UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI "M. FANNO"

CORSO DI LAUREA MAGISTRALE IN BUSINESS ADMINISTRATION

TESI DI LAUREA

"HOW ARTIFICIAL INTELLIGENCE AND THE PUBLIC LAUNCH OF ChatGPT CAN INFLUENCE IPO VALUATIONS"

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MATRICOLA N. 2040913

ANNO ACCADEMICO 2023 – 2024

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INTRODUCTION

The initial public offering (IPO) represents a crucial step for a private company, marking its first sale of shares to the public and its debut on the stock exchange. Deciding to list on the stock exchange is one of the most important decisions in the life of a company and the assessments to be made should not only focus on raising significant capital, which can be crucial for a company's expansion plans, for research and development initiatives or for hiring qualified talent without increasing debt. The listing also represents a transformation that offers a mix of tangible and intangible financial, tax, operational and organizational benefits, including better reputation, greater visibility and prestige among business and financial communities. These advantages contribute to the commercial and marketing leverage, improving customer and supplier relationships and attracting qualified managers, employees and potential partners. This is a transformative and complex undertaking for companies seeking to transform themselves into publicly traded entities that require preliminary "**corporate housekeeping**".

The drive to meet market growth expectations established during the listing process fosters a culture of short-termism, potentially overshadowing long-term strategic goals and increasing vulnerability to unpredictable market dynamics.

The financial benefits and opportunities for shareholders to monetize their investments entail significant expenses, including the gross spread to financial institutions, legal, accounting, marketing, stock market registration fees, and the often underestimated indirect cost of undervaluing shares.

The scenarios analysed in this paper are based on companies navigating the world's largest stock market, the U.S. stock market, which is home to the New York Stock Exchange (NYSE) and NASDAQ. These exchanges differ in their trading models, market capitalization, and listing requirements: the NYSE is known for its hybrid auction market model and the NASDAQ for its all-electronic, technology-focused trading market. Despite these differences, both exchanges play a crucial role in the global financial landscape, hosting some of the world's leading companies. The integrity of the U.S. stock markets is regulated by the SEC and FINRA. In the literature, we find a great many studies and references to the various stages of the process of how these can influence the phenomenon of underpricing, a significant aspect of initial public

offerings (IPOs). In fact, the day of a company's IPO is usually characterized by a marked increase in the share price relative to the initial offering price. This increase represents a cost to the issuing company and pre-issuance shareholders, as it indicates that the proceeds of the offering could have been greater if the shares had been sold at the closing price, or that the same amount of proceeds could have been raised by selling fewer shares. According to this dynamic therefore there is a transfer of wealth from the shareholders, who "leave money on the table" to the initial investors who buy at a lower price compared to what the market is willing to pay for.
Major contributions on the topic come from Ibbotson, Ritter, and Welch, who confirmed a significant relationship between IPOs and underpricing. Despite the predominant focus on U.S. equity markets, the underpricing phenomenon has been observed in a variety of national and sectoral contexts, highlighting its ubiquity in global markets.
It is not possible to identify a single theory able to provide an exhaustive explanation of this phenomenon. Underpricing of IPOs emerges as a complex phenomenon, influenced by a variety of theories ranging from information asymmetry and market strategies to investor psychology and institutional dynamics, offering an in-depth and nuanced view of this practice in equity markets.
II prism of information asymmetry and its market implications has been widely studied and the focus of theories. Ibbotson (1975) and Leland & Pyle (1977) were among the first to explore how underpricing could act as a signaling mechanism to mitigate information asymmetry between issuers and investors, proposing that an initial listing below market value could foster a positive perception among investors. Baron (1982), with his Principal-Agent Theory, further explored this issue, highlighting how information asymmetry between issuers and underwriters could deliberately influence the choice of underpricing. The best-known model, however, is Rock's (1986) Winner's Curse Model, which highlighted how information asymmetry between informed and uninformed investors leads to underpricing because of the risk of uninformed investors overpricing new issues. Finally, Benveniste and Spindt (1989), with Information Aggregation Theory, observed how information frictions could distort the pricing of IPOs, with issuers tending to present themselves as higher-quality companies than they are.

This is followed by institutional theories, with Tinic (1988) interpreting underpricing as a strategy to reduce legal risk and reputational damage for underwriters, or as a price stabilization service. In contrast, Rydqvist (1997) and Taranto (2003) explore the fiscal perspective, suggesting how underpricing can become beneficial in contexts of different tax burdens on growing assets. A crucial role is also attributed to ownership structure, suggesting

how underpricing can facilitate the dispersion of ownership to increase the market value of the controlling stake.
On the behavioural theories front, Welch (1992) and Ritter (1998) introduced the idea of information cascades, while Jungqvist, Nanda, and Singh (2006) explored investor sentiment, pointing out how cognitive biases can influence underpricing.
Finally, other endogenous factors such as corporate group affiliation, lending relationships, reputation of issuers, and monopsonistic power of underwriters, as well as the choice of listing method itself, are considered elements that can affect underpricing.

This thesis aims to explore whether the growing enthusiasm toward artificial intelligence (AI), recognized as one of the most relevant technological advances of our time, endowed with the potential to revolutionize industries, economies, and entire societies, exerts a significant impact on the phenomenon of underpricing in initial public offerings (IPOs).
The event selected as the reference point for this investigation is the launch of ChatGPT on Nov. 30, 2022, a moment after which the enormous potential of AI was made accessible on a large scale, sparking growing interest and marked enthusiasm for this technology.
The objective of the analysis is to investigate whether the popularization and adoption of ChatGPT have introduced a bias in investor behaviours and whether there are factors that may influence market dynamics and investor decisions regarding AI, similar to what has been observed in the earlier stages of previous financial crises.
This research therefore aims to explore the interactions between perceptions of AI and the market valuations of companies that mention it in their IPOs, to determine whether these valuations are motivated by sound economic fundamentals or whether, on the contrary, they are influenced by unrealistic expectations, potentially shaping up as a new example of a speculative bubble in recent financial history.
Through an in-depth analysis of the data collected, along with a comparison of current macroeconomic conditions with historical contexts characterized by speculative bubbles fueled by technological innovations, this paper aims to determine whether there are premonitory signs of unrealistic expectations. These could indicate the emergence of a new financial bubble, fitting into a recurring pattern in recent economic history. The goal is thus to discern whether high valuations in AI-related IPOs reflect sound economic fundamentals or, conversely, are influenced by excessive speculative optimism.

The structure of the thesis is divided into three chapters. In Chapter 1, a detailed examination of Initial Public Offerings (IPOs) is offered, examining the benefits and costs associated with public listing, the participants involved, and the stages of the IPO process. In addition, this chapter explores the phenomenon of underpricing, analysing the various theories in the literature that attempt to explain this trend.

Chapter 2 begins with an overview of the historical contexts in which the three most recent speculative bubbles induced by technological innovations developed: the dot-com bubble, the real estate bubble that preceded the 2008 financial crisis, and the two speculative moments in the cryptocurrency market. This section then dives into the analysis of the observed sample and describes in detail the methodology followed to build the analysis models used. The chapter concludes with an analysis of the data collected, offering an interpretation of the results in light of the theories examined.

Finally, Chapter 3, which serves as a conclusion, positions the results of the analysis in the current economic environment, assessing whether existing conditions may favor the formation of a new speculative bubble. This chapter aims to place the evidence from the analysis into a critical perspective, comparing current macroeconomic dynamics with past ones, to assess the effect of artificial intelligence on the financial market, with a particular focus on IPO valuations, and on investor behavior, with an eye toward the possibility that unrealistic expectations are being formed, potentially a prelude to another financial bubble in recent history.

CHAPTER 1
Initial Public Offerings

1.1 Why a company decides to go public

Firstly, it is necessary to understand which are the motivations and benefits that lead a company to decide to go public. In the same way, it is fundamental to identify the negative factors involved in this choice. The listing process focuses on the need to raise new capital as the IPO is seen as the preferred tool to fulfill this need.
Therefore, an IPO can create the tantalising prospect of having capital available to fund future growth, however, careful thought is needed as it opens the company to greater scrutiny from the public which can change the way business is done and can increase the pressure to maintain growth patterns and meet the expectations of the investors.

Pros and cons of going public

Deeply valuing the benefits and the disadvantages that lead the managers' and the shareholders' decisions on going public, listing the company, it is possible to identify four basic groups of benefits (Deloitte, 2010): financial, tax, operational and organisational benefits.
The capital increase from an IPO provides additional financial support to meet working capital needs for purchases, investments, or to debt repayment. This financial manoeuvre enables a structural reconfiguration of the company, notably through an immediate enhancement of the debt-to-equity ratio. Such improvement often results in a reduction of debt capital costs, as capital raised through an IPO is perceived as less risky compared to that of an unlisted company. This perception enhances the company's credit standing and renders its capital more attractive as collateral. Moreover, an IPO enhances liquidity for management, employees, and existing investors by allowing shares to be traded freely in the market. This increased share liquidity and the resultant availability of more comprehensive information facilitate the company's market valuation. Notably, public companies may enjoy higher market valuations than their

private counterparts, a phenomenon partially attributed to the often upward-biassed analyst recommendations post-IPO (Bradley, Jordan, and Ritter, 2003).

Over time, the financial benefits of an IPO extend to a greater ability to raise capital. Should the company's shares perform well, the company could issue additional shares or debt on favourable terms, thus securing future financing. In addition, IPOs favour acquisition strategies, allowing companies to acquire other companies at attractive prices (Zingales, 1995) and to use public shares as "currency" for such transactions (Brau et al., 2003).

Tax incentives are also a noteworthy benefit, with listed companies potentially enjoying reduced rates designed to encourage the listing process.

On the operational front, an IPO can serve as a strategic manoeuvre by diversifying the firm's ownership and introducing new management styles. This diversification can drastically change or partially alter the company's directive trajectory, with all its merits and drawbacks (Chemmanur and Fulghieri, 1999). Additionally, going public enhances a firm's visibility and reputation, as it becomes subject to more rigorous analysis by broker-dealers, who will compare with other similar companies setting earnings expectations, and continued exposure through worldwide media coverage of financial markets.

This increased visibility can lead to a first-mover advantage, strengthen the company's branding, and enhance its perceived reliability and security among customers and suppliers, indirectly boosting customer satisfaction and the quality certification of the company's business(Maksimovic and Pichler, 2001).

Furthermore, a public company will be more attractive as a partner in a joint venture or other similar relationship since an initial public offering allows insiders to cash out. In fact, by listing itself, the company can provide an attractive exit strategy for major shareholders, such as venture capital and private equity firms, seeking liquidity in the company. This exit strategy is particularly appealing for investors with a time horizon of less than ten years, allowing them to liquidate their holdings at the end of this period (Zingales, 1995; Mello and Parsons, 2000).

By choosing to go public at an optimal time, a company can minimise dilution and secure a higher price for its securities than through private placements or other equity financing methods. This strategic timing ensures that the company parts with a smaller share of ownership in exchange for the same amount of financing.

IPOs also present organisational benefits by improving the flow of internal and external information, such as corporate communication to sponsors, suppliers, collaborators, employees, customers and lenders themselves, thus enhancing transparency and fairness in corporate communications.

The increased visibility and prestige associated with being a publicly listed company, combined with the use of stock options, augment the firm's ability to attract and retain top talent. These instruments not only serve as incentives for managers and employees to contribute to the company's success without increasing cash compensation but also help mitigate the challenges associated with information asymmetry and moral hazard.

In considering the decision to list, a myriad of negative implications deserve careful consideration. The main concern is the potential dilution of control for existing shareholders, which carries the risk of making the company vulnerable to hostile takeovers. New restrictions imposed by stricter disclosure requirements, requiring disclosure of a wider range of information and specific deadlines for disclosure, result in a loss of confidentiality and structural changes by substantially altering the company's information landscape.

Overwork of top management, which often needs to be available to shareholders, brokers, analysts, the press, etc. and they must be also involved in the preparation and certification of written information disclosed to the public and the SEC. This could result in management’s distraction, preventing it from devoting time to running the company.

Going public increases internal pressures to enforce expectations of self-established future growth rates shared in the listing process, from which it will be difficult to deviate. Such pressures entrench a culture of short-termism that can divert management's attention from medium- to long-term goals.

An increasing number of unpredictable external factors (crises, economic conditions, speculative market movements, contexts of anomalous volatility, etc.) can negatively affect the stock price, causing significant damage to the firm’s image and debt rating.

Public companies are also subjected to continuous reporting requirements of operating results, on a quarterly basis, to be submitted to the SEC. This continuous external evaluation throughout the year can intensify the pressure and significantly shorten planning and operational horizons.

This environment is further complicated by increased anti-fraud regulations exposition at the Securities Act of 1933 and the Securities Exchange Act of 1934, which heightened the legal exposure for directors, who have a fiduciary duty to the corporation, that means that they owe it a duty of loyalty and care and must act in good faith and in its best interest. Both cause a restructuring of corporate decision-making.

Greater regulation of corporate governance as a result of the fall in investor confidence caused by the bursting of the Dot-com bubble in 2000 resulting in increased governance standards on the New York Stock Exchange (NYSE) and the Nasdaq Stock Market (Nasdaq) and the costs of control that the company must undergo.

Change in corporate culture and flexibility through the introduction of new staff, from the loss of staff, or from the company's increased accountability to shareholders after the IPO.

1.2 Costs incurred going public

Control costs are not the only costs that arise from the IPO; in fact, the costs or, as Dessy and Vender (2001) call them, “investments” that a listing company faces are multiple and increase significantly both at the time of listing and in the years that follow. A proper and thorough analysis of all possible cost items is necessary to assess the actual feasibility of the listing project. The costs that are generated can be direct or indirect; direct costs are (PwC 2022):

- **Gross spread**: it is the the financial institution's profit from the IPO listing (the difference between the underwriting price received by the issuing company and the actual price offered to the investing public) and it is the largest charge with a percentage that varies between 4.1% and 7% of the capital constituting the IPO in the US. This spread is divided into a fixed fee, which is suitable to cover all preliminary expenses, and a variable fee proportional to numerous factors, such as the performance of the stock in the secondary market, market capitalization and transaction size, project management and proper timing in the timing of listing, the amount of resources devoted during the promotional phase, the results achieved in the auction phase, and the performance of the stock in the secondary market. Breaking it down from another perspective, Corwin and Schultz (2005 p. 447) state that the Gross spread can be divided between “management fees, underwriting fees, and selling concessions. Management fees are between the book manager and co-managers, with the book manager typically receiving a larger share. Underwriting fees, less any underwriting and expenses, are shared among all syndicate members according to the number of shares underwritten. Finally, the selling concession, which ally about 60% of the gross spread, is divided among syndicate members based on the number of shares each is credited”.

  All fees paid to underwriters are subject to FINRA review to ensure that they are not "unfair", and the IPO cannot proceed until FINRA has reviewed these fees.

- **Legal costs**: incurred in the preparation of the registration statement, negotiation of the underwriting agreement, structuring of the offering, corporate governance, housekeeping, due diligence, and other matters arising during the IPO process.
- **Accounting costs**: expenses related to the financial statements and for the auditor's participation in the process associated with the preparation of the registration statement and comfort letters for underwriters.
- **Marketing costs**: overhead expenses incurred during the Roadshow for printing the red herring, the final prospectus and the following distribution.
- **Registration costs**: The company incurs SEC registration costs, calculated at a rate of $110 per $1,000,000 of the aggregate offering amount, Blue Sky fees and FINRA costs in registering with the nongovernmental organisation that writes and enforces rules for brokers and broker-dealers, calculated as a percentage of the offering amount up to $225,500.
- **D&O liability insurance costs**: to cover alleged wrongdoing by directors and officers while acting on behalf of their company or organisation.
- **Exchange markets' fees**: the fee charged by the exchange at the time of entry into the regulated market, to be followed by subsequent fees, is calculated in proportion to the volume of shares traded.
- **Termination Fee**: designed as an insurance policy designed to cover at least the most significant fixed costs in case the IPO does not take place.

According to Heim (2002) direct expenses for a typical IPO can easily add up to $400,000 to 500,000. The listing process also takes time away from senior managers who have to spend hours working with investment bank analysts in preparing the prospectus and other documents for the IPO, so this opportunity cost of working time must be considered.
In addition to these initial costs, there are ongoing indirect costs arising from simply being a listed company. Among them, we have:

- Costs to hire new executives, to support the CEO and the CFO to manage the company, or others to perform accounting, SEC reporting, and tax functions that can provide meticulous and timely disclosure of information that meets the reporting requirements of a public company.
- Additional costs will be incurred in establishing an independent board of directors, audit committee, and other board committees.

- ❖ The possible damage from the outflow of information that can undoubtedly benefit major competitors and that would not have taken place had the company not been listed.
- ❖ the inevitable distortion in the evaluations of investment projects since all those projects that will guarantee profitability in the short to medium term will be preferred by management, this being the time horizon in which the financial community is undoubtedly interested.

As found by Ljungqvist, Jenkinson and Wilhelm in their work "*Global Integration in Primary Equity Markets: The Role of U.S. Banks and U.S. Investors"* (2003), the method by which the company decides to list also affects the total costs of the listing process. Analysing a sample of 2,143 IPOs from 65 countries outside the U.S. in the period 1992 to 1999, they stated the costs incurred by listing using book-building methods are about twice as high as those incurred by listing in fixed-price offerings.

1.3 The listing process

First, a company that wants to list must carefully consider the timing with which to do so. Usually, companies lean toward listing when they are at an expansion stage of their business cycle. According to Teoh, Welch and Wong (1998), at this stage companies have well-developed strategic activities, good management, and a good staff team. Its market share is significant because it has the trust of customers, and it earns recurring positive annual profits.
In fact, to be prepared for the IPO, a firm needs to start thinking about operating as if it were public well before formally applying for the IPO. The substantial amount of preliminary actions not directly related to preparing the registration statement is called "**corporate housekeeping**". During this period, the company must determine whether it is legally positioned for a bid by assessing its compliance with the Foreign Corrupt Practices Act (FCPA) on export controls and environmental regulations, and by ruling out the existence of pending litigation that could jeopardise the IPO.
The Organisational Structure should be clearly reorganized, making it suitable for public investment, through tax, legal, and financial system work to reorganise the various entities

through mergers, liquidations, and another restructuring, while the capital structure should be simplified by redeeming or converting all dilutive securities into common stock.
Organisational documents should not have rights of first refusal to purchase shares, supermajority approval requirements, approval of mergers or change of control transactions, or dual classes of common stock; all provisions are not appropriate for a public company. Conversely, anti-takeover provisions designed to discourage unsolicited or hostile takeovers should be evaluated.
It is necessary to review the balance sheet and off-balance sheet assets to determine whether legal ownership and the existence of all intangible assets, such as intellectual property, can be verified, and to review all related party transactions and relevant contracts to provide greater flexibility by updating or modifying the terms and conditions of those contracts.
Where major corporate initiatives are in place or planned, there are consequences to consider in the registration process. It is ideal to complete or abandon these initiatives to avoid any prospectus revisions, additional filings with the SEC, or re-dissemination of the preliminary prospectus may cause possible delays in registration and severely affect the offering.
Finally, the SEC requires that the company's finances be sufficiently detailed, and you will need to have the financial statements audited in preparation for the IPO. Helpful is hiring an auditor or changing the current one to identify any unforeseen financial hurdles with implications for the IPO process.
Qualification as an "emerging growth company" (EGC) may be exempt from certain regulatory requirements for a limited period (last total annual gross sales of less than $1.07 billion).

The actual listing process will begin once the first listing prospectus has been filed with the appropriate exchange commission, in the United States the Securities and Exchange Commission (SEC), and the subsequent listing application to the relevant exchange market is approved. The exchange market may accept, including requiring amendments, or reject the application.

