	0.62448
Kurtosis	**-1.03063**	**84.01474**	**-0.26298**	**0.775125**	**2.210637**
Skewness	**0.457247**	**7.858709**	**0.662032**	**0.962106**	**1.210374**
Range	0.985	72	2.947	3.897	4.997
Minimum	0.003	1	0.003	0.003	0.003
Maximum	0.988	73	2.95	3.9	5
Sum	189.909	1413.589	856.018	919.248	934.148
Count	516	514	963	982	985

A binary dummy variable for the offer price is created based on the level of kurtosis and skewness. Stocks with offer price below $3.00 are coded as ‘penny’ stocks, equal to one the others are coded as equal to zero.

Reputation of the employed underwriter (UWrank)*

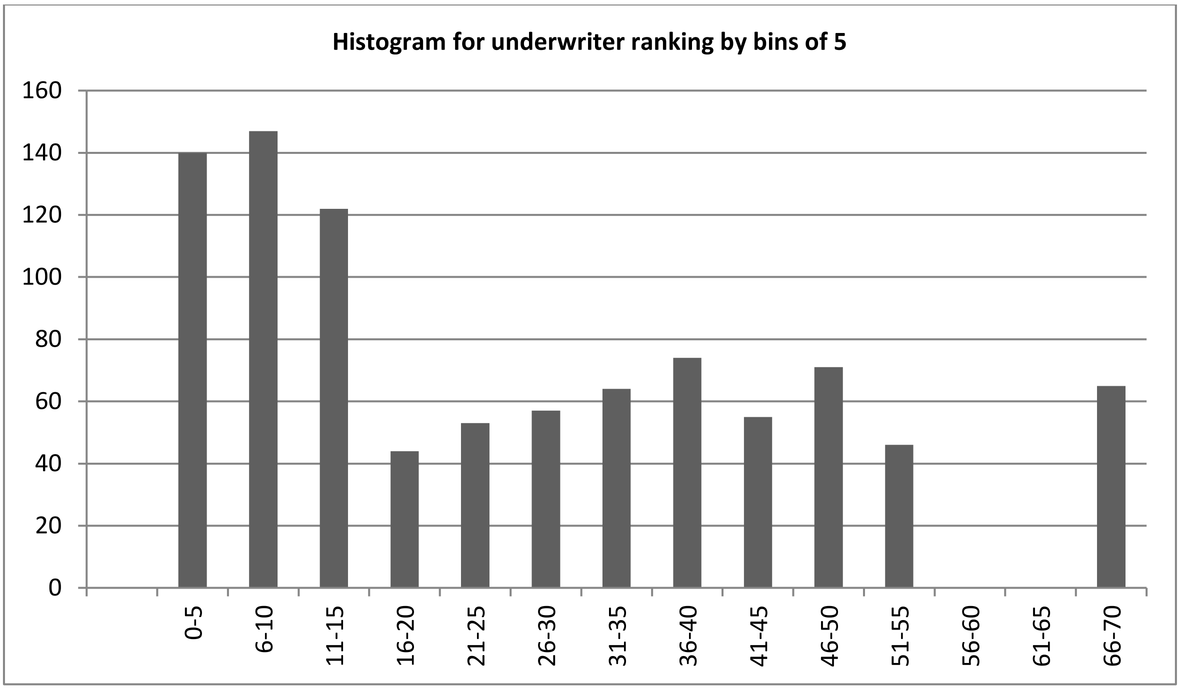
The initial underwriter ranking is based on the number of IPOs subscribed by that underwriter in the full dataset (1984-2016) for the analysis of distribution.

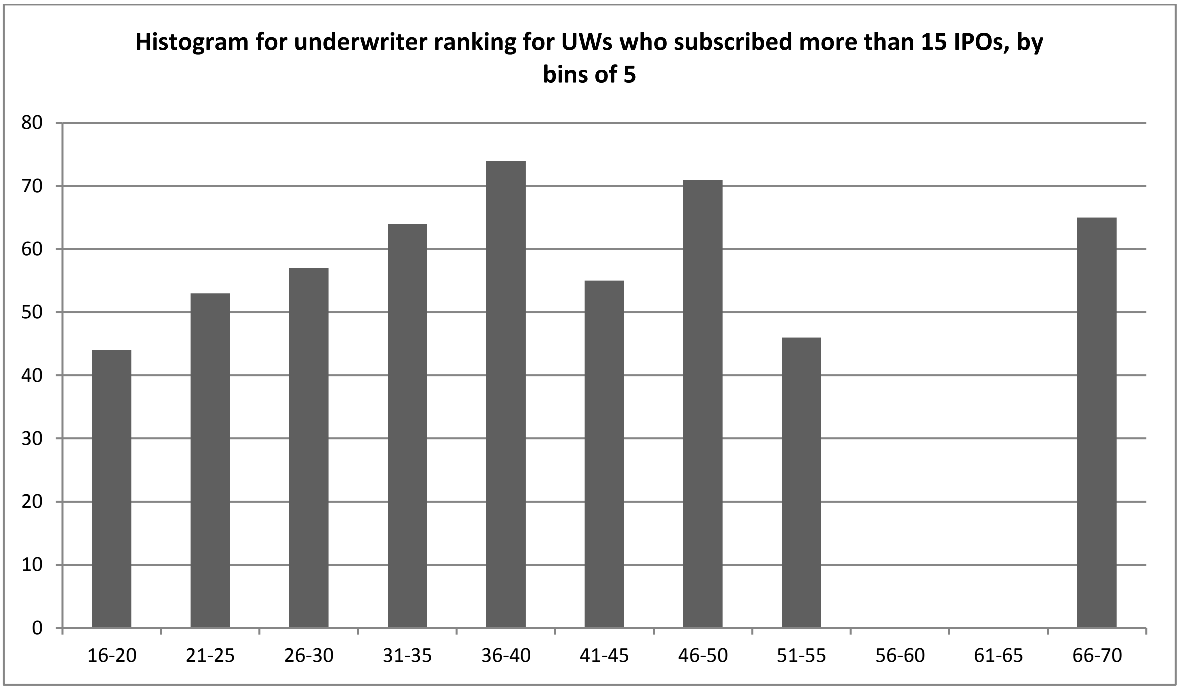
The descriptive statistics analysis show low kurtosis and skewness, meaning that the data for the underwriter ranking is more or less normally distributed. However, the mean is quite far away from the median value and the standard deviation is high.



Descriptive statistics for the underwriter ranking, all underwriters	
Mean	13.4
Standard Error	1.977765
Median	4
Mode	0
Standard Deviation	16.54717
Sample Variance	273.8087
Kurtosis	**-0.04624**
Skewness	**1.015832**
Range	58
Minimum	0
Maximum	58
Sum	938
Count	70

Breaking the number of subscribed IPOs into ranges by 5, shows that the data is more normally distributed for the underwriters who subscribed more than 15 IPOs.





Therefore, the analysis of the normality of the data distribution for the underwriter ranking indicate that the cut off point for creating a binary dummy variable for the prestigious underwriter is 16 IPOs: every underwriter that subscribed 16 and more IPOs in a given dataset is considered 'prestigious' and coded as one; the remainder are coded as equal to zero. The top ranked underwriters account for 13% of all underwriters in the sample. 56% of the underwritten IPOs in the sample use a 'prestigious' underwriter.

Type of offer (OT)*

The table below shows the specification for the dummy variables measuring the type of offer (national, international, mixed IPOs).

No	Type of Offer	Group	Specification	Intercept	Meaning
0	*National IPOs (base group)*	Group a	$d_{i,1}=0, d_{i,2}=0$	α	Relationship between the dependent variable and the national type of offer
1	*International IPOs*	Group b	$d_{i,1}=1, d_{i,2}=0$	$\alpha + \gamma_1$	Extra underpricing/higher probability group b will have compared to the national IPOs
2	*Mixed IPOs*	Group c	$d_{i,1}=0, d_{i,2}=1$	$\alpha + \gamma_2$	Extra underpricing/higher probability group c will have compared to the national IPOs

Industry (SECTOR)*

Table below shows the specification of the dummy variables for the industry sectors[44]. The regression model examining the relationship between industry sectors (SECTOR) and underpricing is specified as following:

$UP = \alpha + \rho_1(\text{Group b})_{i,1} + \rho_2(\text{Group c})_{i,2} + \rho_3(\text{Group d})_{i,3} + \rho_4(\text{Group e})_{i,4} + \rho_5(\text{Group f})_{i,5} + \rho_6(\text{Group g})_{i,6} + \rho_7(\text{Group h})_{i,7} + \rho_8(\text{Group i})_{i,8} + \rho_9(\text{Group j})_{i,9} + \rho_{10}(\text{Group k})i_{,10} + \rho_{11}(\text{Group l})_{i,11} + \varepsilon$

[44] Analysing the relationship between different industries and underpricing for the given dataset through a separate regression analysis gives a more detailed picture and provide a basis for creating a binary dummy variable

No	Sector	Group	Specification	Intercept	Meaning
0	*Financials (base group)*	Group a	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	α	Relationship between UP and the 'Financials' sector
1	*Consumer Products & Services*	Group b	$d_{i,1}$=1, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_1$	Extra UP group b will have compared to the Financials sector
2	*Consumer Staples*	Group c	$d_{i,1}$=0, $d_{i,2}$=1, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_2$	Extra UP group c will have compared to the Financials sector
3	*Energy & Power*	Group d	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=1, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_3$	Extra UP group d will have compared to the Financials sector
4	*Healthcare*	Group e	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=1, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_4$	Extra UP group e will have compared to the Financials sector
5	*High Technology*	Group f	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=1, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_5$	Extra UP group f will have compared to the Financials sector
6	*Industrials*	Group g	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=1, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_6$	Extra UP group g will have compared to the Financials sector
7	*Materials*	Group h	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=1, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_7$	Extra UP group h will have compared to the Financials sector
8	*Media & Entertainment*	Group i	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=1, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_8$	Extra UP group i will have compared to the Financials sector
19	*Real Estate*	Group j	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=1, $d_{i,10}$=0, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_9$	Extra UP group j will have compared to the Financials sector
10	*Retail*	Group k	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=1, $d_{i,11}$=0, $d_{i,12}$=0	$\alpha + \rho_{10}$	Extra UP group k will have compared to the Financials sector
11	*Telecommunications*	Group l	$d_{i,1}$=0, $d_{i,2}$=0, $d_{i,3}$=0, $d_{i,4}$=0, $d_{i,5}$=0, $d_{i,6}$=0, $d_{i,7}$=0, $d_{i,8}$=0, $d_{i,9}$=0, $d_{i,10}$=0, $d_{i,11}$=1, $d_{i,12}$=0	$\alpha + \rho_{11}$	Extra UP group l will have compared to the Financials sector

The regressions results show that the intercept for two sectors, ‘Consumer Staples’ and ‘Consumer Product and Services’ have a positive indicator, while the remaining sectors show a negative relationship. This means that two aforementioned sectors have higher underpricing than the base group, the ‘Financials’ sector, while the rest of the sectors exhibit less underpricing that the IPOs in the ‘Financials’ sector.