1.3.1 *Choosing the Stock Exchange*

The U.S. stock market with a capitalization of $41.5 trillion, over 40.0% of the global stock market capitalization, is the largest in the world, 3.6 times larger than the next largest market, China, and is the deepest, most liquid and efficient among the markets in the world.

The market is characterised by the presence of the 2 largest stock exchanges in the world, the NYSE and NASDAQ, both located in New York. The New York Stock Exchange (NYSE) has a larger market cap than the NASDAQ, which is known for its large selection of technology stocks.

The NYSE

The New York Stock Exchange is the oldest American exchange, founded on May 17, 1792, as a response to the first financial panic in the young nation. The exchange is the leading stock exchange in the world now trading about 1.46 billion shares per day. More than 2,800 companies, ranging from blue chips to new high-growth companies; are listed on the NYSE. Each of these companies must meet stringent requirements, in fact, the NYSE has a reputation for trading strong, high-quality securities.

The main players on the NYSE are specialists (Designated Market Makers) and brokers who create a system that provides investors with competitive prices based on supply and demand. Brokers are employed by investment companies and act on behalf of their companies or clients. Brokers bring buy and sell orders to specialists.

DDMs are responsible for maintaining the equilibrium ensuring that there is always a market for the securities they specify by investing their company's capital to keep the market active and the stock liquid. They have more duties than traditional market makers as they are the human point of contact for the listed company on the trading floor ensuring stability by taking the opposite side of trades when imbalances occur, buying when investors sell and vice versa.

From opening to closing at the NYSE, there's continuous trading, DDMs manage the opening and closing auctions, using human input and algorithms to facilitate price discovery when the volume is typically at its highest. The market officially opens daily at 9:30 a.m. Eastern time (ET), but market participants can enter buy and sell orders starting at 6:30 a.m. These orders are matched, with the highest bidding price paired with the lowest asking price. Orders for the closing auction are accepted until 3:50 p.m. ET, and orders can be cancelled up until 3:58 p.m.

The NASDAQ

The NASDAQ, National Association of Securities Dealers Automated Quotations, was created by the National Association of Securities Details, and opened on February 8, 1971, as the world’s first electronic stock market. Nowadays the NASDAQ carries out about 1.8 billion trades per day, more than any other United States stock exchange, and it’s known as a high-tech exchange that trades many new, high-growth, and volatile stocks.

An electronic exchange uses automated computer networks to make trades and it has no physical trading floor and no one has to be there in person to make trades. NASDAQ is a dealers' market, where brokers buy and sell stocks not from each other but through a market maker that deals in certain stocks and holds a certain number of stocks on their books indicating both bid and ask prices for a security on which they are making a market. More than 500 market-making firms provide liquidity to Nasdaq-listed securities. Although not necessary for trading, this competition helps ensure that buyers and sellers get the best prices.

As described above, the main difference between the two Stock Exchanges lies in the different trading models. NYSE is an auction market having a hybrid trading model that uses both people and technology, whereas NASDAQ is an entirely electronic exchange dealer market. In an auction market, the highest bid for a stock matches the lowest asking price. In a dealer market, buying and selling happen in split seconds electronically through dealers.

The stereotype is that the NYSE is where all of the big blue-chip companies are listed, and the NASDAQ is where tech startups are listed. There's some truth to that because for decades the NYSE didn't allow small, new companies to list, as a result, NASDAQ was the exchange where newer companies could list their IPOs for its more favourable listing requirements. But nowadays, some NASDAQ stocks belong to some of the largest worldwide companies such as Apple, Microsoft, Meta and Tesla.

Even the initial and annual listing fees of the 2 markets differ between the two Exchanges, with the NYSE having a higher fixed fee to list of $295,000 and annual fees calculated at $0.001215 per share, with a set minimum of $80,000 per year.

The Nasdaq stock market, instead, has three tiers with different entry requirements: Nasdaq Capital Market, which has the lowest entry requirements with an initial listing fee of $50,000 and annual fees ranging from $47,000 to $84,000, Nasdaq Global Market and Nasdaq Global Select Market, with entry fees at $270,000, application fee of $25,000, and subsequent annual fees range from $50,000 to $173,500.

Given the lower entry cost, it is understandable that growing companies with lower initial capital prefer Nasdaq.

Stock Indexes

To get an overview of the performance of various stock markets, and of the global market as a whole, stock market indexes have been created. These are portfolios of securities usually composed of the shares of the largest companies listed in the markets, whose trends and

estimates enable investors to assess the movement of the market's value, while also providing an average measure of the share prices of the individual companies that make up the market.
The major existing stock indexes in the U.S. market, and followed worldwide, are the Dow Jones Industrial Average, the Standard & Poor's 500, and the Nasdaq Composite.

1. **Dow Jones Industrial Average** (DJIA) is a stock market index that groups 30 blue-chip stocks of U.S. industrial companies listed on the New York Stock Exchange and Nasdaq; blue-chips are the stocks of large companies that are considered safer.
   The index was created in 1896 by Charles Dow and statistician Edward Jones, two of the founders of the financial information firm Dow Jones & Company and the Wall Street Journal newspaper, is among the oldest indexes in the U.S. market and is widely considered a reliable indicator of the health of the world's largest economy.
   At its origins, the index included only 12 companies but over time the number of stocks increased to 30, turning the index into a key indicator of the performance of the U.S. economy, although the presence of only 30 companies is often criticized as an inadequate representation of the huge U.S. stock market.
   Unlike most other stock indexes, based on market capitalization, the DJIA is a price-weighted index. Stocks with higher prices have a greater weight in the index, and the value of the index is calculated as the sum of the stock prices of its component companies, divided by a factor known as the Dow Divisor (currently 0.152); a factor that is changed each time a component company undergoes a stock split, so that the value of the index remains unchanged.
   The DJIA reached its all-time high of 36,779.65 points in early 2022.

2. The **Standard & Poor's 500** (S&P 500) is a market index created in 1957 by the financial data provider S&P Global that represents the 500 largest companies in the U.S. economy rated according to their size, or market capitalization. The market capitalization of the 500 companies ranges from $4 billion to $2 trillion, with an average capitalization of $67 billion, with a predominance of stocks belonging to the technology sector.
   The index is considered one of the best indicators of U.S. stock market performance since its 500 companies represent 80 per cent of the assets of publicly traded U.S. companies.
   The Index’s price is calculated based on the combined market capitalization of all its member companies.
   Like the DJIA, the S&P 500 reached an all-time high of over 4,800 in January 2022, followed by a sharp decline in 2020 as the pandemic began.

3. The **Nasdaq Composite**, an index introduced in 1971 (the year Nasdaq was founded), tracks the performance of more than 3,000 stocks listed on the Nasdaq stock exchange. Along with the DJIA and the S&P 500, it is one of the best-known and most widely used indexes to describe the performance of the market as a whole, but unlike the other two indexes, it is very broad, containing about 3,000 common stocks, and admitting not only exclusively common stocks, but also other financial derivatives such as stock replacement certificates, minority interests, real estate trust shares, and special securities such as Shares of Beneficial Interest and Limited Partnership Interests.
   The Nasdaq composite is a capitalization-weighted index: all stocks in the index have a weighting factor that depends on the market value of the company. The higher the market value, the greater the company's weight in the index. The product-weighted sum, calculated as the sum of the product of the weighting factor and the price of all stocks, is divided by the so-called index divisor. This ensures that the NASDAQ index is not too large a number.

Regulation authorities

In the intricate landscape of the United States stock market, two pivotal institutions stand out for their regulatory roles: the Securities and Exchange Commission (SEC) and the Financial Industry Regulatory Authority (FINRA).

While both entities have distinct operational frameworks, their collaborative efforts are fundamental to upholding the integrity and efficiency of the U.S. stock market. This synergy ensures a balanced approach to market regulation, intertwining government oversight with industry self-regulation, thus maintaining a robust, transparent, and fair trading environment crucial for investor confidence and economic stability.

The SEC, established by the Securities Exchange Act of 1934, serves as the primary overseer of the U.S. securities markets. This federal agency's cardinal function is to enforce securities laws designed to protect investors; maintain fair, orderly, and efficient markets; and facilitate capital formation. It holds a broad mandate, encompassing the supervision of securities exchanges, brokers, dealers, investment advisors, and mutual funds, ensuring these entities comply with the law and offer transparent financial information to the public. Additionally, the SEC is instrumental in the approval of rules proposed by securities Self-Regulatory Organizations (SROs).

Contrasting with the government-established SEC, FINRA is a non-governmental organisation, authorised by Congress to act as a private-sector SRO. Its inception was a strategic initiative to

bring private sector efficiencies to the regulation of brokerage firms and securities markets. FINRA's role involves the regulation of trading in equities, corporate bonds, securities futures, and options. It's charged with ensuring the ethical operation and financial integrity of brokerage firms and exchange markets, safeguarding market participants from fraud and malpractice, and enforcing rules governing the activities of registered broker-dealer firms and their registered persons.

1.3.2 *Choosing the Underwriters*

Given the difficulties in finding enough buyers for the issued stock and determining the appropriate stock price by proceeding independently, approving the application by the Stock Exchange, the company must select the investment bank (or banks) to advise the company and to provide underwriting services, and a lead underwriter (or underwriters), which will lead the syndicate of investment banks that conducts the IPO, will be appointed.

The main reasons for using underwriters are the broad base of institutional and retail clients to whom they can market the stocks, the support for appropriate valuations they can provide during the process, and the knowledge of market conditions they have.

Ideally, the relationship with a trusted investment bank has been already developed in the years before the decision to go public, as they can assist the company in arranging to finance in its early stage and keep informed about current general and expected market conditions and the mood of investors in the industry, advising on the most appropriate time to go public.

Their sponsorship therefore generally begins in the pre-listing years and will continue well beyond the IPO influencing how your stock performs in the subsequent market.

Therefore, choosing the most suitable underwriters is important and must be weighed against several criteria; underwriters come from different backgrounds and have different preferences regarding the types of companies they want to support.

Among the world's leading investment banks are Goldman Sachs, Bank of America, Morgan Stanley, Citigroup, UBS, and Merrill Lynch. Companies select the underwriter best suited to their needs looking for its abilities to certify, promote, place, and support their offering through a "beauty contest" (or "bake-off") during which each participating bank introduces itself by emphasising its expertise in the IPO process and reputation: recent notable IPOs conducted, post-IPO pricing trends, and preliminary opinions on the company's market value are shown. Similarly, the underwriter looks to the issuer’s characteristics that will affect its short- and long-term profits.

Fernando, Gatchev and Spindt (2005, pag. 2438) in their paper state that "underwriting contracts are executed between those issuers and underwriters who mutually agree that their interests coincide".

As indicated above, it is customary for the firm not to choose a single investment bank to conduct the IPO but to get support from a coalition of banks, called a Syndicate, by appointing an ad un Book-runner. Iannotta writes in his book "Investment Banking" (2010) that a typical syndicate consists of three parts: the management group, the underwriting group and the sales group. "The managing group is composed of the book-runner and other joint bookrunners. The book-runner is responsible for due diligence, roadshow, book-building, and allocation, and, not surprisingly, gets the largest portion of fees. It is not uncommon to see multiple book-runners, especially for the largest IPOs. The joint book-runner(s) might be selected by the book-runner indirectly, setting a lower bound on the portion of the fees, thus limiting the number of banks. The underwriting group is composed of the managing group and non-managing underwriters, the latter usually called managers. Managers underwrite part of the shares, the proportion of which is determined by the managing group. Finally, selling banks (co-managers) just put their best effort into selling the shares, but they do not underwrite shares; in other words, they do not guarantee the allocation." (pag. 61)

The three main criteria evaluated by the firm in choosing high-prestige underwriters are ***overall reputation***, ***the quality of research***, and ***industry expertise*** (Brau and Fawcett, 2006)

The presence of the name of a highly respected investment banking firm as lead underwriter in the company's prospectus positively influences institutional and individual investors' confidence in the shares. The lead underwriters are also seen as the primary source of information by the financial community, thus analyses by research analysts who are experienced and respected by the investors who closely follow the industry in which the company operates, and have prior experience with IPOs in the industry, will be perceived as more quality ones by the community.

Other criteria that matter in screening potential underwriters are:

- ***The market-making and trading desk services post-IPO:*** the responsibility to continue sponsoring the company in the financial community that is taken by the underwriters, dedicating sufficient amounts of capital to take positions (short or long) on the shares to maintain a market.
- ***The distribution capacity:*** not only understood as a broad base of institutional and individual clients that an underwriter has but also the quality of the client base, especially

institutional clients. Important to understand the composition of the customer base and evaluate it in the context of business strategy; favouring institutional or "retail" investors, international investors, or targeting the domestic market.

- ***Price and valuation promises***: the more capable and reputable the underwriter, the more the valuation/price of the shares will fall within a reasonable and acceptable range.
- ***Ability to provide financial advice***: as mentioned earlier, the relationship with the underwriter is intended to last even after the IPO, and this can help in the future to obtain additional financing, advise on potential mergers and acquisitions, or learn about the investing public's attitude toward your company.
- ***Underwriter's calendar***: having an underwriter who does not have to follow other companies through the listing process and can devote sufficient attention during the entire process and, in particular, during the last week or two before your transaction price, when you are marketing your shares. In addition, multiple sequential offerings handled by the same lead underwriters may miss optimal execution windows.

In the analysis of their survey about 1,266 firms that faced the listing process through 2002, Brau and Fawcett pointed out that large firms, already having higher reputational need less appreciation from analysts therefore in the underwriters' choice they focused more on fee structure, non-equity services and "spinning" reputation, and less on the quality of the research analyst. In contrast, smaller firms, as well as high overhang companies, seek to gain a positive reputation through high-prestige underwriters, placing more emphasis on their reputation and expertise. On the other hand, an underwriter must agree to follow up on an IPO and initiate a detailed investigation, which can take several weeks, on previously mentioned aspects such as management quality, employees, product quality and industry potential, strength of customer and supplier relationships, financial and tax positions, key performance indicators, financial performance history and projected growth, and company reputation.

The Investigation is the first part of due diligence that is the responsibility of the underwriter and will serve to prepare a realistic firm's portrait to present to prospective investors, highlighting the company's operations, strengths, and risks and of the projected application of an offering's proceeds. A more detailed and realistic initial presentation can reduce the time and cost of the later stages of the process.

In addition, will be evaluated factors related to the offering itself such as the use of proceeds from the listing and the marketability of the shares considering the state of the markets at that time. It may not be wise to proceed with going public if the amount of money needed to operate

and grow the company effectively is greater than what can realistically be obtained in the market at that time. In another way, underwriters may want to guarantee that a large portion of the proceeds will go to shareholders or if key employees sell shares, both signs of loss of confidence in the company.

The size of the offering also plays an important role in attracting quality investors, and consequently underwriters. Issuing too many or too few shares can negatively alter the price: many institutional investors are disincentivized from investing in insufficiently large offerings because of a potential lack of liquidity in the subsequent market. The number of shares sold should be a function of the price and total valuation of the company.

1.3.3 *Due diligence and registration statement*

Due diligence is the process by which a complete, detailed, and up-to-date information asset about the issuer is obtained during which both parties ensure that all information in the registration statement is accurate, and true, and does not omit material misleading facts.

On the one hand, the company itself is responsible for any material deficiencies, regardless of good faith or the exercise of due diligence. On the other hand, the investment bank's professionals proceed in this way by questioning key people in the company's management to clarify any points in the prospectus that are unclear or difficult to put into context.

At this stage, so-called comfort letters are requested by the underwriters, in which particular aspects or inconsistencies not considered in the auditors' report are requested from the issuer.

Espinasse (2014) in his book highlights three aspects of due diligence; he starts with business due diligence, a stage in which the parties involved begin to familiarise themselves with the company's activities to ensure that they are correctly described in the prospectus. He then moves on to financial due diligence, in which the capital structure, financial statements, business plans, and financial data are thoroughly analysed (these two types of due diligence are a collaborative and iterative process generally consisting of a series of interviews of, presentations by, or question-and-answer sessions with issuer’s senior and operational management). He ends with legal or documentary due diligence, which is the legal counsel's review of all documents (contracts, certificates, etc.) to verify their enforceability and compliance with laws, as well as consistency of disclosure.

All the information subject to the due diligence process is compiled in the Registration Statement, a document to be delivered to the SEC whose main purpose is to provide as much

information as possible, financial and otherwise, to potential buyers about the securities being offered. In it, it is possible to omit some sensitive content that, if disclosed, could harm the company's competitiveness.

The main underwriter who, after a series of meetings that take place over several weeks, is responsible for drafting the document, which is prepared on the standard form S-1 and consists of 2 parts: the "prospectus" or "Red Herring" and "Part II."

The prospectus is the sales and legal document; as Espinasse refers to it as “the only publication that investors should use to make an investment decision to buy shares or certificates evidencing shares in an IPO”. Thus it must be a very clear and understandable document, written in narrative form, in a highly stylized manner following a logical sequence, and using "plain English".

The document contains in the summaries the basic data of the offering, such as names of the registrant and underwriters, the number of shares to be sold with a price range, and a currently empty distribution table. In addition, the document should bear a legend printed in red where it is indicated that the registration statement regarding the offering has been filed with the SEC but has not yet become effective and that the securities cannot be sold, nor can any offers to purchase be accepted, before the effective date; hence the name "red herring." The width of the price range is generally from 10% to 20% but can vary to even more than the average price.

The following paragraphs will list the risk factors, the use of proceeds and dividend policies, capitalization and dilution, the key financial data, the market risks and a description of the business and all parties involved with.

Part Two of Form S-1 contains all information that cannot be contained in the prospectus relating to particular contracts or agreements with underwriters that must still be submitted to the SEC. In some cases, these may be kept at a confidential level.

Next, the document is reviewed by the SEC to verify that the company has provided all relevant information so that investors can make a well-informed decision about whether or not to purchase the shares. The SEC may request a series of comments, recommendations and questions from the company, within 30 days of delivery of the document, through an epistolary correspondence. The issuer must answer through a new letter, and this exchange of comment letters will continue until the prospectus complies with each specific request. Generally, the higher the reputation of the consultants and the company, the fewer questions asked by the SEC.

Having obtained SEC approval, the company will have to ensure that it complies with the relevant blue sky laws in the states where it wants to sell the stock, and FINRA is called in to assess the adequacy of the IPO as a whole.

The period between the initial filing of your registration statement and the time the registration statement is declared effective by the SEC is referred to as the waiting period or quiet period. In the 30 days before registration, the SEC prepares mandatory guidelines to be followed for publication and disclosure of information not coincident with the prospectus itself to avoid "gun jumping", and strategic manoeuvres to try to stimulate demand. Instead, "tombstone" listing announcements may be made with general and approximate info about the offering itself.

The due diligence phase is the first of the three main ones in the IPO process, which is called *"Preparation"*, and it rides on the preparation of the prospectus with related due diligence. Once the issuer has applied for listing to the market authority and the stock exchange, the first phase ends (about 3 months) and we move on to the *"Approaching the market"* phase.

1.3.4 *Marketing, Pricing and Allocation of Shares*

Book-building Process

The first reference to the possible price of the IPO is in the red herring, where a stated price range is presented; therefore, the initial price offering is calculated as the midpoint of the stated price range.

Then, after the registration statement is approved by the SEC, the syndicate of underwriters acquires the portions of the shares to be issued, with the lead underwriter usually purchasing the largest portion, and engaging in the distribution of the stock by striking a balance between institutional and retail investors. Selling the shares issued is a group effort.

The lead underwriter(s) is tasked with "building the book" by collecting and keeping track of all the indicators of interest coming in from the market. To do this, he arranges a series of meetings between the company's top executives and investors. This phase with the series of meetings spread over two or three weeks, and tending to cover cities with key financial centres where institutional investors have indicated interest, is known as a “road-show” and is aimed at presenting the company by consolidating the prestige of the brand and conveying a general feeling of reliability to potential investors, portfolio managers and top analysts, allowing these figures to ask questions about the company and the materials contained in the prospectus, without adding new information.

During the road-show, it is critical to convey the impression of solid leadership and competent, reliable, and attractive management geared toward profitable operations because investors

primarily attend IPO road-shows to get a feel for management, because they are not just investing in the idea or the product; they are investing or betting on the management team (Sherman, 2012). Indeed, characteristics such as education, experience, gender, and status of managers have an impact on investors' interest and evaluation.
For these reasons, the Road-show is particularly important for EGCs where financial performance is less informative and assessment of management is considered more important because investors are more likely to place value on items such as managerial emotion when information is less certain.
During these weeks, investors place non-binding orders that can generate much additional information regarding potential investors' reactions to the offering. Through these reactions, a revision of the proposed price occurs since investors may perceive management differently than underwriters, who often discount softer or less certain information due to reputational concerns, causing price adjustments during the book-building process.

The roadshow is not the only element of the bank's marketing campaign. Other forms of marketing for an IPO, are press briefings and advertising, and these are all critical to the success of the campaign since, according to Khun (1990, p.269) "as much as anything that precedes or follows it, will determine the success or failure of the IPO. The key is to stimulate investor demand for the stock so that, as in basic economics, the demand will exceed the supply."
The importance of the campaign is emphasised by this statement that appeared in the investment newsletter the Fleet Street Letter (November 2003, vol. 66, no.11, p. 1): "Before a company gets to market through an IPO, it spends a fortune on hype, paperwork, and publicity to create demand. The buzz is stirred up before the shares are released. So you never get in cheap. And the cheap ones are usually not worth holding five minutes."
By reinforcing the importance of marketing to issuers and investment bankers even for IPO aftermarket performance, Cook, Kieschnick and Van Ness (2006) analysed a sample of U.S. firm-commitment IPOs from 1993 to 2000 stating that "a positive and significant correlation between retail trading activity during the first day of trading in an IPO and the IPO's pre-issue publicity, […], pre-issue publicity is positively correlated with upward revisions in IPO offer prices and offer price valuations that are above comparable firms in their industry, […], insider wealth exceed their dilution losses when more pre-issue publicity is associated with their IPO, […], initial IPO returns are positively correlated with pre-issue publicity, and […], investment banker compensation is positively and significantly correlated with pre-issue publicity."
The end of the road show, and thus the book-building process, should coincide as closely as possible with the conclusion of the SEC's registration statement review process.

Once the roadshows are over and the offer price is set during the so-called "price meeting," the second phase of the process ends too and the third and last one begins the *going public phase*.

Having declared the registration effective, the underwriters agree on the public sale price with the issuer and also legally agree to their participation in the underwriting by signing the underwriting agreement; that agreement which includes the offering price of the shares, fees, discounts and expense reimbursements, the method of underwriting, representations and warranties, and an indemnification agreement.

Once the underwriting agreement is signed, the company files the final Rule 424 prospectus with the SEC, where the final offering price resulting from the book-building phase is indicated, and thus actual sales begin.

Should it become apparent during the roadshow that if the market is asking for a different size or price of the offering than originally stated in the red herring prospectus distributed, a new, updated prospectus may need to be recirculated.

It is not uncommon that, if the market is unwilling to accept the originally contemplated price range or to absorb an offering of the same size, the company decides to postpone the offering until the market improves, or even to abandon the IPO altogether even with the registration process underway.

On the other hand, it is rare for underwriters to refuse to complete the offering once the registration process has reached an advanced stage. These invested considerable time and expense in the process, and the public perception of an IPO failure is detrimental to the reputation of all parties involved. A turnaround by the lead underwriter could occur only if significant adverse changes in market conditions or serious problems in the company, of which he was not previously aware, occur.

The book-building process described above is one of the three IPO pricing mechanisms and the most popular worldwide. Book-building is characterised by greater discretion granted to the underwriter and the issuer in pricing and allocating shares, and although the investor demand curve is revealed during the roadshow, the final price is not determined by the meeting of supply and demand, but defined as discretionary by the investment bank.

The book-building mechanism is typical of a “firm commitment contract”

Fixed-price offering and Auction

The other two mechanisms are fixed-price offering and auction.

Fixed price offerings are priced concerning the market demand before collecting the orders. Investors are not consulted and the price is already specified in the preliminary prospectus.
The mechanism is characterised by a “fair allocation system” since when the issue is oversubscribed, the shares are allocated on a pro-rata basis based on investors’ bids placed on the day before the IPO.
The main advantage of this method is the low cost and ease of executing the offer. The investors know in advance what they pay in case they receive a proportion of the shares.
Normally, fixed-price offerings are used in “best-effort underwriting agreement", where the underwriter does not actively sell the shares but it only distributes the prospectus, collects orders and performs share allocation with limited discretion.

In the last pricing mechanism, auctions allow the issuer and and the underwriter minimal control in determining the outcome of the IPO: investors are invited to bid for shares specifying the limit price of their offer and the number of shares they are willing to buy. Thus the aggregate demand curve is formed by all the individual orders while supply stays fixed. The final price is determined by the equilibrium between demand and fixed supply. Once the offering is covered, all investors who bid a price above the offer price receive the firm's shares. In the case of a single-price auction, all investors will pay the same price. On the other hand, in a discriminatory-price auction, every investor pays what he bid. Auctions are the least common type of pricing mechanism being normally used in only a few countries.

Having set the final offering price, it is time for the allocation of the shares and a new figure comes into play; a transfer agent, often commercial banks and trust companies, must be appointed to handle the construction of the book and thus transfer ownership of the shares from those who are transferring them.
Depending on the pricing mechanism chosen, allocation discretion might exist; in general, the auction mechanism offers no discretion, while in fixed-price bids discretion depends on the market regulations used in different countries.
Shifting to the book-building mechanism, larger bids systematically get a better allocation, regular investors who participate in many issues, as well as domestic investors and institutional investors, are generally favoured by allocation policy, and finally, if the book-runner receives bids himself he will tend to favour bids submitted directly to his own sales force, thus increasing his fees, rather than to other syndicate members.

The effort the underwriter employs in allocation may also depend on the type of agreement signed with the issuer. There are 3 types: *firm commitment, best efforts commitment* and *all-or-nothing.*. In the former, the underwriter undertakes to buy back unsold shares from the public in case some of them remain unsold. In the *best efforts* case, which is rarely applied or not provided for in markets in general, this obligation is missing. In the latter, if the entire issue is not sold, the issuing will be cancelled and the money raised from investors is returned.
In a best-efforts offering, the closing will not occur immediately, but after all the shares have been sold, or the company and the underwriters agree that the selling efforts can conclude.

The process ends with a formal closing meeting (in person or by telephone) between all parties involved and their respective advisors to exchange documents, certificates and legal opinions.

1.4 First-day underpricing phenomenon

Normally, the yield of the first day, measured as the difference between the closing price of the first day of listing and the offer price, is significantly higher than the market average. Because the prices at which securities are offered are discounted by their actual value, the yield on the first day is called **underpricing** or **equity-premium**.
This underpricing is one of the most significant costs the company incurs during the process and is generally considered an opportunity cost as issuers, selling at a bid price below market value, leave money on the table.

Loughran and Ritter in their paper *"Why Don't Issuers Get Upset About Leaving Money on the Table in IPOs?"* (2002) chave calculated that in the 90s the ipos in U.S. Stock Market were underpaid for more than $ 27 billion, a double amount compared to the 13 billion dollars of bank fees paid by the same issuers. Moreover, the amount left on the table is triple compared to the $8 billion total profit generated in the year before going public: their underwriting represents more than three years of their aggregate profits.

In his 2024 paper, Ritter illuminates the intriguing dynamics of Initial Public Offerings between 1980 and 2023, revealing a consistent underpricing trend. This period saw IPOs achieve an

average return of 20.5 per cent in income-weighted portfolios and 18.9 per cent in equally weighted ones, suggesting a potential negative side effect due to the greater representation of smaller firms in the latter. The IPO market, inherently cyclical, exhibits periods of intense activity and lulls, closely reflecting wider economic and market trends. ***Hot issue*** and ***cold issue periods*** are the terms used in financial markets to describe these periods. Hot periods are marked by robust IPO activity with strong investor demand and often high initial returns leading the companies that go public during these periods to be able to secure skyrocketing valuations based on potential future growth rather than traditional financial metrics and raise more capital.

A *hot issue period* often aligns with bullish stock markets, sectoral hype in specific industries, mainly due to technological innovation, and conducive economic conditions like low-interest rates and strong growth; conditions that lead to increasing optimism in investor sentiment and a speculative behaviour driven more by the fear of missing out and the allure of rapid wealth creation than by fundamental analysis.

A notable hot issue period in IPO history occurred during the late 1990s, specifically aligning with the dot-com boom. This era, spanning approximately from 1998 to 2000, was characterised by an unprecedented surge in the number and performance of initial public offerings in the technology sector, particularly internet-based companies and related new technologies, the advent of which created new business opportunities and the conviction of a changing economic landscape. The favourable macroeconomic environment, with high liquidity and availability of capital, as well as the favourable regulatory environment, facilitated and encouraged the IPO of an increasing number of companies. However, many of these companies lacked sustainable business models and were buoyed by market optimism, fueled by intense media coverage and public interest in the technology sector, rather than solid financial data.

In contrast, a cold period sees a slowdown in IPO activity and is characterised by lower investor interest, modest initial returns, and more cautious valuations. Typically, it aligns with a bear market with weak overall stock market performance, recessions or economic downturns that lead to reduced investor confidence and capital availability, and stringent regulatory environments that can increase the cost and complexity of IPOs. A shift in investor sentiment toward risk aversion then occurs, inducing a reduction in demand for new equity issues.

The most notable periods of cold issuance occurred in the early 1990s when the economic recession and the impact of the Gulf War led to a downturn in IPOs; after the bursting of the dot-com bubble in 2000, when the IPO market experienced a significant slowdown due to the loss of investor confidence, especially in technology stocks; during the global financial crisis of 2007-2008, which led to a sharp decline in IPO activity amid uncertainty in the housing market and the credit crunch; and finally, more recently, with the onset of the COVID-19

pandemic in early 2020, which caused significant market volatility and a temporary slowdown in IPOs as companies faced unpredictable conditions before the market recovered.

Several authors have documented various aspects of this IPO cyclicality in the literature. Ibbotson, Sindelar, and Ritter (1994) argued that market "temperature" affects both the number of successful offerings and the quantity and variability of underpricing of IPOs, indicating that two- or even three-digit underpricing is common in hot markets, as opposed to the lower underpricing that characterises cold periods.

Helwege and Liang (2004) investigated the differences between IPOs in hot and cold markets from 1975 to 2000 finding that hot and cold IPO markets do not significantly differ in the characteristics of the firms going public. Both hot and cold market IPOs are concentrated in the same set of industries, with little variation in their profits, age, or growth potential. Moreover, cold markets may exhibit more industry concentration since many industries tend to have their hot markets at the same time. This suggests that hot markets are likely driven more by investor optimism than by changes in firm quality or technological innovations.

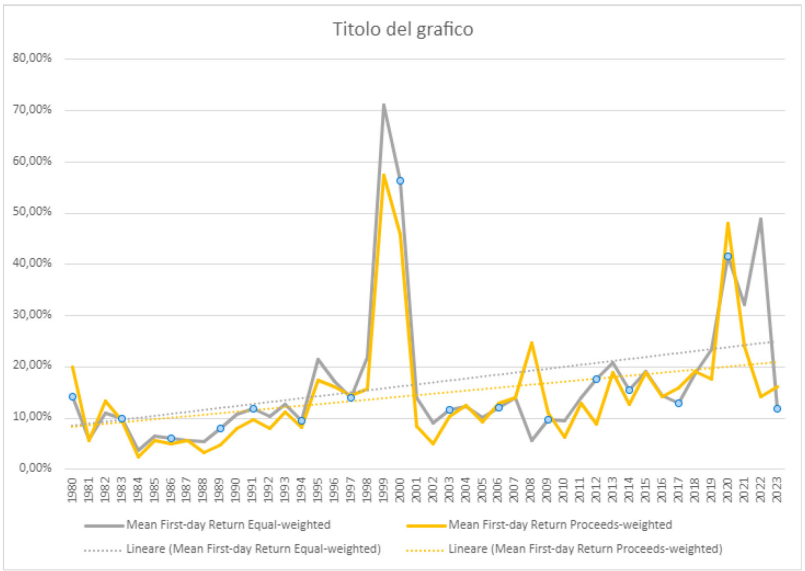


Figure 1 *- Number of IPOs and average initial return by month from 1960 to 2018 source: own re-elaboration of Ritter (2024)*

IPO-Underpricing, defined as the percentage change tra the closing price on the first day of trading e l'offer price, è the initial performance on the first day of trading è può essere calcolato utilizzando la Raw Initial Return (RIR) formula:

$$RIR_{i,t} = \frac{P_{i,1} - P_{i,0}}{P_{i,0}}$$

where $RIR_{i,t}$ is the raw initial return on the first trading day of the company i, $P_{i,1}$ is the first trading day closing price and $P_{i,0}$ is the IPO offer price disclosed in the 424 prospectus.
The Raw Initial Return formula generates reliable results in the case of perfect market conditions; in the absence of opportunity cost and time lags between the closing date of the bid registration period and the first actual trading day.
Should this date vary, thus generating imperfect market conditions, it is more appropriate to use the Market Adjusted Initial Return formula. The latter adjusts the Raw Initial Return formula taking into account the general performance of the stock market in the time interval between the closing date of the share subscription and the first day of trading.
IPO underpricing, using the Market Adjusted Initial Return (MAIR) formula, is calculated as follows:

$$MAIR_{i,t} = \left[\frac{P_{i,1} - P_{i,0}}{P_{i,0}} - \frac{MI_{i,1} - MI_{i,0}}{MI_{i,0}}\right]$$

where $MI_{i,1}$ is the market index at the end of the first trading day and $MI_{i,0}$ is the market index at the end of the shares subscription period.
Because the positive (or negative) daily performance of the entire stock market can influence the increase (or decrease) of a stock's first-day closing price even in cases where the actual quotation begins immediately after registration, the Market Adjusted Initial Return formula generally yields more reliable results than the Raw Initial Return formula.

The phenomenon of underpricing is well documented in the literature; the first to observe it in the early 1970s were Akkerlof (1970), Reilly (1973), and Ibbotson (1975), who concluded, however, that it was a mere mystery (Pazarzi, 2014).
In the years that followed, more theories followed; although the main ones focused mainly on the correlation between underpricing and asymmetric information among the parties involved, many other theories focus on ownership dispersion caused by IPOs, future legal disputes that might arise and investors' behavioural biases have been advanced.

Moreover, in addition to theories, much empirical research has been advanced. The factors analysed and considered influential by the level of underpricing were mainly firm- and economy-specific factors, underwriter reputation, market timing of the initial public offering, and the pricing mechanism adopted.

1.4.1 *Asymmetric information*

Asymmetric information there may be between investors, between issuers and underwriters and between underwriters or issuers and investors.

One of the first discussed was the Principal-agent theory by Baron (1982) who firstly explicated a model based on information asymmetry by analysing that between issuing firm and underwriter assuming that investment banks have more information about the demand for the shares offered and the capital market than issuing firms. Therefore an Issuing firm will prefer to delegate pricing and allocation decisions to the chosen underwriters by allowing them to underprice to compensate for the use of their superior info.

According to him, "the value to the issuer of the banker's distribution effort is an increasing function of the issuer's uncertainty, so greater uncertainty increases the demand for the advising and distribution services of the banker" (Baron, 1982, p.956) thus concluding that the greater the level of ex-ante uncertainty and the greater the asymmetry between issuer and underwriter, the greater the level of underpricing.

However, Muscarella and Vetsuypens (1989) analysing a sample of investment banks going public through "self-underwritten" IPOs, showed that contrary to the implications of Baron's model, even such self-mercified offerings are characterised by statistically significant underpricing, comparable to that of other IPOs conducted by underwriters on behalf of issuing firms.

More recently Schenone (2004) found that firms with a pre-IPO banking relationship with a potential underwriter are less underpriced showing that a previous banking relationship helps alleviate information asymmetry between firms and underwriters, and thus underpricing.

Ljungqvist and Wilhelm (2003) deeply analysed the changes in incentives incurred during the dot-com bubble to mitigate agency conflict finding two solutions for the issuer. The first, also identified by Baron in his model, is the realignment of incentives by designing contracts that make the compensation of underwriters a growing function of the offer price; the second is the

direct monitoring of the underwriters' marketing efforts and price behaviours. Therefore, they say that underpricing will be less, the greater the incentives for monitoring

Winner's curse model

The best-known model is the "**winner's curse model**" developed by Rock (1986), who analyses the information asymmetry between investors and enshrines underpricing as a direct result of the winner's curse problem that afflicts uninformed investors when they submit purchase orders for new issues.

Drawing on Akerlof's (1970) "The market for Lemons" theory and differentiating investors between informed and uninformed investors, Rock observes that informed investors pay only for IPOs that they expect to trade at a premium over the offering price and leave the market when an IPO is overpriced, unlike uninformed investors who apply to each new IPO; echoing Rock, "Even though the firm and its agent know more than any single individual in the market, they know less than all the individuals in the market combined." (Rock, 1986, pag. 190). Moreover, Rock assumes that the issuing firm is unable to distinguish informed and uninformed investors in share allocation and cannot acquire information from informed investors in advance, so it is forced to underlie its IPO for two reasons: i) as compensation for acquiring the information from informed investors, ii) as an incentive for uninformed investors to participate in the market by compensating for adverse selection. The model is set in a market for firm commitment where once agreed and fixed price and quantity to be issued the IPO could face either excess demand or excess supply. Since in the latter case the allocation can be rationed by the underwriter, Rock assumes that oversubscription happens only when informed investors subscribe to the new issue.

The original Rock's model, which is still viewed in the literature as the starting point to analyse the effects of information asymmetries among investors was later extended by Beatty and Ritter (1986) showed how if the uncertainty increases ex-ante, the problem of the curse of the winner intensifies. The greater the uncertainty about the value of information, the greater both the bias toward uninformed investors and the necessary underpricing; i.e., the value of information itself. To be willing to submit a purchase order for share an investor will demand that more money be 'left on the table'.

Applied in the European Market, characterised by pro-rata base allocation and rationing freely available information, the model issues the unexpected proof that, subscribing to all new issues, an uninformed investor will obtain a return that is not statistically different from the risk-less rate however the high level of underpricing in the observed period (Levis, 1990).

Picking up on Rock's model assumption that Institutional investors are the best-informed part about the firm's industry but are not incentivized to reveal their purchasing interests, Benveniste and Spindt (1989) formulate the information-gathering theory where they observe the existence of two types of information frictions that influence the price of IPOs. The first stems from the fact that issuing firms are asymmetrically well-informed about their corporate situation and tend to influence prices by presenting themselves to investors as firms of higher quality than they are. The second, taken by Rock, is that institutional investors are symmetrically well informed about the issuing firm's competitors, the industry, the economy in general, and private information that cannot be credibly conveyed.

Thus, a problem regarding IPO pricing arises: on the one hand, neither the issuing firm nor the underwriter can know exactly what the market valuation of the shares will be. On the other, investors have no incentive to disclose positive information before the sale and want to pay a lower initial price for the shares and then resell them at a higher price for more information disclosed. Therefore, underpricing arises as a natural cost to compensate investors who are positively informed about the value of the shares for the truthful disclosure and disclosure of their positive private information.