Regression Statistics	
Multiple R	0.140128927
R Square	0.019636116
Adjusted R Square	0.008079764
Standard Error	37.1564167
Observations	1031

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	12	28150.34	2345.862	1.699162	0.061842
Residual	1018	1405450	1380.599		
Total	1030	1433600			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	22.38542149	2.388505	9.372148	4.45E-20
Financials - BASE GROUP	0	0	65535	#NUM!
Consumer Products & Services	**2.556843218**	**4.38637**	**0.582906**	**#NUM!**
Consumer Staples	**10.58262018**	**7.951725**	**1.330858**	**0.183534**
Energy & Power	-5.328952352	4.769632	-1.11727	0.264144
Healthcare	-5.706889842	4.814654	-1.18532	0.236169
High Technology	-3.703263953	3.893728	-0.95108	0.341787
Industrials	-10.16548303	5.190852	-1.95835	0.050462
Materials	-5.046555508	4.465192	-1.1302	0.258659
Media & Entertainment	-1.044724518	5.15976	-0.20248	0.839586
Real Estate	-5.171645977	5.820692	-0.88849	0.374485
Retail	-4.425281488	5.772083	-0.76667	0.443456
Telecommunications	-7.797288154	7.192005	-1.08416	0.27855

The coefficient for the ‘Consumer Staples’ is the highest and specifying ‘Consumer Staples’ as the base group shows that indeed the level of underpricing is the highest in this sector.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.140341907
R Square	0.019695851
Adjusted R Square	0.008140203
Standard Error	37.15528469
Observations	1031

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	12	28235.98	2352.998	1.704435	0.060754
Residual	1018	1405364	1380.515		
Total	1030	1433600			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	32.96804167	7.584291	4.346885	1.52E-05
Consumer Staples (BASE GROUP)	0	0	65535	#NUM!
Consumer Products & Services	**-8.025776961**	**8.429468**	**-0.95211**	**#NUM!**
Financials	**-10.58262018**	**7.951483**	**-1.3309**	**0.18352**
Energy & Power	**-15.91157253**	**8.635095**	**-1.84266**	**0.065669**
Healthcare	**-16.28951002**	**8.660043**	**-1.881**	**0.060258**
High Technology	**-14.28588413**	**8.183951**	**-1.7456**	**0.081183**
Industrials	**-20.74810321**	**8.874692**	**-2.3379**	**0.019586**
Materials	**-15.62917569**	**8.470749**	**-1.84508**	**0.065317**
Media & Entertainment	**-11.6273447**	**8.856543**	**-1.31285**	**0.189528**
Real Estate	**-15.75426616**	**9.257173**	**-1.70184**	**0.08909**
Retail	**-15.00790167**	**9.226688**	**-1.62658**	**0.104137**
Telecommunications	**-18.37990833**	**10.17539**	**-1.80631**	**0.071165**

Based on the results of this regression a set of 11 dummy variables for the industry sectors was created and used in the overall regression for the level of IPO underpicing: IPOs in the 'Consumer Staples' sector are coded as BASE Group creating 11 dummy variables as specified below.

No	Sector	Group	Specification	Intercept	Meaning
0	*Consumer Staples (base group)*	Group a	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	α	Relationship between the IPO underpricing and the 'Consumer Staples' sector
1	*Consumer Products & Services*	Group b	$d_{i,1}=1$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_1$	Extra underpricing group b will have compared to the BASE group
2	*Energy & Power*	Group c	$d_{i,1}=0$, $d_{i,2}=1$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_2$	Extra underpricing group c will have compared to the BASE group
3	*Financials*	Group d	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=1$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_3$	Extra underpricing group d will have compared to the BASE group
4	*Healthcare*	Group e	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=1$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_4$	Extra underpricing group e will have compared to the BASE group
5	*High Technology*	Group f	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=1$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_5$	Extra underpricing group f will have compared to the BASE group
6	*Industrials*	Group g	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=1$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_6$	Extra underpricing group g will have compared to the BASE group
7	*Materials*	Group h	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=1$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_7$	Extra underpricing group h will have compared to the BASE group
8	*Media & Entertainment*	Group i	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=1$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_8$	Extra underpricing group i will have compared to the BASE group
9	*Real Estate*	Group j	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=1$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_9$	Extra underpricing group j will have compared to the BASE group
10	*Retail*	Group k	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=1$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_{10}$	Extra underpricing group k will have compared to the BASE group
11	*Telecommunications*	Group l	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=1$, $d_{i,12}=0$	$\alpha + \rho_{11}$	Extra underpricing group l will have compared to the BASE group

Industry dummy variables for the probability of an IPO being in a wave and the probability of an IPO being a Pioneering IPO is specified following the earlier findings of this research. ‘Financials’ sector exhibits the highest number of IPOs in the specified sample and for that reason is coded as the BASE group. Table below shows the specification for the industry dummy variables for the probit regression.