With this theory, Benveniste and Spindt stated the so-called Market feedback hypothesis, i.e., that underpricing is directly related to the ex-ante value of investors' information, the level of presale and the level of interest in the premarket. However, underpricing can be reduced by investment bankers through the book-building process by inducing investors to reveal their private information during the pre-selling phase, and then giving the same investors allocation priority as compensation, being able to use the leverage of expected future profits and increasing the efficiency of the capital acquisition process.

The theory of information collection is supported by the results of Cornelli and Goldreich (2001) emerged from the analysis of a data set that includes books of 39 international stock issues, to analyse the investment bank's allocation decision.

They found that investment banks regularly ration shares, in particular: price-contingent bids, revised bids (especially upward revisions) and large bids are favoured since they provide useful information for setting the issue price.

Even bids submitted directly to the book-runner, that increase its revenues, are subjected to favourable allocations.

Moreover, underwriters favour regular customers (compensated for buying both in good and bad issues), domestic investors (viewed as better informed) insurance companies and pension funds.

Conversely, Jenkinson and Jones (2004) with a simple of 27 European IPOs managed by several underwriters, concluded that underwriters discriminate only between long-term and short-term investors, preferring the former, and do not prefer well-informed investors.

Henley's (1993) findings are consistent with Benveniste and Spindt's pricing and allocation schedule. Her results indicate that "underwriters prefer to compensate investors for truthfully revealing information by allocating a smaller number of highly-underpriced shares rather than a larger amount of slightly. underpriced shares" (pag. 233) since the share allocation mechanism only is not sufficient to fully compensate investors due to the rationed shares offered. "In other words, the final offer price only partially adjusts to new information. The result is that issues that have positive revisions in the offer price and good information revealed are significantly more underpriced than other 1POs." (pag. 249)

In opposition to Rock and his conclusion that informed investors impose a winner's curse on uninformed investors by bidding only for underpriced offerings, Hanley and Wilhelm (1995), studying a sample of 38 IPOs run by a single underwriter between 1983 and 1988, observed that well-informed institutional investors are unable to leverage their information advantage over time to avoid investing in overpriced offerings: they capture the lion's share of the profits associated with underpriced offerings, but only at the cost of participating in less attractive offerings.
The study found that institutional investors have a prominent position in both underpriced issues (70 per cent of stocks) and overpriced offerings. Moreover, they also receive a large share of issues both for which pre-bid interest is strong and for those where interest is weak.
Rcok's hypothesis that issuing firms compensate by underpricing the participation of uninformed investors is challenged by Jenkinson and Ljungqvist (2001), who show that in cases where demand from informed investors is insufficient to absorb the entire supply, uninformed investors may invest through informed institutional investors (investment funds), paying a fee to take advantage of their superior information, while avoiding overpriced shares.

Signalling theory

In "*Signalling theory*", the information asymmetry between issuers and investors is analysed in the opposite case, with the issuing company as the more informed party.
Here underpricing is seen as a signal to investors to show that the good quality of the firm allows them to sacrifice initial revenues from the IPO for higher future revenues.

Ibbotson (1975, pag. 264) first stated that underpricing was a voluntary practice of the issuer to "leave a good taste in investors' mouths", followed then by Leland and Pyle (1977) who concluded that entrepreneurs are induced “to take larger equity positions in their firms than they would if the information could be directly transferred” (pag. 372). Through a model focusing on entrepreneurs' funding in projects whose true quality is known only to them, they noted that entrepreneurs' willingness to invest in their projects is a signal of the quality of the project itself. Signalling is therefore a welfare cost aimed at increasing the value of the enterprise.

In a 1982 paper, Downes and Heinkel attempt to consider dividend policy and retention of ownership as the two possible actions that make entrepreneurs able to communicate or report their otherwise unobservable insider knowledge. Their empirical results show that firms in which entrepreneurs maintain a high percentage of ownership have higher values. On the other hand, they state that dividend reporting plays a negative role in determining value and this is attributable to possible variables omitted in the model.

Later in 1989 multiple studies on the topic were conducted by Allen and Faulhaber, Grinblatt and Hwang and Welch. Allen and Faulhaber took the theory further, distinguishing good and bad firms in their model and concluding that only the former can afford to use the higher underpricing as a signal about their quality because they expect to recoup the loss with subsequent performance; something bad firms cannot do. So the level of underpricing is positively correlated with good firm quality. Grinblatt and Hwang resumed the concept of fractional holding, noting that higher retention of newly issued shares is a sign of good firm quality and manager optimism. Their model positively relates the degree of underpricing, the issuer's frictional holding and the value of the company. Endly, for Welch underpricing is a tool of high-quality firms to induce low-quality firms to voluntarily disclose their quality when imitation costs alone are not enough.,

For Chemmanur (1993), however, underpricing is used by insiders of high-value firms to stimulate demand and to induce investors to a higher firm’s information production.

Michaely and Shaw (1994) examine the signalling hypothesis comparing two markets in which the degree of information heterogeneity differs substantially: the sample of 947 US IPOs during 1984-1988 included both a sample of IPO master limited partnerships (MLPs) and a sample of "regular" IPO. Limited partnerships derive more than 90 per cent of their income from certain qualified sources thus “the special feature of the MLP IPOs that enables us to test Rock's model is that institutional investors largely avoid them and the market knows that” (pag. 281). Not finding any underpricing for the MLP IPO market where investors are relatively homogeneous, they attribute underpricing to the presence of information asymmetries between investors and

not finding empirical support for the signalling models. In addition, they found that firms that underprice more return to the reissue market less frequently, so underprice is not significantly related to the reissue decision. Finally, firms issued by more reputable investment underprice experience higher earnings and pay higher dividends.

1.4.2 *Institutional theories*

Moving on from information asymmetry to other theories that adopt institutional explanations to rationalise the phenomenon. Three "***institutional theories***" can be found in the literature focusing respectively on investor litigiousness and particularly strict American liability rules, on price "manipulation" by underwriters and stabilisation services in the after-market, and, finally, on tax arguments.

Lawsuit avoidance hypothesis

As previously said, the insight of Logue (1973) and Ibbotson (1975) is that underpricing is caused by a voluntary action of the issuer. The issuing firm deliberately leaves money on the table as an underwriting tool to reduce the likelihood of possible litigation and future shareholder actions.

This thinking was later taken up by Tinic (1988) in his "***Lawsuit avoidance hypothesis***"; the first institutional theory. He views underpricing as a form of insurance against legal liability and related reputational damage for investment bankers. Hughes and Thakor (1992) elaborated on the hypothesis by arguing that, in pricing decisions, the underwriter also evaluates a trade-off between current income and expected future litigation costs, both of which increase IPO pricing.

Finally, Lowry and Shu (2002) deduce that "unlike other forms of insurance that firms can purchase, underpricing lowers the potential damages that plaintiffs can recover, and thus reduces plaintiffs' incentives to bring a lawsuit against the firm" (pag. 310) and point out that "firms that engage in more underpricing significantly lower their litigation risks" (pag. 333).

Price stabilisation hypothesis

The second institutional theory relates the ***price stabilisation*** service provided by underwriters to limit price drops in the first aftermarket period.

Some authors, noting that some IPOs are price stabilised immediately after their issue, and some are not, argued that underpricing is a consequence of stabilisation performed by investment banks.

According to the model devised by Benveniste, Busaba, and Wilhelm (1996), the underwriters, by committing to stabilise the price in the after-market phase, cause their incentive to overestimate investors' interest in the book-building phase to fade away. Overestimation would aim to persuade more purchases at a price higher than the underwriter's initial estimate (cascade effect) and thus higher fees. This is because investors, knowing of the possibility of opportunistic behaviour on the part of the underwriter, may opt not to take part in the book. Therefore "a commitment to price stabilisation effectively bonds the underwriter against overstatement of pre-offer interest and subsequent overpricing of the issue" (pag. 225).

Aggarwal (2000) starts his paper with a comprehensive analysis of exactly how underwriters' aftermarket activities are conducted, distinguishing between three types of activities performed: *pure stabilisation, aftermarket short covering* and *penalty bids.*

With ***pure stabilisation***, underwriters continue to purchase unallocated shares at a fixed price that does not exceed the bid price. This allows them to defer a potential price drop in the event of weak offerings.

The ***aftermarket short covering*** consists of overallotment or "green shoe" options. These options allow underwriters to sell additional shares up to a maximum of 15 per cent of the offering, and are exercisable for 30 days, thus taking a short position before the offering.

It is common that in offerings where weak demand is expected, underwriters often take a "naked short" position by allotting more than 115% of the stated size of the offering

This is the main form of stabilization, as it achieves the same purpose as pure stabilization, but is less risky and can be done without disclosure; as Aggarwal explains "If the price of the IPO drops in the secondary market, the short position is covered with shares purchased in the aftermarket. However, underwriters typically do earn a seven per cent spread on all shares issued; therefore, they have the incentive to exercise the overallotment option, and it is not surprising to find them exercising this option even for offerings that start trading a little below the offer price. If the price of the IPO rises, then the overallotment option is used to cover the short position. If the short position is more than 15 per cent, the naked short must be covered by purchases in the secondary market at prices above the offer price" (pag. 1079)

Finally, ***penalty bids*** are used to control flipping (a term used for the sale of shares received in an initial allotment in the immediate aftermarket) or the resale of shares. Penalty bids may be signed in the underwriting agreement for those syndicate members whose "flippers" customers quickly "flip" shares in the aftermarket. This flipping practice may cause the lead underwriter

to incur two associated costs: the sales commission paid for the resold shares and the possible decrease in the resale price.

The objective of all three aftermarket activities is to support influence prices; with the first two activities, demand for shares is stimulated, while penalty bids serve to limit supply. Therefore, price support activities are considered a complement to underpricing.

To manage aftermarket activities, underwriters can use combinations that best suit the situation; for example, in weak bids, underwriters must have a short position large enough to absorb the selling pressure exerted by flipping, otherwise the share price will fall.

Aggarwal concludes his work by analysing short covering activity on a sample of 114 U.S. IPOs issued between May and July 1997. In his results, he found that short aftermarket covering costs for the lead underwriter are minimal, amounting to three to four percent of underwriting commissions and that aftermarket activities usually last 10 to 15 days.

Moreover, contrary to claims in the literature that stabilisation is done only for deals that trade at or below the offering price, he found that "underwriters are actively engaged in aftermarket activities even for offerings that are trading a little above the offer price. These offerings would probably trade at or below the offer price if underwriters were not engaged in aftermarket activities." (pag. 1100)

Tax advantages hypothesis

Finally, by the third hypothesis underpricing can be advantageous from a tax point of view.

Based on the idea that wages are taxed more heavily than capital gains and therefore paying employees with underpriced shares would lead to lower tax expenditures, Rydqvist (1997) and Taranto (2003), studying the Swedish and U.S. markets respectively, both came to the fact that underpricing decreases as the tax rate for growth assets increases.

Rydqvist noted how average underpricing drastically fell in 1990, when Swedish tax authorities subjected underpricing-related gains to income tax, eliminating the incentive to award undervalued shares to employees.

Similarly, Taranto's empirical results show that companies that rely on stock options tend to underprice more. This is because there is an incentive for stock option holders to undervalue the company's IPO. After all, they will pay taxes in two stages: an income tax when they exercise the option (*on the difference between the strike price and "fair market value"*) and a deferred capital gains tax when they sell the underlying shares previously obtained (*difference between "fair market value" and the sale price*). Since the second tax is deferred and relative

tax rates are generally lower than income tax rates; and since the "fair market value" in U.S. tax law corresponds to the bid price, the managers' incentive to undervalue the price is generated.

1.4.3 *Ownership depression theories*

Ownership depression theories, on the other hand, focus on changes in ownership structure and ownership dispersion caused by IPO; According to Stoughton and Zechner (1998, pag 47) "rationing provides a mechanism whereby different classes of investors may be treated differentially, although they all purchase securities at a common price".

Zingales, Booth and Chua were the first to deeply investigate this topic. Whereas Zingales (1995) showed that a greater dispersion of ownership strengthens the market value of the controlling share, and therefore owners are incentivized to use the IPO to create a widespread property while maintaining a control block to extract more surplus from a potential buyer. Booth and Chua (1996), examining the connection between the public facility and the property, conclude that companies tend to create a dispersed ownership structure, rationing shares, to increase market liquidity for their shares.

Brennan and Franks (1997), based on the reduced monitoring hypothesis, which says that "the greater dispersion of outside holdings reduces incentives for new shareholders to monitor current management." (pag. 392), advanced the best-known model in this regard, in which they show that managers, by producing oversubscription through underpricing, perform strategic share allocation, discriminately distributing more to small investors to retain control. This discrimination among potential subscribers reduces the chances of a hostile takeover. Moreover, the size of the underpricing is negatively related to the size of large blocks assembled after the IPO.

In contrast, Stoughton and Zechner (1998) construct a model where stock rationing is done in favor of large shareholders rather than toward small ones. According to this hypothesis, a structure that incentivizes monitoring of outsiders, minimizing agency costs and thus increasing the value of the firm is obtained; in fact, large investors have a greater ability to monitor management than small ones. They therefore conclude that underpricing should be positively correlated with the ability to ration in favor of large shareholders and that it should be greater for companies with high benefit-to-cost ratios in monitoring assets.

Finally, Smart and Zutter (2003), comparing single-class IPOs with dual-class IPOs, observe that the former show greater underpricing because "Dual-class managers retain voting control

even when large commonshare blocks form. Dual-class managers have no incentive to underprice to create dispersed ownership." (p. 107).

1.4.4 *Behavioural theories*

Finally, in the ***Behavioural Theories***, consideration is given to how investor behaviour influences underpricing. The basic assumption is that the IPO price is bid up beyond its real value by irrational investors. The most prominent behavioural insights are provided by informational cascades of Welch (1992) and Ritter (19938), by Ljungqvist "investor sentiment" with their "investor sentiment" model, and by the prospect theory of Loughran and Ritter (2002).

Bandwagon effects

Firstly, Welch (1992) observes that investors' purchase choices rely completely on information from the choices of investors before them, not taking into account any private information privately available to them. An informational "cascade" by following sequential sales where one investor acts like the investors before him is created, and as he explained, "the pricing decisions of issuers can reflect informational cascades-where later investors rely completely on the purchasing decisions of earlier investors and ignore their own information" (p. 723). Later Ritter (1998) says "The IPO market may be subject to bandwagon effects. If potential investors pay attention not only to their own information about a new issue but also to whether other investors are purchasing, bandwagon effects may develop. If an investor sees that no one else wants to buy, he or she may decide not to buy even when there is favourable information" and thus "an issuer may want to underprice an issue to induce the first few potential investors to buy, and induce a bandwagon, or cascade, in which all subsequent investors want to buy irrespective of their own information". (pp. 8-9)

Analysing the Israeli market, Amihud (2003) argues for Welch's cascade theory where less informed investors copy the well-informed ones; "demand is either extremely high or there is under subscription, with very few cases in between" (p. 2). The U-shaped allocation distribution indicates that investors either overwhelmingly underwrite new issues or largely abstain.

Sentiment investors

The first to develop a model pricing determination of IPOs in hot issue markets with the presence of sentiment investors are Ljungqvist, Nanda and Singh (2006) who attempt to capture the equilibrium response of issuers and underwriters in the face of divergent investor opinions. In the model, which does not rely on private information or information asymmetries, they break down the demand side into two types of investors: sentiment investors and rational investors

The first is unsophisticated small investors unable to distinguish noise from relevant information and with mistaken beliefs about the fundamental value of an asset. For these reasons, they are prone to episodes of optimistic or pessimistic "sentiment" about the stock market. In contrast, rational investors, which include institutional investors, hold “beliefs that correspond to unbiased estimates of the issuing firm’s future prospects” (pag. 1672).

Arguing that the issuer should try to capture as much as possible of the excess in valuation over fundamental value from exuberant investors, but not being able to flood the market with stocks that would depress the price, Ljungqvist et.al identifies as the optimal strategy that of "staggered selling" in several stages, holding part of the stocks in the inventory to prevent the price from falling. This direct strategy, however, is not allowed by regulatory constraints on price discrimination and stock holding.

To circumvent this limitation, the issuer uses regular institutional investors who, having obtained the stock, will proceed to resell it to sentiment investors, at prices aimed at limiting supply. Institutional investors will therefore require the shares to be underpriced to compensate for the risk of a drop in the price, but since the offer price exceeds the fundamental value of the shares the issuer benefits from this underpriced allocation.

In the long run, the company's share price falls revealing the natural fundamental value of a company, and all the sentiment investors who hold the shares in their inventory will suffer as the price falls.

Cornelli, Goldreich and Ljungqvist (2006) analyse the influence of investors' overoptimism and over-pessimism. When there is overoptimism, investors are willing to pay a price above the fundamental value, and a high market price is observed; on the other hand, when there is over-pessimism, investors are cut off from the market and no distortion in the market price is expected. Therefore, "issuer can appropriate the surplus by setting a higher issue market price when the aftermarket price is expected to be above the fundamental value” (pag. 1214).

Analysing grey market prices for a sample of European IPOs, they confirm the existence of asymmetric relationships between short-term aftermarket prices and long-term returns. They observe that in phases of over-optimism, aftermarket prices are on average 40.5 percent higher. They conclude by confirming the presence of two types of investors in the market, stating that sophisticated investors take advantage of investor sentiment and "underwriters and book building investors take anticipated demand from overoptimistic investors into account, though only when they can profit from such demand by selling overpriced shares to sentiment investors in the aftermarket" (pag. 1214).

Prospectus theory

Loughran & Ritter (2002) shift the focus to the bargaining power of issuers and theorise how underpricing is generated by biases between decision-makers alone. As already mentioned in the first section of the chapter, issuers knowingly leave a large amount of money on the table compensating for the loss of initial wealth with the large yield of the first day and often do not consider this "initial loss" an important consideration in selecting subscribers for a subsequent offer, reconfirming those who conducted an underpriced IPO (Krigman, Shaw and Womack, 2001).

The ***Prospectus theory*** from Loughran and Ritter assumes that "issuers care about the change in their wealth, rather than the level of wealth" and predicts that "issuers will sum the wealth loss from leaving money on the table with the larger wealth gain from a price jump, producing a net increase in wealth for pre-issue shareholders" (p. 414).

It is noted that most of the money left on the table comes from a reduced number of IPOs for which the offer price was positively revised from the range in the preliminary prospectus. Usually, the price range shown in the prospectus, which reflects the decision maker's initial valuation, differs systematically from the IPO offer price; the price that is only partially adjusted to the public information revealed during the roadshows or to the change in broadcasters' expectations. In those few IPOs, the price appreciation more than compensates for the underpricing. With this reasoning, Loughran & Ritter demonstrate the existence of a covariance of the amount of money left on the table and unexpected wealth changes. An increase in the initial price is perceived by issuers retaining shares in the issued company either as an increase in wealth on the shares retained or as a loss of wealth in order not to sell at a higher initial price. Therefore, if the perceived gain is greater than the loss, they will allow low-cost subscribers.

Empirical results reflect Hanley's empirical model (1993), in which it is documented that the first day of return is linked to the revision of the offer price and in particular the average return

of the first day is much higher for those IPOs where the offer price is revised upwards (32%) compared to those where the offer price is revised downwards (4%).
Finally, they argue that underpricing is an indirect form of compensation to underwriters. Although at first glance the benefit is a missed revenue on their fees calculated on the lower gross spread, subscribers benefit from underpricing in 2 ways: "First, it makes it easier to find buyers for IPOs, reducing their marketing costs [...]. Second, investors will engage in rent-seeking behaviour to improve their priority for being allocated shares in hot IPOs.
Among other things, they do this by trading with the brokerage arm of the underwriters and overpaying for commissions. This rent-seeking behavior on the part of potential IPO investors increases the revenues of the underwriter beyond that measured when focusing exclusively on the gross spread" (Loughran and Ritter, 2002, p.416).
Thus, according to the *prospectus theory*, underwriters benefit from a less transparent compensation mechanism when in the pre-sales phase demand becomes particularly and unexpectedly intense and the opportunity cost related to underpricing is perceived as less significant than the direct fees paid.