No	Sector	Group	Specification	Intercept	Meaning
0	*Financials (base group)*	Group a	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	α	Relationship between probability and the ‘Financials’ sector
1	*Consumer Products & Services*	Group b	$d_{i,1}=1$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_1$	Extra probability group b will have compared to the BASE group
2	*Consumer Staples*	Group c	$d_{i,1}=0$, $d_{i,2}=1$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_2$	Extra probability group c will have compared to the BASE group
3	*Energy & Power*	Group d	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=1$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_3$	Extra probability group d will have compared to the BASE group
4	*Healthcare*	Group e	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=1$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_4$	Extra probability group e will have compared to the BASE group
5	*High Technology*	Group f	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=1$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_5$	Extra probability group f will have compared to the BASE group
6	*Industrials*	Group g	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=1$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_6$	Extra probability group g will have compared to the BASE group
7	*Materials*	Group h	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=1$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_7$	Extra probability group h will have compared to the BASE group
8	*Media & Entertainment*	Group i	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=1$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_8$	Extra probability group i will have compared to the BASE group
9	*Real Estate*	Group j	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=1$, $d_{i,10}=0$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_9$	Extra probability group j will have compared to the BASE group
10	*Retail*	Group k	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=1$, $d_{i,11}=0$, $d_{i,12}=0$	$\alpha + \rho_{10}$	Extra probability group k will have compared to the BASE group
11	*Telecommunications*	Group l	$d_{i,1}=0$, $d_{i,2}=0$, $d_{i,3}=0$, $d_{i,4}=0$, $d_{i,5}=0$, $d_{i,6}=0$, $d_{i,7}=0$, $d_{i,8}=0$, $d_{i,9}=0$, $d_{i,10}=0$, $d_{i,11}=1$, $d_{i,12}=0$	$\alpha + \rho_{11}$	Extra probability group l will have compared to the BASE group

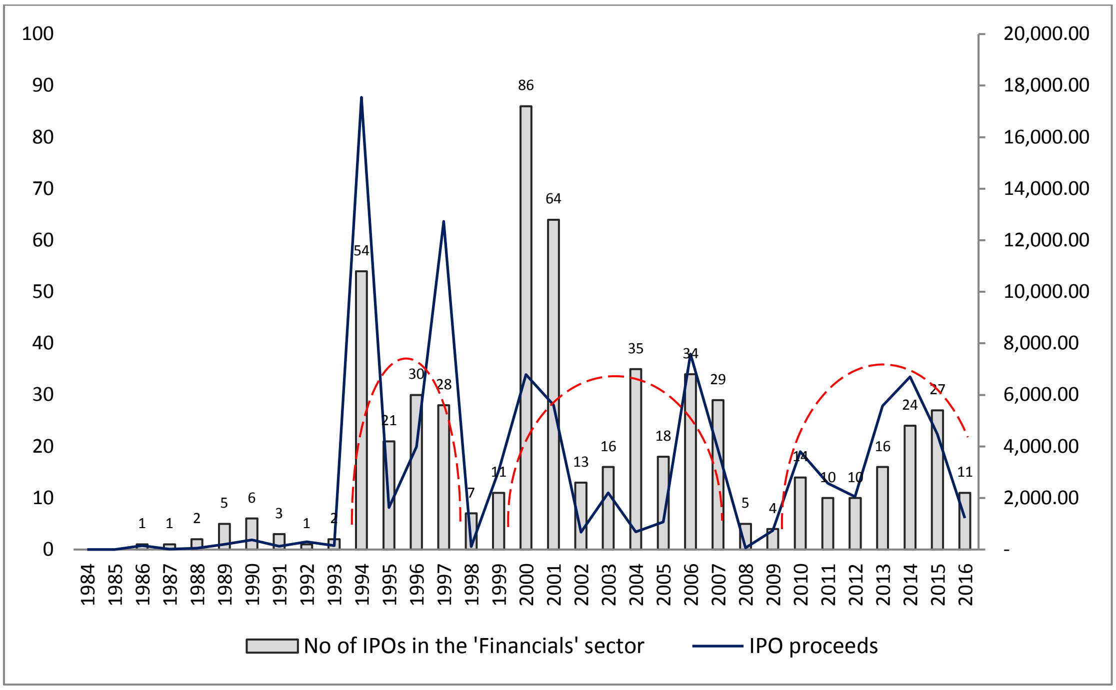
Appendix D: IPO waves

Yearly IPO waves in different industries.

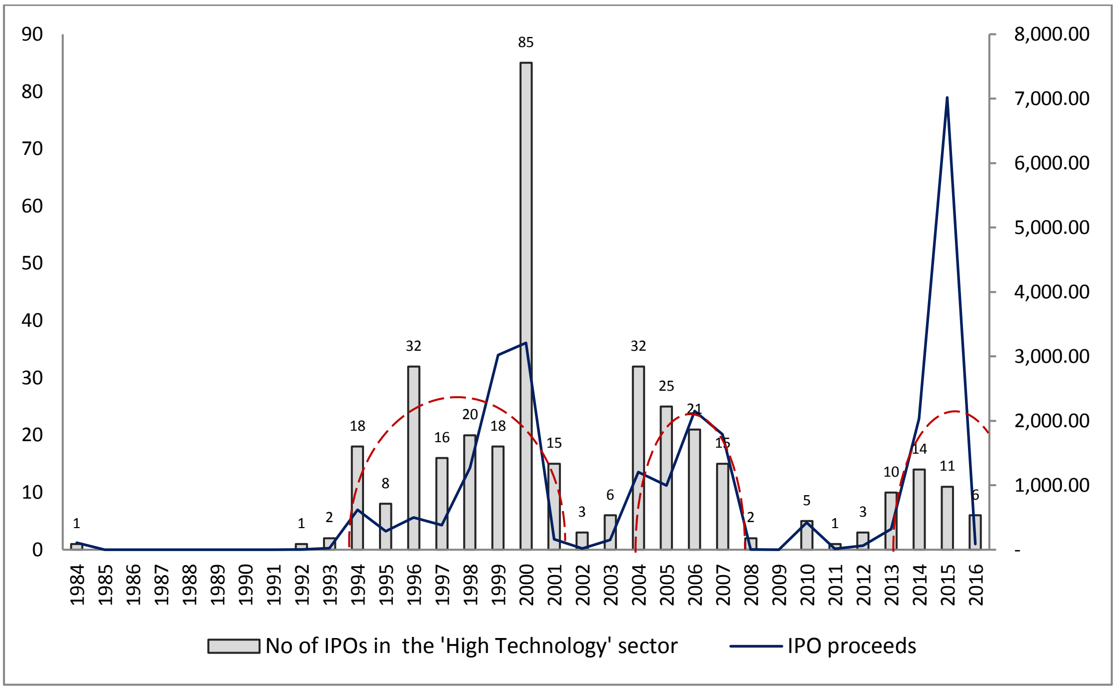
The table presents the overview of the yearly IPO waves for the IPOs of the UK-based companies in '*Media and Entertainment*', '*Industrials', 'Materials', 'Healthcare', 'Energy and Power', 'Retail'* sectors issued during the period from January 1984 to December 2016. *Italics indicate suggested end of the wave for the purpose of this investigation.

No	Wave	Peak	Date	Description	Duration, years
Yearly IPO waves in the Media and Entertainment sector					
1	1994 - 1998	11	1994	Complete	5
2	2000 - 2001	29	2000	Complete	2
3	2004 - 2005	24	2004	Complete	2
Yearly IPO waves in the Industrials sector					
1	1994	14	1994	Complete	1
2	1996 - 1997	23	1996	Complete	2
3	2000 - 2007	13	2006	Complete	8
Yearly IPO waves in the Materials sector					
1	1996 - 1997	12	1997	Complete	2
2	2003 - 2007	20	2005	Complete	5
Yearly IPO waves in the Healthcare sector					
1	1994 - 1998	10	1996	Complete	5
2	2000 - 2002	13	2000	Complete	3
3	2004 - 2006	14	2004, 2005	Complete	3
4	2014 - *(2016)**	12	2014	Incomplete	3
Yearly IPO waves in the Energy and Power sector					
1	1989 - 1990	10	1990	Complete	2
2	2004 - 2006	18	2004	Complete	3
Yearly IPO waves in the Retail sector					
1	1994 - 1998	14	1996	Complete	5
2	2014 - *(2016)**	12	2014	Incomplete	3

Yearly IPO proceeds in the 'Financials' sector.
The figure presents an overview of the yearly IPO proceeds in the 'Financials' sector in relation to the IPO waves for the sample of 588 IPOs of the UK-based companies issued from January 1984 to December 2016. For the 'Financials' sector the highest IPO proceeds happen within IPO waves; they generally follow the increase in IPO numbers and decline dramatically during the trough periods.