1.4.5 *Other factors affecting the underpricing*

Other endogenous factors related to the characteristics of issuing agents have been analyzed in the literature over the years; in the various studies since the 1970s, the Book-building process and specific characteristics of both firms, underwriters and auditors have been considered as possible causes of underpricing. Correlations with age, size, ownership structure, competitive advantage, or economic sector of the firm, or again, with the reputation of the underwriters and their monopsony power, have been found.
As mentioned in the first chapter, the younger the firms, the more ex-ante uncertainty there is at the time of listing. Therefore a negative relationship between the firm's age and the level of underpricing exists. Underpricing is also negatively correlated with the size of the offering; the smaller the offering, the higher the initial return (Ritter, 1991). A wider price range in the prospectus is also perceived as a sign of increased uncertainty for investment banks in assessing the price of an issue, as well as the expected size of the offer. Both are ex-ante uncertainty proxies that have a positive correlation with underpricing. (Hanley, 1993)
The possible correlation with existing borrowing relationships underlies the model of James and Wier (1990), who illustrate that firms that at the time of listing have previously established

borrowing relationships are less underpriced than firms without an established borrowing relationship. Underlying this result is the fact that the ex-ante uncertainty of issuing a firm's equity value in the secondary market is reduced by the existence of a borrowing relationship.

Focusing instead on firms' credit ratings, first there is Boot et al. (2006) who show how credit ratings are a "focal point" for firms and their investors because rated firms are subject to constant monitoring and pressure to improve their credit quality from rating agencies. Liu and Malatesta (2006), considering firms' seasoned equity offerings (SEOs), showed how the existence of credit ratings reduces information asymmetry and thus how firms with credit ratings are significantly underpriced less than those without credit ratings.
An and Chan (2008) extended the earlier study from the SEOs to the IPO markets, analyzing a sample of U.S. common share IPOs from 1986 to 2004, confirming how again the existence of a rating reduces uncertainty about firm value and therefore IPOs with ratings at the time of listing are significantly underpriced less than IPOs without ratings. Their study also found that "it is the existence of credit ratings, not the credit rating level, that reduces the IPO underpricing" (pag. 595) and that ratings reduce the degree of price revision during the book-building process,
An additional factor analysed is the affiliation with a corporate group. Beckman et al. (2001) observed how in the Japanese system "keiretsu-affiliated firms are more fully priced under the auction pricing system than are their independent counterparts" (p. 533). In contrast, Ghosh (2005) and Marisetty and Subrahmanyamb (2010), observing the Indian market, conclude that firms affiliated with a group underprice more than stand-alone listed companies.

Multiple authors have ascertained how issuers' reputation is positively correlated with underpricing. Among the first was Logue (1973) who, studying a sample of 250 IPOs all offered by negotiation, and not by auction, found significant differences in the average initial return between the IPOs performed by prestigious and non-prestigious investment banks observing that the greater the bargaining power of the issuer, the lower the underpricing. Logue argues that “prestigious underwriters are more selective than non-prestigious underwriters in the issues they underwrite; they may even specify a minimum size” (pag.100) therefore the underwriters themselves are used as signals by potential investors to assess the quality and risk of the listed company. Prestigious underwriters' issues are associated with higher underpricing because “non-prestigious investment bankers may not feel that their potential returns from underwriting small issues of common stocks justify the expense of gathering sufficient information and searching out investors' preferences so they may price closer to equilibrium” (page 102).

Titman and Trueman (1986) shift the focus to auditors and develop a model where they state that an issuer who has favourable information about his or her company has the incentive to disseminate it to the market through the quality of the investment banker and the auditor. This positively affects the value of the company. Like them, Beatty (1986) provides an empirical study where he identifies that new issues audited by the Big Eight reveal fewer uses of funds, fewer risk factors, and tend to have a shorter registration period than non-Big Eight clients.

Balvers et al. (1989), through a model that explicitly incorporates the relationship between investment banker and auditor, confirm the previously documented findings that both investment bankers' and auditors' reputations hurt underpricing. High-reputed investment bankers more frequently use prestigious auditors underpricing less. Just as he did, Carter and Manaster (1990) also showed that deals followed by reputable underwriters are associated with lower risk, and thus underwriter reputation is inversely related to positive initial returns. In their results, consistent with Beatty and Ritter's inverse relation between underpricing and issue quality, they hypothesise that underpricing is costly and that therefore, as price increases, low-risk firms seek to reveal their characteristics by selecting high-prestige underwriters and that these prestigious underwriters, to maintain their reputation, only market IPOs of low-prestige firms.

Barry et al. (1990) and Megginson and Weiss (1991) are pioneers in the topic of Venture Capitalists supporting young companies. The former observes that the presence of venture capitalists is perceived as providing better control of listing firms. The latter, analysing an equal number of VC-backed and non-VC-backed IPO offerings over the period 1983-1987, concludes that "larger venture capitalists tend to use the same underwriters with great frequency. In addition, VC-backed firms can attract higher quality underwriters and auditors as well as a larger institutional following than non-VC backed IPOs" and again "by reducing the asymmetry of information [...] venture capitalists can lower the costs of going public" (p. 901).

In contrast, investigating the role of venture capitalists in underpricing IPOs between 1980 and 2000, Lee and Wahal (2004) observed that VC-backed IPOs exhibit higher underpricing (10.3 percent) than non-VC-backed IPOs (5.0 percent). In their work, they relied on the "grandstanding hypothesis" which predicts that "the relation between bringing companies public and fundraising ability should be stronger for young venture capital firms" (Gomper 1996, page 136). IPO underpricing is thus a strategic maneuver induced by venture capitalists to successfully exit their investment.

Another theme analysed, is the **monopsony power of underwriters**, i.e their excess power that allows them to force underpricing when it suits them. Ritter (1984) and Tinic (1988) observed that prestigious investment banking firms prefer to avoid underwriting small, highly speculative issues, and if they do so, they take advantage of their superior position to underprice the IPO. This allows them to sell a large part of the issued stocks to their large clients, saving on marketing and advertising costs. Even Chalk and Peavy (1987) denote the tendency of larger underwriters to allocate unpriced shares to investors with whom they have frequent transactions, thereby easily increasing their commission income.

Finally, the listing process adopted by the company influences the level of underpricing. Biais and Faugeron-Crouzet (2002) sought to analyze what is the most efficient sales and underwriting process to control the amount and volatility of underpricing. Since the book-building mechanism is used exclusively in the United States (except for smaller offerings), they analyzed European markets, and in particular, the French market, where all three issuance mechanisms are used.

They concluded that, although the bookbuilding process generates higher expected proceeds than the fixed-price method (the process thanks to the analysis of the information collected ensures a final price that reflects intrinsic value thus reducing the level of underpricing), auctions are the most optimal mode.

On the one hand, Kutsuna and Smith (2001) thought that book building allows issuers to obtain a higher price for their shares, but it also entails a cost of revealing shares that could result in higher underpricing, which is partly taken up. The initial price of auction offerings, on the other hand, incorporates more information about current and recent past market conditions than book-building offerings.

Derrien and Womack (2003) and Ljungqvist, Jenkinson, and Wilhelm (2003) also advance their studies with the goal of understanding which mechanism minimises the level of underpricing.

On one hand, Ljungqvist, Jenkinson, and Wilhelm (2003) concur with Kutsuna and Smith's argument, adding that the positive effect of book-building in reducing the degree of underpricing outweighs the costs paid to underwriters in terms of commissions and marketing fees. Indeed, they note that the book-building process, despite costing twice as much as fixed-price offerings, due to the trade-off between quality and price in underwriting IPOs is becoming increasingly popular outside the United States. However, the method leads to lower underpricing only when it is conducted by U.S. banks and/or targets U.S. investors. Finally, they highlight how the growing preference for book-building has been observed mainly in Europe, while fixed-price methods still dominate in Asia.

On the other hand, Derrien and Womack, examining the French market in turn, obtain a result in accord with Biais and Faugeron-Crouzet: the auction mechanism is associated with lower underpricing and less variance in underpricing than the book-building and fixed-price methods, especially in hot market conditions. It is also noted that the variable number of days between the pricing and offering date depending on the IPO procedures affects underpricing. There is a caveat in their outcome, however: the type of auction used in France is not exactly a pure uniform-price auction.

It can be inferred from this result that underwriters thus face a problem of an agency conflict of interest that pits issuer clients, who may prefer the auction method because it would guarantee higher revenues from the issue price, and investor clients, who prefer the book building process that allows them to disclose shares in exchange for compensation in the form of underpricing. Resuming Iannotta (2010, p.92): "If the issuers were to decide what mechanism adopt, they would probably choose to minimize underpricing, thus opting for auction approach. However, underpricing is beneficial to investment banks and to their investor clients, who, differently from issuers, are repeat customers. As long as investment banks control the access to institutional investors, they will decide what mechanism to use and it will be book building, which allows them discretion in allocations. Nonetheless, whenever there is discretion there is a potential abuse, as I will discuss in the next section."

Finally, a different point of view is brought by Jagannathan and Sherman (2005) who, while acknowledging the transparency of the rules for allocating auction allowances, state that these have failed in almost every country where they have been attempted. They then advance a hypothesis of "non-standard" auctions designed to overcome the problems of standard auctions taking the form of more transparent versions of book building; but if this is to be the solution they suggest going the opposite route: "retaining the strengths of the basic book building method, and incorporate those features of auctions to make book-building more transparent and accessible" (page 72).

1.5 Stabilisation

Price stabilisation in initial public offerings is multifaceted and plays a crucial role in the after-gone public phase of the IPO. As seen above, the first trading days are generally characterised by strong volatility and extraordinarily high trading volumes, thus generating the possibility of immediate instability in the aftermarket. The underwriters have the task of stabilising the price to ensure a smooth transition of a company from private to public ownership, continuing to maintain market stability, investor confidence and the overall success of the IPO; all essential elements for the smooth functioning of financial markets.

By analysing in more detail the role of stabilisation and the influence on the essential elements for the smooth functioning of financial markets, it can be seen that stabilisation, If well implemented, positively influences investor confidence in both firm and underwriters, market integrity and short- and long-term performance.

By ensuring that the stock price does not fall below the IPO price immediately after listing, underwriters help mitigate the perception of a failed IPO, which is important for retail investors and crucial for investor sentiment who are generally more sensitive to initial post-IPO performance. Indeed, if the stock were to start falling and the underwriter did not intervene to stabilise the market, there would be the risk of triggering a downward spiral in the share price with discouraged investors making an early sale. Stabilisation efforts serve to prevent this by providing a safety net, thus avoiding the sale of panic.

Implementing a level of control and predictability is important to maintain confidence among market participants, particularly in markets characterised by volatility. Stabilisation activities help in the complex mechanism of price detection by finding the equilibrium price for a new security to mitigate extreme volatility, which could otherwise obscure the company's true market valuation.

A good ability to stabilise an IPO successfully is a matter of reputation for subscribers. Successfully managed IPOs improve the credibility and reliability of subscribers, which can lead to more business in the future. Underwriters need to demonstrate their ability to focus not only on the short-term post-IPO but to operate stabilisation activities with long-term implications. Clients with strong IPO performance are more likely to opt for future equity offerings and will be viewed more favorably by investors.

Furthermore, by adopting ethical practices of price stabilization, and respecting the regulatory framework, underwriters will strengthen the integrity of financial markets and protect against unethical business practices, reducing the likelihood of being sued for performance issues.

1.5.1 *Stabilization Mechanisms*

According to the 1940 Security and Exchange Commission (SEC) definition, stabilization is intended to absorb an oversupply of stock and consists of "the buying of a security for the limited purpose of preventing or retarding a decline in its open market price to facilitate its distribution to the public".

To prevent market manipulation, stabilization activities are governed by detailed market rules that set out the manner, timing, registration requirements, and price limitations associated with such activities, and in the final prospectus of the IPO is disclosed the information with on which these activities will be undertaken, making known the name of the stabilization agent and how it will be undertaken. Stabilization is conducted by only one manager in the syndicate on behalf of all syndicate members, which is usually the book-runner, and any losses or gains as a result of stabilization are shared among the syndicate according to each manager's underwriting commitment.

As seen in the previous chapter, the post-closing stabilization activities that an agent can undertake are multiple, from pure stabilization, which as Aggarwal explains occurs when there are unallocated shares, to the overallotment option, but also lock-up provisions, bonus shares, and penalty bids.

Overallotment option

With the overallotment option, commonly called the "Green Shoe" named after the company that pioneered this practice in 1963 (The Green Shoe Manufacturing Company), the stabilisation agent is allowed to take a short position by selling 15 percent more of the shares that it has underwritten (underwriting shares means buying those shares.). The investment bank therefore is selling shares that it does not own by borrowing them from the issuer or its shareholders. To do this, together with the selling shareholders, it must agree in the final prospectus a concession for an option to buy their shares in the next 30 days. The investment

bank will then have to return the borrowed shares and by holding a call option on those shares, there are two possible scenarios: from a given, when the price falls the bank simply repurchases these shares from investors at a lower price, counteracting the drop in demand generated and slowing (or reversing) the fall in price. At the end of the stabilisation period, it returns the borrowed and purchased shares to the issuer at a lower price than when they were sold, thus generating a profit.

On the other hand, if the price rises the investment bank will exercise the Green Shoe by repaying the shareholders the price the shares issued more at the offering price, covering its short at no cost. The option is part of a service provided by the investment bank, so the issuer grants it free of charge; thus, the bank will deliver the proceeds of the allotted shares to the issuer and receive the commission on the total proceeds sold, generating a profit.

Generally, Green Shoes are assigned only to placement tranches, and not to retail or public offerings. In addition, shares repurchased by the Greenshoe cannot be resold, but in some cases local regulations allow the practice, which is called "refresh the shoe."

It is not always effective in stabilising the market price.

The investment bank exercises the option anyway, whenever the level of overpricing is less than the fees on the total proceeds to the issuer. If the market price is only slightly lower than the IPO issue price, the trading profits from repurchasing the shares in the market may not be high enough to offset the opportunity cost of waiving the fees.

On the other hand, in cases where, due to the extreme selling pressure on the newly listed shares, the stabilizing agent is forced to wait for the offer to find a natural price level before proceeding to purchase shares in the market, the Green Shoe option does not work (Iannotta, 2010)

Naked shorts

The U.S. jurisdiction allows to allocate of an additional amount on top of the Greenshoe to provide additional "ammunition" to stabilise the supply. If the stabilising agent anticipates a particularly volatile subsequent market, it can go naked short on an additional amount of stock using its balance sheet; these stocks are non-borrowed by the issuer’s shareholders. It is a rare and risky practice that has lost large sums of money to banks that have adopted it to stabilise supply when it has not proved necessary. (Espinasse, 2014)

(figure espinasse p. 305).

Lock up provisions

Lock-up provisions are contractual agreements between the issuer's shareholders first and the investment bank designed to thus encourage stabilization by limiting the supply of shares and sending a credible signal that insiders will not cash in. Indeed, shareholders are restricted in selling shares for a period generally of 180 days after the IPO while management typically for 1 year. The period may also be more extended (a signal of commitment to long-term success), but nevertheless, there is no evidence that a longer lock-up period results in a more favorable IPO price. On the contrary, there is ample evidence that the share price decreases as the lock-up period expires. For the selling pressure generated at these times and to incentivize retail investors to buy, bonus shares are awarded at the expiration of fixed intervals.

Bonus shares

These are shares allocated free of charge to initial subscribers in the event of uninterrupted share ownership for a fixed time frame. As with lock-up provision, the objective is to limit a subsequent sale of shares.

Penalty bids

As mentioned earlier, these instruments are used to control the flipping or the resale of shares by discouraging investors from withdrawing shares in the first days or weeks of trading. The penalty bids, in the United States, accompanied by Greenshoes, consist of a reduction in fees imposed on a syndicate member if the stabilizing agent repurchases Greenshoes shares from one of the investors to whom the underwriter distributed the shares.

1.5.2 *Stabilization Regulations*

Stabilisation is covered by detailed market rules, which extensively cover the manner, timing, registration requirements, and price limitations associated with such activities. These rules aim to prevent price manipulation and ensure a fair and transparent market during the IPO process, protecting both investors and the company going public

In the United States, rules related to stabilisation activities in the context of IPOs are governed by the Anti-manipulation Rules Concerning Securities Offerings (Rule 10b-7) of the Securities Exchange Act of 1934, which provides specific guidelines to ensure the transparency and fairness of market stabilisation transactions.

First, Rule 10b-7 requires the placement syndicate to disclose in the prospectus the possibility that stabilisation activities may be conducted. This is to inform investors that such actions may be taken to support the share price during the period immediately following the IPO. The stabilisation agent must then record each transaction in special registers to provide an "audit trail."

Although the stabilisation period begins on the date of the first public announcement of the offering (showing the share price) and ends on the earlier of the 30th day after the closing of the offering and the 60th day after the grant date, the SEC still recommends "relatively short time limits" that generally translate to that the continuation of stabilisation activities should not exceed the first few trading days post IPO.

The SEC also imposes price limits in stabilisation that do not allow underwriters to purchase shares at a price higher than that set for the initial public offering. Stabilisation transactions cannot exceed the offering price or the highest bid made by an independent dealer. Should subsequent stabilisation bids occur, they cannot exceed the initial bid unless an independent buyer and seller trade on the company's main stock exchange at a price between the initial stabilisation bid and the bid price. In that case, this becomes the new stabilisation price limit.

Finally, Rule 10b-7 also specifies other specific features of the different implementable arrangements mentioned above, such as the 30 days to exercise the overallotment option, which is intended as an indicator of the maximum stabilisation period. (Geddes, 2005)

Quiet period

An important part of the SEC's efforts to maintain fair and orderly markets and protect investors concerns the regulation of the quiet period, or "waiting period," that is imposed both before and after an IPO, during which any public statements about the company beyond those contained in the registration statement and prospectus are restricted. The company and related parties are restricted in their statements to prevent management or other insiders from releasing information that could artificially inflate the stock price by affecting the IPO process. The purpose is to ensure that investors' decisions are based on the information contained in the prospectus and not on advertising or cosmetic statements.

Factual marketing communications and responses to unsolicited inquiries about the offering are exempt from the limitations and therefore allowed during the quiet period.

The quiet period begins when the registration statement is filed with the SEC and ends when the shares begin trading.

After this first phase, the "post-IPO" quiet period is extended for a new 40 days during which IPO underwriters cannot publish research reports on the company. This is designed to prevent

them from price manipulation due to potential conflicts of interest. Indeed, underwriters who have just helped the company go public could publish overly optimistic or pessimistic opinions about the stock.

The SEC's goal is to maintain a level playing field and to ensure that all investors have access to the same information.

The dispositive rules on the quiet period are complemented by Regulation Fair Disclosure (Reg FD), which requires all publicly traded companies to disclose material information to all investors at the same time, ensuring that no investor enjoys an unfair advantage based on access to information.

The SEC may sanction through IPO approval delays, fines, or other penalties companies that violate regulations during the quiet period.

1.6 IPOs long-term returns

The phenomenon of long-run underperformance in the IPO market represents a third significant anomaly documented in IPO-related literature.

Ritter, first independently (1991) and later backed by Loughran (1995), pioneered long-term underperformance studies that challenged the common belief in IPO price efficiency, suggesting that investors might be overly optimistic about the revenue potential of new public companies. He succeeded in confirming in the academic literature the effective inefficiency of the long-term returns of the IPOs that since December 1985 had been advertised by Forbes.