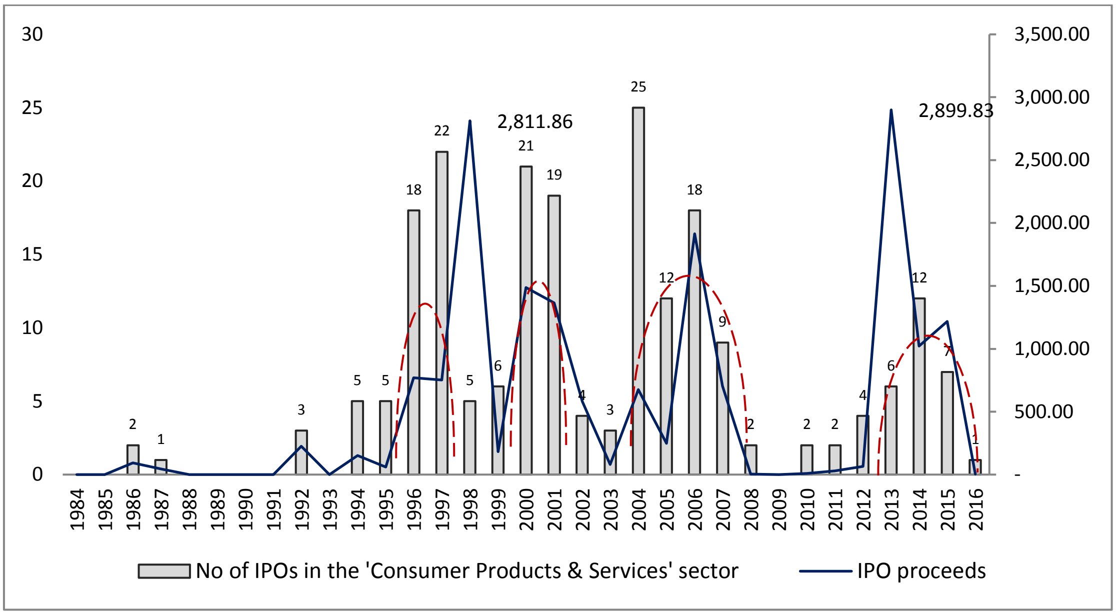


Yearly IPO proceeds in the 'High Technology' sector.
The figure presents an overview of the yearly IPO proceeds in the 'High Technology' sector in relation to the IPO waves for the sample of 370 IPOs of the UK-based companies issued from January 1984 to December 2016. The 'High Technology' sector displays a similar picture as the 'Financials' sector. An interesting observation for this sector is that while the highest numbers of IPO transactions occur in 2000, the highest IPO proceeds happen in 2015 when the number of IPOs is almost eight times less than in 2000.



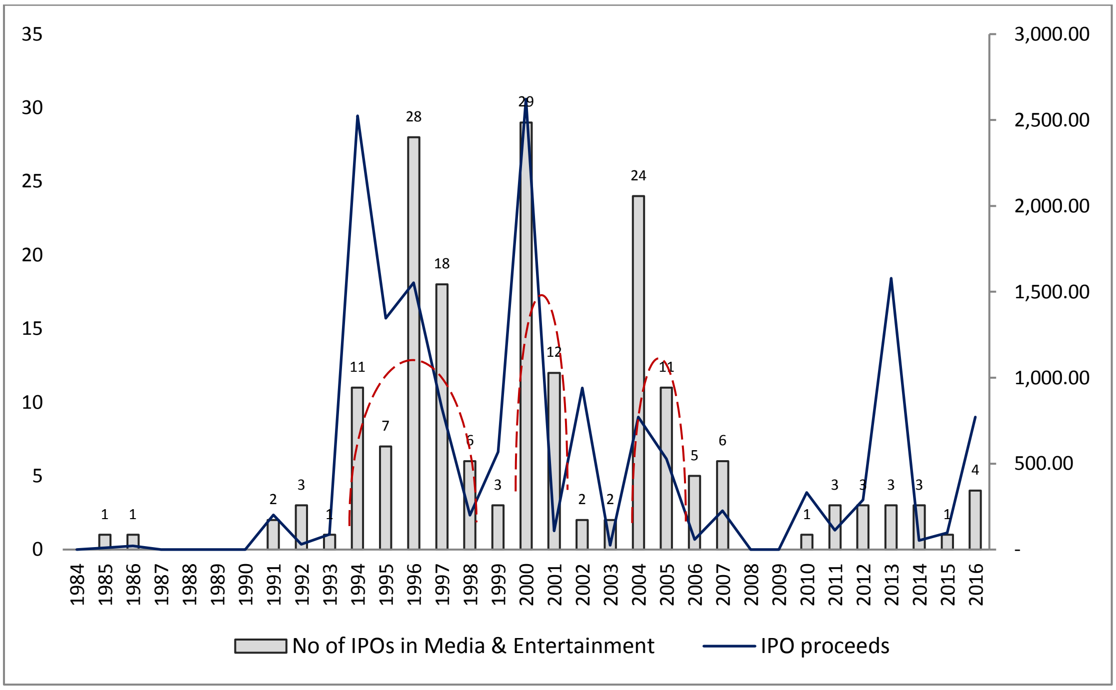
Yearly IPO proceeds in the 'Consumer Products & Services' sector.

The figure presents an overview of the yearly IPO proceeds in the 'Consumer Products & Services' sector in relation to the IPO waves for the sample of 214 IPOs of the UK-based companies issued from January 1984 to December 2016. The situation is slightly different for this sector. While the dynamic of the level of IPO proceeds generally correspond to the development of IPO waves for this sector, the highest IPO proceeds follow a different pattern. The highest IPO proceeds for this sector happen in two periods: in 1998 and in 2013, the levels of these proceeds are similar to each other and the number of IPO transactions in the two years is quite low (five and six IPOs respectively) comparing to other periods and peaks of the IPO waves. Also, for the first wave the level of IPO proceeds is the highest after the wave (the wave finishes in 1997 and the highest IPO proceeds for this period happen in 1998).