Ritter's (1991) initial findings, resulting from analysing the long-term performance of 1,526 initial public offerings in the United States from 1975 to 1984, found significant underperformance of these IPOs relative to already listed companies comparable in size and industry in the three years following the IPO.

Four years later, together with Loughran, they expanded the previous sample to include IPOs and SEOs and extended the time frame from three to five years. The new analysis found significant underperformance for both IPOs and SEOs relative to nonissue firms even over five years following the offering. Loughran and Ritter (1995, page 46) state that: “firms issuing stock during 1970 to 1990, whether an IPO or an SEO, have been poor long-run investments for investors. The average annual return during the five years after issuing is only 5 percent for firms conducting IPOs, and only 7 percent for firms conducting SEOs. Investing an equal amount at the same time in a non-issuing firm with approximately the same market capitalization, and holding it for an identical period, would have produced an average compound return of 12 percent per year for IPOs and 15 percent for SEOs”. These findings are also supported by Lowry's (2003) results, according to which IPOs in low-volume periods outperformed IPOs in high-volume periods.

These data are consistent with the hypothesis that firms take advantage of transient windows of opportunity by issuing shares when, on average, they are substantially overvalued. Consequently, at the time of issuance, market prices reflect the capitalization of transitory operating improvements. However, when the transitory nature of operating performance becomes evident, stocks underperform. Loughran and Ritter’s final evidence is one in which they observe how this underperformance generally begins six months after the issue. Therefore, as the under-execution is delayed, the link with the issuing companies is less evident for the market.

Several theories have been proposed to explain this long-term underperformance. Helwege and Liang (2004) are among those who suggest that there is a correlation between the timing of IPOs, capitalization of "windows of opportunity," and excessive investor optimism, which leads to inflated offering prices. Indeed, taking up their results, some evidence is found "that hot market IPOs are more likely to have lower earnings, they have lower capital expenditures and R&D ratios, are the same age at the time they go public, and do not exhibit faster sales growth or higher profits in the five years following the IPO than cold market IPOs." (pag. 565)

Other hypotheses focus on the inherent characteristics of young, fast-growing companies that often experience a decline in operating performance post-IPO, leading to diminishing stock returns in the long run.; or aging in the positive relationship with ownership dispersion post-IPO: a decline in ownership concentration and a deterioration in operating performance.

Finally, Ritter (1998), with his research on the subject, also noted how companies that went public in the 1970-1993 period produced an average annual return of only 7,9% in the five years after the offering, underperforming by 5,2% per year compared to a control group of non-issuing companies (13,1%).

CHAPTER 2
Empirical research on AI effects in the listing process

2.1 Introduction

As mentioned earlier, the stock market is characterised by inherent cyclicality, where periods of economic growth and investor optimism alternate with phases of recession and caution. This cyclicality is accentuated by the presence of "hot issue markets" in which the issuance of new stocks becomes particularly attractive due to high market expectations, often related to technological innovations or significant economic changes. However, these hot markets can sometimes result in speculative bubbles, where company valuations become significantly detached from their economic fundamentals, driven more by investor euphoria than by rational analysis.

Prominent examples include the dot-com bubble in the late 1990s and early 2000s when enthusiasm for the potential of the Internet led to a frenzied rush to IPOs of tech companies, many of which had little or no profit. The bursting of the bubble in 2000 wiped out billions of dollars of market value and caused severe financial losses for investors.

Another recent historical example of a speculative bubble is the U.S. housing bubble that preceded the 2008 global financial crisis. In this case, excessive speculation in the housing market, fueled by risky mortgage lending and complex financial instruments, led to a dramatic rise in house prices in 2004-2006, followed by an equally dramatic collapse.

Finally, the most recent examples of speculative euphoria involve the cryptocurrency market, which has shown similar trends to previous cases. Cryptocurrencies experienced rapid increases in value until peaks in 2017 first and 2021 later when Bitcoin reached nearly $20,000 in the first case and $60,000 in the second, followed by sudden collapses that caused it to lose about 80 percent of its value in the following years.

These examples highlight the cyclical nature of the stock market and the human tendency for collective euphoria when faced with new investment opportunities, often with little regard for

the underlying risks. Each speculative bubble leaves behind important lessons about investor psychology, market regulation, and the need for greater prudence and analysis in the investment process.

Dot-com Bubble

The beginning of the new millennium was marked by an irrational exuberance in technology and Internet companies that led to the explosion and subsequent collapse of the so-called dot-com bubble.

In the literature, theories about the exact time of the bubble's onset are discordant. For some, the bubble saw its inception in March 1995 with the extraordinary excitement caused by the IPO of Netscape Communications, Inc.

Others, however, point to as the initial triggering event the speech on "irrational exuberance" delivered in late 1996 by then-FED Chairman Alan Greenspan, who asked his interlocutors the rhetorical question "How do we know when irrational exuberance has caused asset values to rise unduly?" caused many world markets to collapse in the following days. His words had a strong impact, both because his view of fundamental values was respected and because investors feared that his rhetorical question was a prelude to a tightening of monetary policy.

Finally, DeLong and Magin (2006) argue instead that the dot-com bubble began only in 1998, as before then the U.S. stock market did not exhibit significant bubble characteristics.

Among the pieces of the puzzle to the root cause of the dot-com bubble were 3 government regulatory manoeuvres In 1999, the Glass-Steagall Act of 1933, which prohibited commercial banks from engaging in underwriting activities, was deregulated. The repeal of this law gave rise to internal conflicts of interest within the banks themselves. Being able to re-engage in underwriting practices, commercial banks began to advise customers to invest in products that benefited the banks' financial interests, thus fostering those notorious fraudulent underwriting practices that came to light only three years later. The deregulation of the law has also been linked to the causes of the 2008 financial crisis (Delossantos, 2023).

Preceding the previous deregulation, the Taxpayer Relief Act of 1997 and the Securities Litigation Uniform Standards Act of 1998 were also introduced. The former, which was aimed at reducing the tax rate on capital gains, allowed companies to reduce interest on debt, encouraging them to take increasingly drastic risk positions. The second, on the other hand, made it more difficult for investors to file class action lawsuits against companies for securities fraud.

Another piece of the puzzle was the common fraudulent practices in place in the late 1990s; in fact, analysts at top investment firms on Wall Street used to issue fraudulent reports in which

earnings were inflated. These false reports, along with media propaganda, fueled the irrational euphoria of unsophisticated investors who relied on these firms to manage their investments being completely unaware of the fictitious numbers they presented, leading them to "gamble" rather than invest (DeLong & Magin, 2006).

A third piece of the puzzle that significantly influenced stock prices during the dot-com bubble was the selling behaviour of insiders, who artificially inflated prices through recurring patterns of allocation and subsequent resale of shares in the secondary market in exchange for bribes to the allocating underwriters.

Finally, venture capital (VC) firms also played a significant role in the overvaluation of companies during the dot-com bubble. These overinvested in start-ups, then encouraging them to make large investments in turn in mass advertising to establish brand names, often basing investment valuations on the web traffic generated by these marketing campaigns, leading to overinvestment and contributing to the inflation of the bubble.

U.S. housing bubble

Following the Dot-com Bubble and the terrorist attacks of September 11, 2001, the FED adopted a policy of very low-interest rates to stimulate the economy. This policy, which made it extremely cheap to borrow money, together with the financial innovation of mortgage loan titling and increasing speculation due to an unprecedentedly optimistic environment in the housing market, pushed both households and investors to consider buying real estate as an attractive and relatively affordable opportunity with the belief that house prices could only rise. The titling of mortgage loans and the development of so-called private-label mortgage-backed securities (without credit risk protection) spread credit risk through the global financial system but also made it extremely difficult to assess and manage that risk, especially when the quality of the underlying mortgages began to deteriorate.

Between 2001 and 2006, the use of collateralized debt obligations (introduced in the early nineties) exploded, and in particular the market for subprime mortgages, mortgages structured with artificially low initial interest rates that rise sharply after an initial period.

Anyone, even people with a low credit rating, gained access to these "subprime" mortgage loans to buy property. Demand thus grew by leaps and bounds, consequently raising property prices as well. This easy access to credit and the expectation that house prices would continue to rise encouraged widespread speculation that further fueled the rise in house prices, moving them further and further away from their real economic value. Investors, seeking higher returns, made extensive use of these financial instruments to buy properties to resell later at a higher price.

Rising rates on subprime mortgages and market saturation caused default rates to rise sharply and mortgage payments became unaffordable for many homeowners who had taken out loans by mortgaging the same properties. The increasing numbers of foreclosed properties were put back on the market by increasing supply, in an environment where demand began to decline. The collapse in house prices, fueled by loss of confidence and panic selling; led to the collapse of the housing market, exacerbated by the high house price appreciation in previous years that had masked the underlying problems, and the freezing of financing for CDOs.

Indeed, Demyanyk and Van Hemert (2011) found a steady deterioration in loan quality in the six years before the crisis, arguing that securitizers were partially aware of this. This decline in quality was monotonic, but not equally distributed among different types of mortgages; subprime mortgages with high-interest rates became increasingly riskier than those with low interest rates.

Moreover, the increase in the overall riskiness of subprime mortgages has not been accompanied by an increase in the markup of subprime mortgages, which has instead decreased over time.

Lim (2008) states that, what began as a credit crunch in the subprime mortgage sector, quickly spread to all other banking sectors reaching as far as consumer loans (credit cards and auto loans). Banks began to hoard liquidity to meet their credit obligations, effectively blocking the money market.

Major central banks had to implement a coordinated effort to pump hundreds of billions of liquidity into the banking system and calm the money market while governments had to step in to rescue those financial institutions that suddenly found themselves exposed to huge losses related to mortgage-based financial products. Some of those financial institutions went bankrupt, most famously Lehman Brothers and a prolonged economic recession began that resulted in the global financial crisis of 2008.

This housing bubble and its subsequent collapse highlighted the dangerous interconnection between credit policies, financial innovation, speculation, and economic stability,

Cryptocurrencies Bubble

The recent cryptocurrency market has experienced a tumultuous path that embodies the archetypal modern speculative bubble. The first of the two most emblematic episodes of this dynamic occurred in 2017, when a frantic rush to purchase, fueled by general euphoria, caused cryptocurrencies to record extraordinary gains, attracting the attention of institutional and individual investors worldwide. Leading the market has been Bitcoin, whose price soared to close to $20,000 in December of that year.

The market boom can be attributed to several key factors. First, the growing awareness and acceptance of cryptocurrencies as a new asset class with the potential to revolutionise existing payment and financial systems. Blockchain technology has also been praised for its security and transparency further fueling investor enthusiasm.

Second, the macroeconomic and financial environment of low-interest rates has prompted investors to seek higher returns outside traditional financial markets, making cryptocurrencies an attractive option despite their volatility.

Third, speculation artificially inflated prices, detaching them from fundamental values. Many were buying cryptocurrencies not to use them as a medium of exchange or store of value, but to sell them at a higher price in the future.

The introduction of increasing regulation by financial authorities around the world, a series of high-profile cryptocurrency thefts, and the exhaustion of speculative euphoria meant that the market underwent a dramatic correction as early as 2018, with Bitcoin losing about 80 percent of its value since its December 2017 peak.

A new "boom and bust" cycle in the market occurred in 2021 when Bitcoin's price hit $65,000 in November. Again, several factors fueled the market explosion. The first was the increasing adoption of Bitcoin as a payment instrument by both institutional investors and companies such as Tesla, which conferred unprecedented legitimacy as a store of value and as an investment asset. This has boosted investor confidence and pushed the price upward. Second, the massive fiscal stimulus packages that were issued by various governments in response to the COVID-19 pandemic raised concerns about inflation and currency devaluation. Bitcoin was increasingly perceived as a hedge against inflation, leading to an increase in demand and price. Third, media coverage drove a significant increase in public interest in cryptocurrencies. Moreover, the adoption of more user-friendly trading platforms has made cryptocurrencies accessible to a wider audience. This has led to an influx of new investors into the market, further fueling the bull run.

Finally, as before, investor speculation also played a significant role.

After reaching the peak, Bitcoin suffered a drastic price drop to be attributed to a combination of factors such as profit-taking, stricter national regulations, and decreased speculative interest, which together contributed to a significant market correction.

Following the late 2021 peak, many investors decided to realise their profits by selling their holdings and triggering massive selling that generated downward pressure on prices. Panic selling also began among speculators who had bought cryptocurrencies as investments without fundamental understanding or long-term interest.

Many nations, in response to environmental concerns and financial risks, introduced stricter regulations on cryptocurrencies that significantly impacted market sentiment, causing uncertainty and fear among investors.
The strong influence of social media and media coverage that had fueled public interest reversed course. Negative comments from influential figures in finance and technology began, causing a shift in market sentiment and overreactions among investors. Elon Musk himself, who had previously adopted Bitcoin as a means of payment for his company, began to discredit the long-term sustainability of Bitcoin as an asset, expressing concerns about the environmental impact of the mining procedure.

These episodes, although distinct in context and underlying technology, share several common characteristics, including unbridled investor optimism, speculation, and a shift in asset prices away from their fundamental values. They have also all had drastic effects on regulatory policy and resulted in more audits for top-rated companies, priorities for investor safety, and more eyes on the street.

In the current context, artificial intelligence is emerging as the latest technological frontier, promising to revolutionise sectors ranging from medicine to mobility, and security education, capturing the public imagination and attracting significant investment. Similar to the scenario before the dot-com bubble, we are witnessing a surge in investments in AI startups, an increase in the market value of companies claiming to implement AI solutions in their core business, and an increased inclusion of AI-related terms in filings to the SEC. Renaissance Capital in a research on the role of artificial intelligence in the context of U.S. IPOs presented in April 2023, highlights how from 2017 onward the trend of companies incorporating AI and machine learning into their operations has grown, increasingly increasing the number of U.S. IPOs mentioning AI in their prospectuses making these technologies central to their appeal to IPO investors. The peak number of IPOs with mentions on artificial intelligence reached in 2021 is 148 which represented 37% of the total number; while in the first 4 months of 2023, although the number has shrunk to only 21 case histories, these represent over 50% of the total. This rapid escalation of artificial intelligence and related investments raises questions about possible disconnects between market valuations and the actual economic value of the companies involved. In this context, which may foreshadow a potential new financial bubble, the importance of trying to distinguish between speculative euphoria and the real value generated by AI adoption emerges to be able to assess whether history is repeating itself or

whether, on the contrary, we are facing a technological evolution with a more solid basis than in the past.

Research papers can already be found in the literature both to understand the great potential of artificial intelligence in the financial field, but also to identify the risks of its misuse. Munshi, Patel, et al (2022) using AI to predict the performance of IPOs and obtain results with 91.95 percent accuracy, emphasize the importance of adopting AI to detect market trends and improve investment strategies. their research demonstrates the potential of AI models to improve the predictability of IPO outcomes, offering valuable insights to investors navigating the stock market.
Fatouros et al (2023), on the other hand, explore the potential of ChatGPT in analyzing financial sentiment compared to currently used models such as the FinBERT model, highlighting its improved analysis of financial sentiment (+35% in sentiment ranking) and predictions of market returns, encouraging further research in financial services applications.
Krause (2023) explores the use of AI, including ChatGPT, to improve investment due diligence in private companies due to its ability to process large volumes of data without bias.

With this thesis, we embark on an exploratory study to understand whether the exponential rise and growing enthusiasm for artificial intelligence and its revolutionary applications, such as ChatGPT, are significantly shaping market valuations of IPOs; in particular, it focuses on the presence of references to AI in the SEC filings of companies that have listed in the past two years, to assess whether this can be seen as a source of fueling the growing enthusiasm around artificial intelligence. It is intended to assess the effects that may occur both during the book-building period in the construction of the price and size of the offering and in the first weeks of listing, a key period for price settling once it has impacted real market dynamics.

2.2 Data Sources

The analytical sample intended for the present study was defined by collecting from the IPO calendar published on the NASDAQ website a history of all Initial Public Offering (IPO) initiatives in the U.S. market, regardless of the reference exchange, assuming as a time frame the two years framing the pubic launch date of Chat GPT, starting from December 2021 until December 2023. Out of the 405 observations initially collected, a critical exclusionary choice was made against entities configured as Special Purpose Acquisition Companies (SPACs), companies formed specifically to raise funds through an initial public offering and viewed as a means for companies to go public without going through the traditional and more rigorous process of an IPO. The final sample records a set of 226 observational entities.

2.3 Variable description

For each of the 226 companies, SEC filings were observed, focusing on finding key variables that reflect the market dynamics and strategies adopted by the companies in the initial public offering process. The price ranges given in Form S-1 or subsequent amendments, and the final offering price given in Prospectus 424 at the time of listing, were collected to calculate whether the companies experienced a change in the offering price during the listing period. Similarly, changes in the size of the offering were observed, i.e., the change from the amount of capital the company indicates it intends to raise with the preliminary filings to the amount offered on the day of listing.

The length of the listing period, expressed in days incurred between the first publication of Form S1 and the publication of the final prospectus on the day of listing, was then considered.

Finally, the qualitative analysis of the SEC filings included the identification of mentions of artificial intelligence (variable "*AI*"), in the sections on corporate strategy and risk factors of companies, to assess the importance attached to technological innovation and its possible impact on company valuations and investor interest.

Conjointly with the SEC Filings, financial platforms, such as YahooFinance, stockanalysis.com, and the NASDAQ website, were consulted to retrieve the closing prices of the first day of listing and the fourth week of listing (calculating 20 business days). These were used to calculate the underpricing level of each IPO and construct a short-term performance index to assess price stabilisation in the market.

Artificial Intelligence

To go into more detail in the investigation of the role of artificial intelligence (AI) in Initial Public Offerings, a more granular approach was taken to understand how companies treat and communicate the importance of AI in their public offering documents. Particular attention was paid to distinguishing between mentions of AI as a factor within or outside the organisation, a crucial differentiation that led to business strategies and market perceptions of technological innovation.

To rationalise this distinction, multiple control variables were created to categorise companies based on their mention of AI in SEC filings. An initial distinction was implemented independently of whether AI is mentioned as an internal and/or external factor; the variable "*AI_strategic*" was assigned value 1 if the company mentions AI as an integral part of the internal process, their business strategy, their products, and services, or the future growth strategy to be adopted; the variable "*AI_risk*", on the other hand, was assigned value 1 if AI is mentioned in the paragraphs on risk factors of the external environment, mentioning market trends, competitive pressures, or growth opportunities regardless of whether AI is mentioned in the integration of internal processes.

Subsequently, 3 other variables that are closely dependent on each other (and on the previous two) were introduced; specifically, the variable "*AI_onlyS*" takes value 1 for all those companies that mention AI only as an internal factor; the variable "*AI_onlyR*" takes value 1 for all those companies that mention AI only as an external risk factor; finally, for those companies have a 360-degree consideration of AI by mentioning it both as internal strength and as a general industry risk, the variable "*AI_SR*" takes value 1.

This distinction was critical to more accurately assess the impact of AI on company valuations and market dynamics associated with IPOs. By analysing the control variables concerning other financial and market indicators, it was possible to explore whether and how the presence of AI in the strategic core of companies or their external operating environment affects market attractiveness to investors.

In order to provide a more detailed and multifaceted understanding of the dynamics influencing IPOs, allowing us to identify trends, correlations, and potential causations in a rapidly changing market environment, additional control variables were then identified to be incorporated into our model to allow us to examine the impact of various contextual factors on the performance of IPOs.

The starting point from which the idea for this thesis was born is the launch of ChatGPT and the effect this may have had on the perception of ordinary investors on IPOs involving artificial intelligence. Therefore, the variable "*POST*" is considered, which takes value 1 for all those IPOs that occurred after the pivotal date of Nov. 29, 2022 (and value 0 for earlier ones). In subsequent models, the variable is observed both in autonomy and in interaction with the AI variable in all its facets (depending on the reference model). In the first case, it is analysed whether and how the new listings are affected by the market momentum, and whether this has varied over the time interval considered. In the second case, the variable provides an opportunity to isolate the time effects associated with the public access to the revolutionary new technology in the market on investor perceptions and how this may or may not have influenced IPO valuations.

Control variables

Another factor considered was the sector to which the companies belonged, with a specific distinction between those operating in STEM (Science, Technology, Engineering, and Mathematics) fields and those in non-STEM fields. Through the control variable "*Sector_STEM*", which takes value 1 for STEM companies, we aim to explore how sector affiliation affects IPO dynamics, hypothesising that STEM companies might be perceived as more attractive or more likely to adopt artificial intelligence as an internal factor and key driver for growth.

Finally, the last factor considered is the listing market in which the companies were listed. In the sample considered only 36 observations are listed on the New York Stock Exchange (NYSE), for them the "*NYSE*" variable will take value 1, while for the remaining ones listed at NASDAQ, the value will be 0. This one aims to analyse whether there are significant differences in IPO performance or pricing strategies based on the listing market, hypothesising that NASDAQ attracts more technology-driven companies and start-ups, categories in which the use of AI is more prevalent.

2.4 Descriptive analysis

Based on the variables presented above, four initial linear regression models were constructed to explore the relationships between the characteristics of IPOs and various factors, including technological innovation, time impact related to ChatGPT launch, duration of the listing process, choice of the stock market, and sector and market membership
Each model focuses on a specific aspect of IPO performance or characteristics, using a different dependent variable (*table 1*).

The first model aims to explore how AI mention, timing of the IPO versus ChatGPT launch, length of the listing process, and membership in STEM sectors and one stock market versus another influence the change in the offering price:

$$[1]\ \boldsymbol{Y_{Delta\_price}} = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Listing\_period + \\ + \beta_5 Sector\_STEM + \beta_6 NYSE + \varepsilon$$

The second model, twin to the first turns attention to variations in the size of the supply:

$$[2]\ \boldsymbol{Y_{Delta\_size}} = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Listing\_period + \\ + \beta_5 Sector\_STEM + \beta_6 NYSE + \varepsilon$$

The third model analyses underpricing as a dependent variable, incorporating changes in price and supply size as additional predictors, relative to the independent variables in the other models

$$[3]\ \boldsymbol{Y_{Underp}} = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Listing\_period + \\ + \beta_5 Sector\_STEM + \beta_6 NYSE + \beta_7 Size\_price + \\ + \beta_8 Delta\_size + \varepsilon$$

The last model aims to observe the behaviours of stock price stabilisation in the first 20 days of listing.

$$[4]\ \boldsymbol{Y_{Performance}} = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \\ + \beta_4 Listing\_period + \beta_5 Sector\_STEM + \beta_6 NYSE + \varepsilon$$

In each model, β_0 represents the intercept, betas are the coefficients measuring the effect of each independent variable on the dependent variables, and ϵ is the error term.
The AI×POST interaction is particularly interesting because it allows us to assess whether the impact of AI on IPOs varies significantly in the period after ChatGPT's launch compared with the period before.

Looking at the first outputs of the models (*Table 1*), we see that the models for underpricing and performance show high Residual standard errors among the values of the 226 distributions in our sample, respectively 37.453 (df = 217) and 19.675 (df = 219). After also graphically observing the dispersion of the values for the dependent variables (*Figure 2*), we note how the presence of some outliers for underpricing and performance could untruthfully influence the results of the analysis.

	Dependent variable:			
	Delta_price (1)	Delta_size (2)	Underpricing (3)	Performance_sp (4)
AI	0.014	-0.007	-15.354*	-6.895
	(0.043)	(0.128)	(8.007)	(4.205)
Post	0.019	0.010	-14.932**	-7.766**
	(0.035)	(0.105)	(6.620)	(3.475)
AI:Post	0.008	-0.086	14.902	6.633
	(0.056)	(0.167)	(10.474)	(5.499)
Listing_period	-0.0001	-0.0003	-0.010	-0.003
	(0.0001)	(0.0002)	(0.015)	(0.008)
Sector_STEM	0.035	0.093	2.973	1.825
	(0.029)	(0.086)	(5.404)	(2.820)
NYSE	0.035	-0.040	-2.648	-0.777
	(0.037)	(0.111)	(7.001)	(3.670)
Delta_price			-20.911	
			(12.663)	
Delta_size			-3.413	
			(4.253)	
Constant	-0.098***	-0.030	14.616**	7.482**
	(0.035)	(0.104)	(6.657)	(3.435)
Observations	226	226	226	226
R2	0.026	0.017	0.054	0.037
Adjusted R2	-0.001	-0.010	0.020	0.011
Residual Std. Error	0.200 (df = 219)	0.597 (df = 219)	37.453 (df = 217)	19.675 (df = 219)
F Statistic	0.964 (df = 6; 219)	0.635 (df = 6; 219)	1.561 (df = 8; 217)	1.412 (df = 6; 219)
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 1 *- Statistic output from liner regression model number [1] to [4]*

We therefore proceed to harden the model before continuing with the analysis.

As a first option, cleaning the observations with outlier data was evaluated using the statistical method IQR (Interquartile Range) through which the difference between the third and first quartiles (Q3 - Q1), i.e., the range of values occupying the middle half of the data set, was calculated. We then cleaned the sample of all those values above and below x1.5 to the lowest 25 percent of the data and the highest 25 percent of the data, providing a measure of variability that is less sensitive to extreme fluctuations than other measures such as variance.

Through this procedure, however, nearly 20 percent of the observations would have been lost, ending up with a clean sample of only 184 observations.

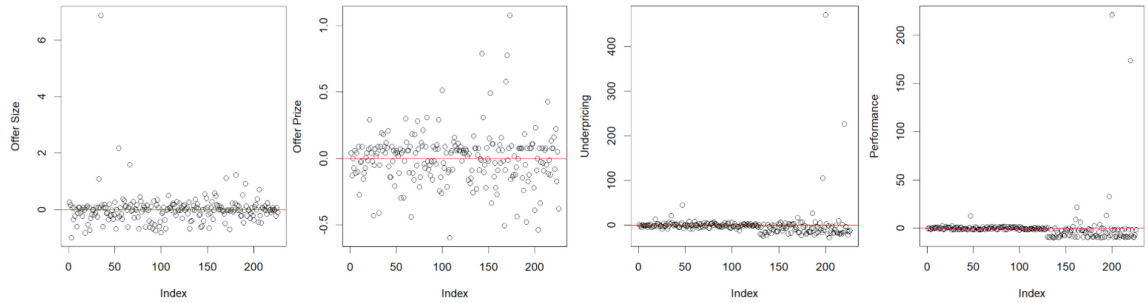


Figure 2 *- Dependent variables values' dispersion*

Therefore, it was decided to follow another route, applying the winsorization technique to the data of the 2 variables, which allowed replacing all values below the 5th percentile with the value at that percentile and, similarly, replacing data above the 95th percentile with the value at that percentile. With this, extreme values were limited, reducing the impact of outliers on the mean, variance, and other descriptive statistics, hardening the data set without having to lose observations (figure 2). Recalculating the previous models using the new values shows that the residual standard errors of the previous two models have drastically reduced, increasing the robustness of the data sample (table 2). It is also noted that the “Listing_period” independent variable, in addition to not being statistically significant in any model, minimally influences the coefficients of all four dependent variables. It is therefore decided not to consider it in subsequent analyses.

	Dependent variable:			
	Delta_price	Delta_size	Under_wins	Perf_wins
	(1)	(2)	(3)	(4)
AI	0.014	-0.007	-2.100***	-0.474
	(0.043)	(0.128)	(0.670)	(0.339)
Post	0.019	0.010	-2.856***	-1.081***
	(0.035)	(0.105)	(0.554)	(0.280)
Listing_period	-0.0001	-0.0003	0.001	0.0003
	(0.0001)	(0.0002)	(0.001)	(0.001)
Sector_STEM	0.035	0.093	-0.394	0.134
	(0.029)	(0.086)	(0.452)	(0.227)
NYSE	0.035	-0.040	-0.722	-0.121
	(0.037)	(0.111)	(0.585)	(0.296)
Delta_price			-1.639	
			(1.059)	
Delta_size			-0.098	
			(0.356)	
AI:Post	0.008	-0.086	2.254**	0.437
	(0.056)	(0.167)	(0.876)	(0.443)
Constant	-0.098***	-0.030	3.283***	0.925***
	(0.035)	(0.104)	(0.557)	(0.277)
Observations	226	226	226	226
R2	0.026	0.017	0.157	0.094
Adjusted R2	-0.001	-0.010	0.126	0.069
Res. Std. Error (df = 219)	0.200	0.597	3.132 (df = 217)	1.587
F Statistic (df = 6; 219)	0.964	0.635	5.047*** (df = 8; 217)	3.782***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 2 - *New statistic output from liner regression model number [1] to [4] with winsorized variable for Underpricing and Performance variables*

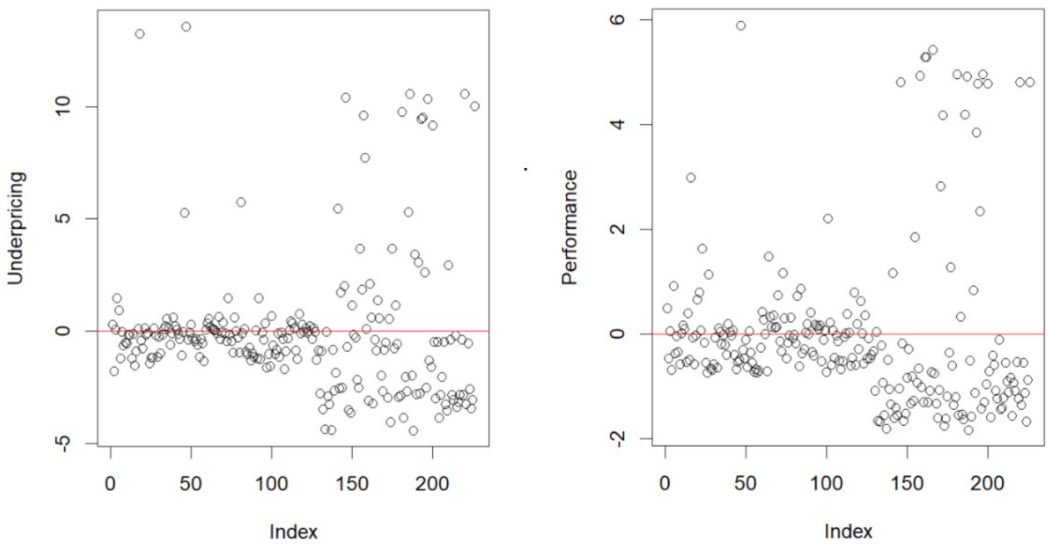


Figure 3 *- Variables Underpricing and Performance dispersion of values after winsorization*

In refining the analysis, taking a cue from Loughran and McDonald (2013), who in their work considered the effect of the way filings were drafted on price revisions during the listing period and post-IPO volatility, the control variable called "“*Revision_UP*”," which takes a value of 1 in the case where the bid price experienced an increase during the listing period, was also considered. The introduction of this variable made it possible to group companies that manifested an increase in the offering price into a specific sample, with the aim of investigating whether this was due to the presence of artificial intelligence (AI)-related mentions in their SEC documents. The underlying hypothesis is that companies that revised up the offering price during the listing period might have distinctive characteristics, such as a strong emphasis on technological innovation or AI capabilities, that could positively influence investors' expectations during roadshows and justify an increase in offering value.

The fifth model is thus constructed as follows:

$$[5]\quad \boldsymbol{Y_{Revision\_UP}} = \beta_0 + \beta_1 AI + \beta_2 POST + \beta_3 (AI * POST) + \beta_5 Sector\_STEM + \beta_6 NYSE + \varepsilon$$

The outcomes of this new model, compared with the benchmark delta_price model show that the probability of the presence of references to artificial intelligence is higher in those listing fees that revised the bid price upward during the roadshow. In addition, significance is also present in the coefficient of the NYSE variable. This means that in the last two years, companies that chose to list on the NYSE revised the price positively during roadshows more frequently than those newly listed on the NASDAQ (table 3). 10 listing firms of the 36 that chose the New

York Stock Exchange as market exchange revised the average value of the range initially presented positively. In the entire sample of 226 IPOs, only 39 had a positive adjustment to the offering price before listing.

	Dependent variable:	
	Delta_price	Revision_UP
	(1)	(2)
AI	0.011	0.189**
	(0.043)	(0.079)
Post	0.014	0.034
	(0.035)	(0.065)
Sector_STEM	0.034	0.080
	(0.029)	(0.053)
NYSE	0.039	0.136*
	(0.037)	(0.069)
AI:Post	0.011	-0.090
	(0.056)	(0.104)
Constant	-0.114***	0.025
	(0.034)	(0.062)
Observations	226	226
R2	0.014	0.058
Adjusted R2	-0.009	0.037
Residual Std. Error (df = 220)	0.201	0.372
F Statistic (df = 5; 220)	0.619	2.729**
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 3 *- Comparison between new introduced control variable Revision_UP model [5] and variable Delta_pirce*

In much academic research, the primary data sources collected have been subjected to corrections and filtering. Recurring, especially in research examining the long-term performance of IPOs, is the refining of the sample from all those IPOs that have an offering price below a certain threshold, usually earmarked at $5, to focus on a market segment considered more representative of stable and less speculative companies.

Loughran and Ritter (2004) emphasize the importance of considering sample quality in post-IPO performance analyses, arguing that low-priced IPOs may be subject to different market dynamics, which include greater speculation and volatility. Excluding them from the analysis helps to obtain a clearer analysis focused on market dynamics relevant to companies of greater size and financial stability. Therefore, this criterion is often used to mitigate the effect of highly volatile and risky stocks, typically associated with penny stocks, which can distort the analysis of market dynamics and IPO performance.

Taking a cue from these theoretical underpinnings, again in this analysis we wanted to try to differentiate IPOs with an offer price less than or equal to 5 from those with the highest offer

price. As has happened before, the desire not to reduce the already limited sample observations prompted the choice to introduce an additional control variable. A cleanup in fact would have limited the sample to 150 observations if a threshold limit greater than or equal to $5 was considered; it would have halved it, to 114, if only IPOs with an offer price strictly greater than $5 were considered.

Also in the choice of the control variable, the 2 case histories, and consequently 2 variables, were evaluated; the "*Dollar5*" variable that assigned value 1 to all those IPOs with a bid price greater than or equal to $5 and the "*Dollar5up*" variable that instead excluded a bid price equal to 5$.

The following 3 linear models were modeled and compared for each dependent variable:

[6] $$Y = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Sector\_STEM + \beta_5 NYSE + \\ + \beta_6 Dollar5 + \beta_7 Dollar5up + \varepsilon$$

[7] $$Y = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Sector\_STEM + \beta_5 NYSE + \\ + \beta_6 Dollar5 + \varepsilon$$

[8] $$Y = \beta_0 + \beta_1 A + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Sector\_STEM + \beta_5 NYSE + \\ + \beta_6 Dollar5up + \varepsilon$$

The decision to adopt the variable "*Dollar5up*" as a sample selection criterion follows the analysis of the coefficients resulting from the models above. Both variables demonstrated significance toward the delta_price and underpricing variables in the only cases where they were considered individually, and particularly in the case of underpricing, the dollar5up variable proved more significant in negatively influencing the data than the other. (Tab 4)
The final choice therefore fell on using this to integrate all models from here on.

Delta_price

	Estimate	Std. Error	t value	Pr(>|t|)	
Dollar5	0.09193	0.03908	2.352	0.0195	*
Dollar5up	0.06065	0.03654	1.660	0.0984	.

	Estimate	Std. Error	t value	Pr(>|t|)	
Dollar5	0.13850	0.02731	5.072	8.34e-07	***

	Estimate	Std. Error	t value	Pr(>|t|)	
Dollar5up	0.1223655	0.0256897	4.763	3.46e-06	***

Delta_size

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5	0.042124	0.122839	0.343	0.732
Dollar5up	0.043806	0.114854	0.381	0.703

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5	7.577e-02	8.532e-02	0.888	0.376

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5up	0.072088	0.079772	0.904	0.367

Underpricing

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5	-0.16717	0.64791	-0.258	0.79664
Dollar5up	-0.88190	0.60200	-1.465	0.14438

	Estimate	Std. Error	t value	Pr(>|t|)	
Dollar5	-0.81731	0.47328	-1.727	0.085603	.

	Estimate	Std. Error	t value	Pr(>|t|)	
Dollar5up	-0.98829	0.43766	-2.258	0.02493	*

Performance

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5	0.4244	0.3239	1.310	0.191444
Dollar5up	-0.5796	0.3029	-1.914	0.056933 .

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5	-0.02073	0.22679	-0.091	0.927251

	Estimate	Std. Error	t value	Pr(>|t|)
Dollar5up	-0.2947	0.2111	-1.396	0.164193

Table 4 *- coefficients of control varables "Dollar5" and "Dollar5up" applied on the model presented [6] to [8]*

Thus, the basic models that form the core of the research were defined. These models explore the relationships between the dependent variables "*Delta_price*", "*Revision_up*", "*Delta_size*", and 20-day performance (winsorized values) with the independent and control variables carefully selected in the previous steps. The independent variables include "*Sector_STEM*" (indicating whether a company belongs to the STEM sector), "*NYSE*" (distinguishing companies listed on the New York Stock Exchange from those on NASDAQ), "*Dollar5up*" (offering price above $5), and "*POST*" (indicating whether the IPO occurred after the launch of ChatGPT). **Mentions of artificial intelligence** in SEC documents are considered as a key variable to analyze the effect of AI on IPOs. The *interaction between AI and POST* is also examined to determine whether the influence of AI on IPOs varies with the period considered.

In the model focused on underpricing, we also include Delta_price and Delta_size as additional independent variables. This methodological choice is based on the assumption that variation in bid price and bid size can influence underpricing, thus avoiding misattributing effects to artificial intelligence that could be explained by other factors. The inclusion of these variables allows us to refine the analysis, providing a more detailed understanding of the dynamics governing IPO underpricing.