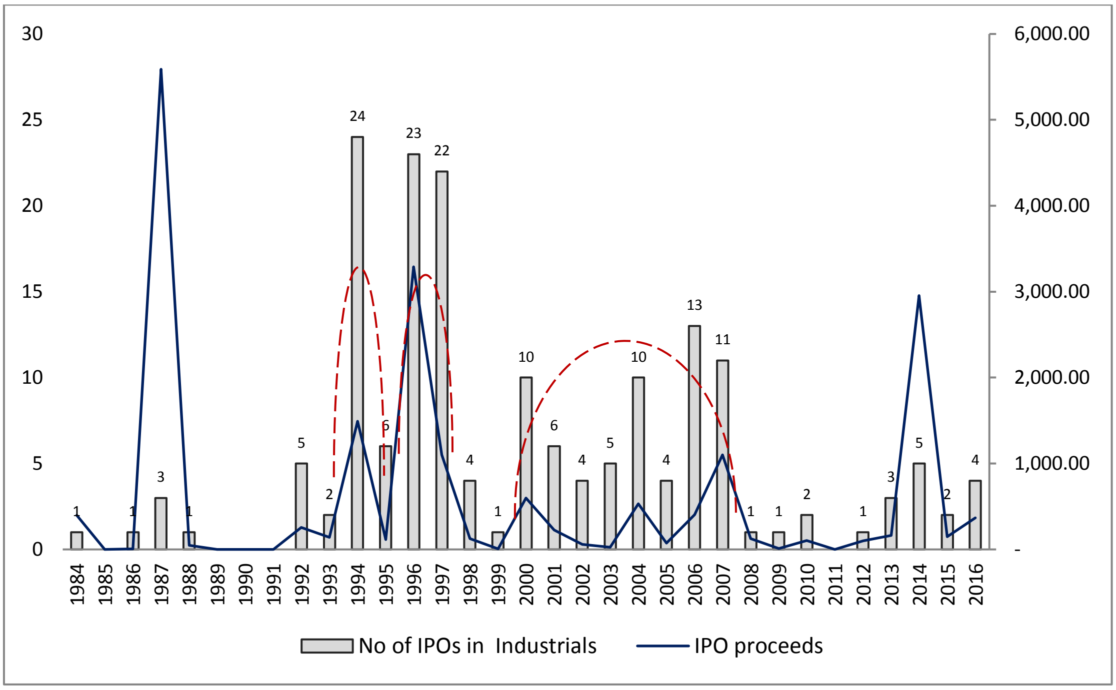
Yearly IPO proceeds in the 'Media & Entertainment' sector.

The figure presents an overview of the yearly IPO proceeds in the 'Media & Entertainment' sector in relation to the IPO waves for the sample of 190 IPOs of the UK-based companies issued from January 1984 to December 2016.



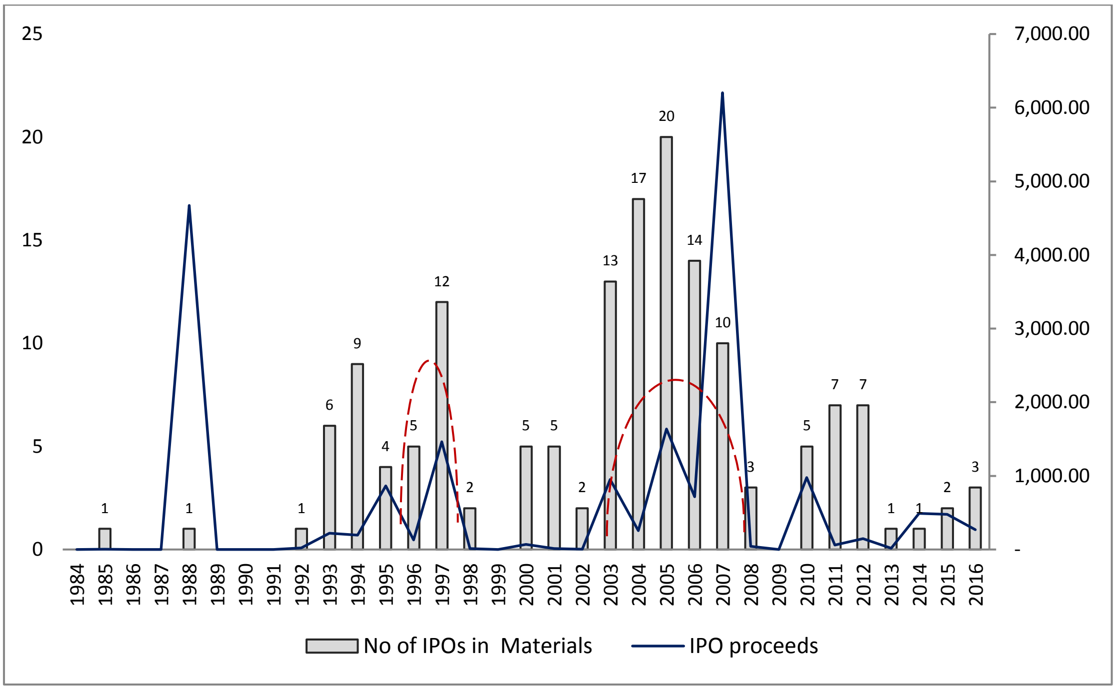
Yearly IPO proceeds in the 'Industrials' sector.

The figure presents an overview of the yearly IPO proceeds in the 'Industrials' sector in relation to the IPO waves for the sample of 175 IPOs of the UK-based companies issued from January 1984 to December 2016.

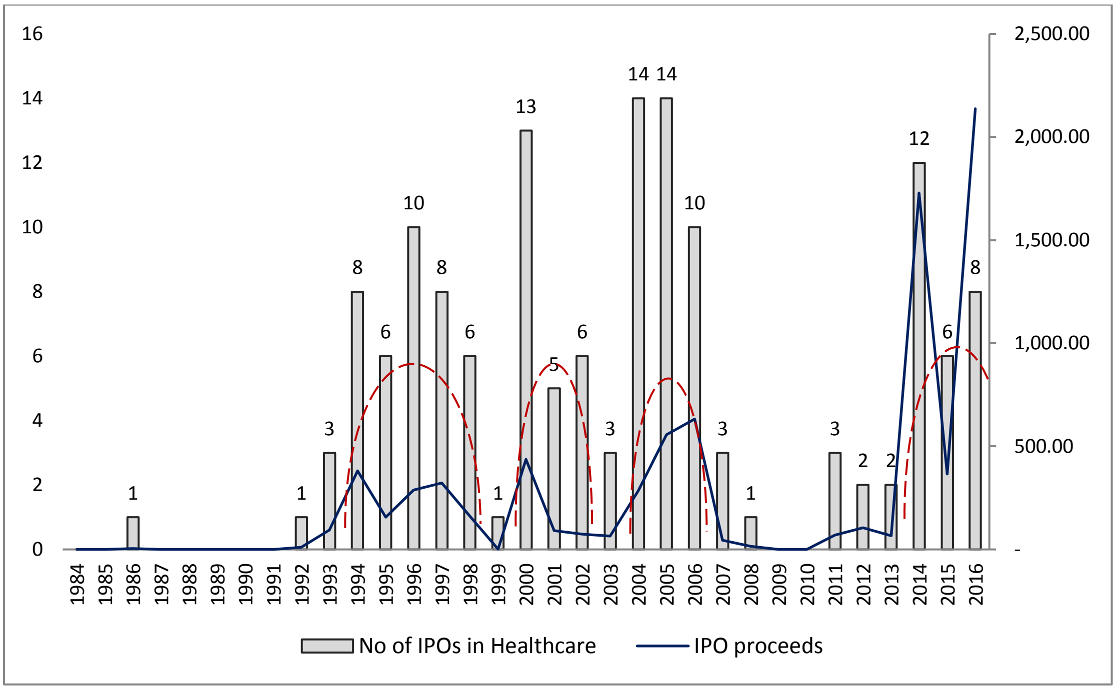


Yearly IPO proceeds in the 'Materials' sector.

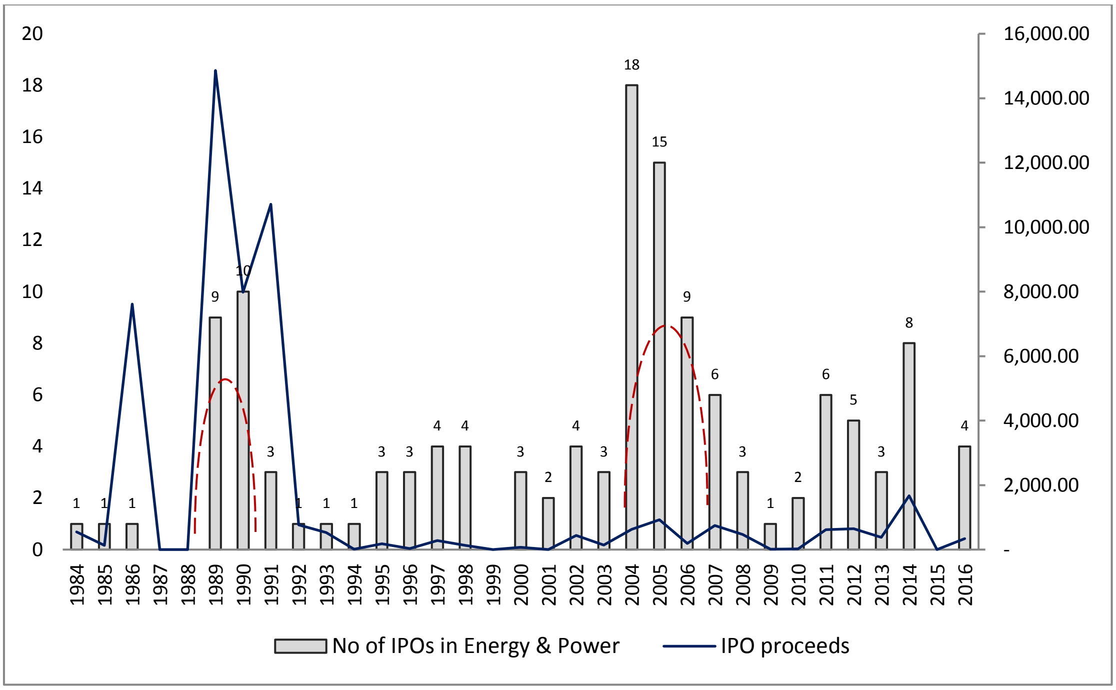
The figure presents an overview of the yearly IPO proceeds in the 'Materials' sector in relation to the IPO waves for the sample of 156 IPOs of the UK-based companies issued from January 1984 to December 2016.



Yearly IPO proceeds in the 'Healthcare' sector.
The figure presents an overview of the yearly IPO proceeds in the ‘Healthcare’ sector in relation to the IPO waves for the sample of 146 IPOs of the UK-based companies issued from January 1984 to December 2016.



Yearly IPO proceeds in the 'Energy & Power' sector.
The figure presents an overview of the yearly IPO proceeds in the ‘Energy & Power’’ sector in relation to the IPO waves for the sample of 134 IPOs of the UK-based companies issued from January 1984 to December 2016.



Yearly IPO proceeds in the 'Retail' sector.

The figure presents an overview of the yearly IPO proceeds in the ‘Retail’ sector in relation to the IPO waves for the sample of 110 IPOs of the UK-based companies issued from January 1984 to December 2016.