Therefore, the seven final models are:

Model to assess the overall effect of AI mentioned:

[9] $$Y = \beta_0 + \beta_1 AI + \beta_2 POST + \beta_3 (AI * POST) + \beta_4 Sector\_STEM + \beta_5 NYSE + \beta_6 Dollar5up + \varepsilon$$

Model to evaluate the effect of AI mentioned as an internal factor:

[10] $$Y = \beta_0 + \beta_1 AI\_strategic + \beta_2 POST + \beta_3 (AI\_strategic * POST) + + \beta_4 Sector\_STEM + NYSE + \beta_6 Dollar5up + \varepsilon$$

Model to evaluate the effect of mentioning AI as an external factor:

[11] $$Y = \beta_0 + \beta_1 AI\_risk + \beta_2 POST + \beta_3 (AI\_risk * POST) + + \beta_4 Sector\_STEM + \beta_5 NYSE + \beta_6 Dollar5up + \varepsilon$$

Model to evaluate the effect of mentioning AI as an internal or as an internal factor:

[12] $$Y = \beta_0 + \beta_1 AI\_strategic + \beta_2 AI\_risk + \beta_3 POST + + \beta_4 (AI\_strategic * POST) + \beta_5 (AI\_risk * POST) + + \beta_6 Sector\_STEM + \beta_7 NYSE + \beta_8 Dollar5up + \varepsilon$$

Model to evaluate the effect of AI if it is mentioned exclusively as an internal factor:

[13] $$Y = \beta_0 + \beta_1 AI\_onlyS + \beta_2 POST + \beta_3 (AI\_onlyS * POST) + + \beta_4 Sector\_STEM + \beta_5 NYSE + \beta_6 Dollar5up + \varepsilon$$

Model to evaluate the effect of AI if it is mentioned exclusively as an external factor:

[14] $$Y = \beta_0 + \beta_1 AI\_onlyR + \beta_2 POST + \beta_3 (AI\_onlyR * POST) + + \beta_4 Sector\_STEM + \beta_5 NYSE + \beta_6 Dollar5up + \varepsilon$$

Model to assess the effect of AI if it is mentioned either as an internal or external factor to the company:

[15] $$Y = \beta_0 + \beta_1 AI\_SR + \beta_2 POST + \beta_3 (AI\_SR * POST) + \beta_4 Sector\_STEM + + \beta_5 NYSE + \beta_6 Dollar5up + \varepsilon$$

2.5 Results

The analysis shows that the mention of artificial intelligence (AI) in SEC documents of listed companies does not play a predominant role in complexly shaping market dynamics. However, it emerges that an upward adjustment of the offering price in the bookbuilding process is more frequent, both in quantitative (Revision_up) and qualitative (Delta_price) terms, in companies that mention AI. This occurs regardless of whether AI is considered an internal factor already integrated into the company's operations or a potential external risk factor to be monitored [AI tab].
The analysis also reveals that companies with an initial listing price above $5 tend to experience a high probability of upward revision of their price. This phenomenon can be explained by the inherent characteristics of these companies: a higher initial listing price can be interpreted as an indicator of greater value and stability, serving as a quality signal that attracts institutional investors and decreases the perception of risk. In addition, companies with a higher initial listing may have more resources and high-profile financial advisors, allowing them to adopt more aggressive pricing strategies and show greater flexibility in upward price revisions in response to favorable market conditions or marked investor interest.

In contrast, the models used in the analysis did not provide convincing explanations for variations in the number of shares offered. This suggests that these decisions are the result of internal strategic assessments, made in concert between underwriters and issuing companies, based on considerations and factors not included in the scope of this analysis (*table 5*).

Focusing now on the model outputs related to underpricing, it is evident that the presence of references to artificial intelligence in SEC filings is associated with significant negative effects on the level of this. This suggests that companies that included mentions of AI in their SEC filings and listed during the period under consideration tended to leave less "money on the table," bringing the offering price closer to the nominal value perceived by investors at the time of listing.

	Dependent variable:				
	Delta_price	Revision_UP	Delta_size	Under_wins	Perf_wins
	(1)	(2)	(3)	(4)	(5)
AI	0.014	0.194**	-0.010	-2.110***	-0.474
	(0.041)	(0.076)	(0.128)	(0.664)	(0.338)
Post	0.024	0.054	0.005	-2.906***	-1.091***
	(0.034)	(0.062)	(0.105)	(0.548)	(0.279)
AI:Post	0.0005	-0.110	-0.086	2.310***	0.453
	(0.054)	(0.099)	(0.167)	(0.869)	(0.442)
Sector_STEM	0.017	0.048	0.081	-0.292	0.174
	(0.028)	(0.051)	(0.086)	(0.450)	(0.229)
Dollar5up	0.123***	0.239***	0.082	-0.907**	-0.289
	(0.027)	(0.049)	(0.082)	(0.450)	(0.218)
NYSE	-0.002	0.056	-0.059	-0.465	-0.035
	(0.037)	(0.068)	(0.114)	(0.596)	(0.303)
Delta_price				-1.046	
				(1.095)	
Delta_size				-0.053	
				(0.353)	
Constant	-0.162***	-0.070	-0.098	3.812***	1.082***
	(0.034)	(0.062)	(0.105)	(0.576)	(0.278)
Observations	226	226	226	226	226
R2	0.102	0.152	0.015	0.171	0.100
Adjusted R2	0.077	0.128	-0.012	0.140	0.075
Residual Std. Error	0.192 (df = 219)	0.354 (df = 219)	0.597 (df = 219)	3.106 (df = 217)	1.581 (df = 219)
F Statistic	4.129*** (df = 6; 219)	6.524*** (df = 6; 219)	0.573 (df = 6; 219)	5.589*** (df = 8; 217)	4.050*** (df = 6; 219)
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 5 *- outputs of model [9] applied to the 5 different dependet varables*

The inclusion of the post-time control variable, which identifies IPOs that occurred after the ChatGPT launch, revealed an additional negative effect on underpricing, indicating that companies listed in the last year (2023) manifested lower levels of underpricing than those listed in the 12 months previous ChatGPT. This finding could reflect greater market efficiency or a different perception of risk by investors in 2023.

However, coefficient analysis of the interaction between AI mentioned in SEC filings and the control time variable shows a significant positive effect on underpricing. This result implies that despite the general trend of lower underpricing in 2023, firms that mentioned AI in their filings experienced underpricing levels that contradicted the market trend. This observation comes in the context of the U.S. stock market recovering in 2023 following a particularly difficult year. Indeed, while 2022 saw a significant decline in the major market indices, with the S&P 500 posting a double-digit annual loss (18 percent) for the first time in more than a decade, 2023 was notable for a marked recovery, especially in the second quarter, driven primarily by the technology sector and related industries. This recovery can be partially attributed to the growing interest in and success of artificial intelligence-related technologies.

Finishing this first general evaluation of the results with the model that aims to understand the influence of various factors on the performance on the 20th day of IPO listing, it can be seen that the negative coefficient (-1.091) and statistically significant for the POST variable suggests that IPOs that occurred after the launch of ChatGPT tend to perform lower than those made before that date. This could indicate a change in investor behaviour or market conditions. The other factors analysed do not show a significant influence suggesting that, at least in this model, these factors do not have a direct or identifiable influence on the market performance of IPOs over the period examined and further research is needed to explore market dynamics and the effects of new technologies in more depth. This is confirmed by the low value of the adjusted R-squared (7.5 percent) indicating that the included variables explain only a small part of the variability in the performance at day 20 of IPOs suggesting the existence of other factors not considered that could influence the performance of IPOs.

Delving deeper into the analysis regarding the different types of mentions of artificial intelligence in SEC filings, through the control variables specially elaborated above, it is possible to observe that a listed company is more likely to revise the offer price upward in the book-building period if it has already integrated permanently the use of artificial intelligence into its production process or its products and services, or exhibited a willingness to increase investment in R&D for the purpose of integrating it into its near-term growth strategy than if the artificial intelligence is recognized as a possible external threat. Looking at the outcomes of the regression models [10] and [11] (*table 6*) applied to the dependent variable "Revision_UP" it is possible to see that the coefficient of the variable AI_strategic (0.170**) is both greater and more significant than the coefficient of the variable AI_risk (0.141*).
Conversely, when considering the same regression models applied to assess short-term performance, recognizing AI as a possible external threat is more significantly impacting the stock price depreciation in the market in the first 4 weeks of listing (-0.624*).
Finally, since the two variables are non-binding and mutually exclusive, if both are included in the same model [12] they lose significance giving no useful observations (*table 7*).

	Dependent variable:				
	Delta_price	Revision_UP	Delta_size	Under_wins	Perf_wins
	(1)	(2)	(3)	(4)	(5)
AI_strategic	-0.016	0.170**	-0.001	-1.849***	-0.301
	(0.043)	(0.079)	(0.133)	(0.697)	(0.353)
Post	0.021	0.070	-0.002	-2.654***	-1.016***
	(0.032)	(0.059)	(0.098)	(0.514)	(0.260)
AI_strategic:Post	0.015	-0.155	-0.103	1.952**	0.283
	(0.056)	(0.104)	(0.175)	(0.917)	(0.464)
Sector_STEM	0.018	0.045	0.084	-0.261	0.181
	(0.028)	(0.052)	(0.086)	(0.454)	(0.229)
Dollar5up	0.123***	0.246***	0.081	-0.927**	-0.295
	(0.027)	(0.049)	(0.082)	(0.454)	(0.219)
NYSE	-0.001	0.049	-0.052	-0.511	-0.047
	(0.037)	(0.068)	(0.114)	(0.597)	(0.302)
Delta_price				-1.189	
				(1.102)	
Delta_size				-0.055	
				(0.355)	
Constant	-0.153***	-0.054	-0.103	3.607***	1.006***
	(0.033)	(0.062)	(0.103)	(0.568)	(0.274)
Observations	226	226	226	226	226
R2	0.101	0.137	0.016	0.159	0.095
Adjusted R2	0.076	0.113	-0.011	0.128	0.070
Residual Std. Error (df = 219)	0.193	0.357	0.597	3.128 (df = 217)	1.586
F Statistic (df = 6; 219)	4.100***	5.800***	0.576	5.136*** (df = 8; 217)	3.822***

	Delta_price	Revision_UP	Delta_size	Under_wins	Perf_wins
	(1)	(2)	(3)	(4)	(5)
AI_risk	0.036	0.141*	0.027	-1.684**	-0.624*
	(0.046)	(0.085)	(0.143)	(0.751)	(0.377)
Post	0.024	0.028	0.004	-2.609***	-1.069***
	(0.030)	(0.056)	(0.094)	(0.497)	(0.250)
AI_risk:Post	0.001	-0.036	-0.147	2.208**	0.583
	(0.060)	(0.112)	(0.188)	(0.987)	(0.496)
Sector_STEM	0.019	0.050	0.079	-0.286	0.170
	(0.028)	(0.052)	(0.086)	(0.455)	(0.228)
Dollar5up	0.121***	0.237***	0.087	-0.955**	-0.296
	(0.027)	(0.049)	(0.083)	(0.456)	(0.218)
NYSE	0.002	0.073	-0.066	-0.535	-0.062
	(0.037)	(0.069)	(0.115)	(0.604)	(0.304)
Delta_price				-1.034	
				(1.109)	
Delta_size				-0.024	
				(0.356)	
Constant	-0.167***	-0.038	-0.108	3.502***	1.074***
	(0.033)	(0.061)	(0.102)	(0.567)	(0.269)
Observations	226	226	226	226	226
R2	0.107	0.138	0.016	0.154	0.103
Adjusted R2	0.082	0.115	-0.011	0.123	0.078
Residual Std. Error (df = 219)	0.192	0.356	0.597	3.137 (df = 217)	1.579
F Statistic (df = 6; 219)	4.354***	5.851***	0.604	4.937*** (df = 8; 217)	4.193***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 6 *- outputs of model [10] above and model [11] below applied to the 5 different dependent variables*

In the last instance, firms that use AI without recognizing the external threat, firms that do not use AI only identify it as an external threat (*table 8*) and finally, those that use it and also recognize the external threat (*table 9*) are analyzed and differentiated. For the 2 categories of firms that recognize it as a favorable factor, the negative impact on underpricing is lower but more significant. For only those companies that make a comprehensive assessment of AI, in 2023 (after the launch of ChatGPT) the effect on underpricing changed trend becoming positive significantly. For the other two categories, the effect becomes positive too but without showing significance.

	Dependent variable:				
	Delta_price	Revision_UP	Delta_size	Under_wins	Perf_wins
	(1)	(2)	(3)	(4)	(5)
AI_strategic	-0.056	0.139	-0.022	-1.432*	0.064
	(0.053)	(0.098)	(0.165)	(0.865)	(0.437)
Post	0.018	0.053	0.021	-2.821***	-1.058***
	(0.033)	(0.061)	(0.102)	(0.535)	(0.271)
AI_risk	0.071	0.054	0.041	-0.773	-0.664
	(0.057)	(0.105)	(0.177)	(0.930)	(0.469)
AI_strategic:Post	0.044	-0.151	-0.058	1.399	-0.071
	(0.065)	(0.121)	(0.203)	(1.061)	(0.537)
Post:AI_risk	-0.031	0.053	-0.138	1.326	0.625
	(0.070)	(0.129)	(0.217)	(1.136)	(0.574)
Sector_STEM	0.020	0.049	0.082	-0.261	0.169
	(0.028)	(0.052)	(0.087)	(0.455)	(0.230)
Dollar5up	0.120***	0.239***	0.087	-0.968**	-0.294
	(0.027)	(0.049)	(0.083)	(0.456)	(0.220)
NYSE	0.006	0.065	-0.064	-0.451	-0.066
	(0.037)	(0.069)	(0.116)	(0.605)	(0.306)
Delta_price				-1.168	
				(1.110)	
Delta_size				-0.034	
				(0.356)	
Constant	-0.159***	-0.058	-0.107	3.682***	1.065***
	(0.034)	(0.062)	(0.105)	(0.577)	(0.277)
-Observations	226	226	226	226	226
R2	0.111	0.146	0.018	0.165	0.103
Adjusted R2	0.079	0.115	-0.018	0.126	0.070
Residual Std. Error (df = 217)	0.192	0.356	0.599	3.132 (df = 215)	1.586
F Statistic (df = 8; 217)	3.403***	4.642***	0.509	4.238*** (df = 10; 215)	3.119***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 7 *- outputs of model [12] applied to the 5 different dependet varables*

	Dependent variable:				
	Delta_price (1)	Revision_UP (2)	Delta_size (3)	Under_wins (4)	Perf_wins (5)
AI_onlyS	-0.033	0.186	-0.074	-1.750*	0.055
	(0.062)	(0.115)	(0.193)	(1.017)	(0.512)
Post	0.026	0.044	-0.043	-2.197***	-0.927***
	(0.028)	(0.053)	(0.088)	(0.465)	(0.234)
AI_onlyS:Post	0.010	-0.179	0.067	1.388	-0.039
	(0.076)	(0.142)	(0.237)	(1.249)	(0.629)
Sector_STEM	0.018	0.046	0.081	-0.252	0.178
	(0.028)	(0.052)	(0.087)	(0.458)	(0.230)
Dollar5up	0.123***	0.238***	0.079	-0.848*	-0.286
	(0.027)	(0.049)	(0.082)	(0.458)	(0.219)
NYSE	0.0002	0.050	-0.044	-0.534	-0.070
	(0.037)	(0.068)	(0.114)	(0.603)	(0.303)
Delta_price				-1.210	
				(1.113)	
Delta_size				-0.075	
				(0.358)	
Constant	-0.155***	-0.021	-0.093	3.205***	0.910***
	(0.031)	(0.058)	(0.097)	(0.541)	(0.257)
Observations	226	226	226	226	226
R2	0.103	0.129	0.012	0.144	0.092
Adjusted R2	0.078	0.105	-0.015	0.113	0.067
Residual Std. Error (df = 219)	0.192	0.358	0.598	3 .155 (df = 217)	1.588
F Statistic (df = 6; 219)	4.180***	5.418***	0.457	4.579*** (df = 8; 217)	3.691***

	Delta_price (1)	Revision_UP (2)	Delta_size (3)	Under_wins (4)	Performance_sp (5)
AI_onlyR	0.135	0.181	-0.047	-1.916	-4.783
	(0.088)	(0.165)	(0.276)	(1.468)	(9.086)
Post	0.028	0.012	-0.036	-2.191***	-6.008**
	(0.027)	(0.051)	(0.085)	(0.452)	(2.807)
AI_onlyR:Post	-0.099	-0.017	0.037	2.135	4.931
	(0.102)	(0.191)	(0.319)	(1.694)	(10.513)
Sector_STEM	0.020	0.054	0.080	-0.296	2.382
	(0.028)	(0.052)	(0.087)	(0.460)	(2.853)
Dollar5up	0.119***	0.233***	0.080	-0.845*	-4.024
	(0.026)	(0.049)	(0.083)	(0.459)	(2.722)
NYSE	-0.00004	0.073	-0.049	-0.615	0.249
	(0.037)	(0.068)	(0.114)	(0.606)	(3.766)
Delta_price				-0.980	
				(1.122)	
Delta_size				-0.057	
				(0.359)	
Constant	-0.165***	-0.014	-0.098	3.164***	6.441**
	(0.031)	(0.057)	(0.096)	(0.543)	(3.160)
Observations	226	226	226	226	226
R2	0.112	0.135	0.012	0.139	0.036
Adjusted R2	0.088	0.112	-0.015	0.107	0.009
Residual Std. Error (df = 219)	0.191	0.357	0.598	3.165 (df = 217)	19.690
F Statistic (df = 6; 219)	4.596***	5.708***	0.437	4.373*** (df = 8; 217)	1.354
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 8 *- outputs of model [14] above and model [15] below applied to the 5 different dependent variables*

	Dependent variable:				
	Delta_price (1)	Revision_UP (2)	Delta_size (3)	Under_wins (4)	Perf_wins (5)
AI_SR	-0.0003	0.112	0.048	-1.412*	-0.454
	(0.050)	(0.094)	(0.156)	(0.827)	(0.415)
Post	0.022	0.041	0.001	-2.416***	-1.008***
	(0.029)	(0.054)	(0.089)	(0.473)	(0.237)
AI_SR:Post	0.027	-0.093	-0.231	2.048*	0.404
	(0.071)	(0.132)	(0.219)	(1.163)	(0.583)
Sector_STEM	0.017	0.046	0.082	-0.274	0.180
	(0.028)	(0.052)	(0.086)	(0.457)	(0.229)
Dollar5up	0.122***	0.245***	0.090	-0.968**	-0.304
	(0.027)	(0.050)	(0.083)	(0.460)	(0.220)
NYSE	-0.001	0.060	-0.061	-0.581	-0.064
	(0.037)	(0.068)	(0.114)	(0.602)	(0.302)
Delta_price				-1.138	
				(1.111)	
Delta_size				-0.022	
				(0.359)	
Constant	-0.157***	-0.025	-0.115	3.359***	1.008***
	(0.032)	(0.060)	(0.100)	(0.560)	(0.266)
Observations	226	226	226	226	226
R2	0.102	0.125	0.019	0.146	0.097
Adjusted R2	0.077	0.101	-0.008	0.114	0.072
Residual Std. Error (df = 219)	0.192	0.359	0.596	3.153 (df = 217)	1.584
F Statistic (df = 6; 219)	4.128***	5.204***	0.689	4.623*** (df = 8; 217)	3.911***
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 9 *- outputs of model [15] to the 5 different dependent variables*

CONCLUSION

Analysis of the incidence of mentions of artificial intelligence in SEC documents related to initial public offerings (IPOs) over the past two years suggests that, unlike previous cycles of technological excitement such as the dot-com bubble and the rise of cryptocurrencies, artificial intelligence is not generating a similar climate of speculation in the IPO industry. This trend can be attributed to several factors.

The time frame considered in the analysis (Dec 2021-Dec 2023) was marked by high volatility in the U.S. stock market.

The year 2022 was marked by considerable volatility in the U.S. stock market due to several macroeconomic challenges, changes in monetary policies, and geopolitical uncertainties. Rising inflation in the United States, fueled by factors such as escalating energy and commodity costs as well as disruptions in supply chains, prompted the Federal Reserve to revise its monetary strategy. In response, the Fed has raised interest rates to moderate the economy and keep inflation in check, which has profoundly affected stock markets, impacting corporate valuations and raising borrowing costs.

Although in 2022 many countries began to emerge from the most critical stages of the COVID-19 pandemic, concerns about a potential recession, triggered by the consequences of new virus variants, continued to worry investors. Nevertheless, the U.S. economy has shown remarkable resilience, continuing on its path of recovery.

Further complicating the picture was the Ukraine conflict outbreak, which generated geopolitical instability, affecting energy and commodity prices and adding layer of uncertainty to global financial markets.

The year 2023 proved to be a year of recovery for markets, although it was again marked by high volatility. The Federal Reserve (Fed) continued with its monetary policies aimed at controlling inflation. High-interest rates continued to exert a significant influence on the stock market, affecting capital costs and corporate valuations. The COVID-19 pandemic maintained its impact on the global economy, as did geopolitical tensions, exacerbated by the onset of a new conflict between Israel and Palestine.

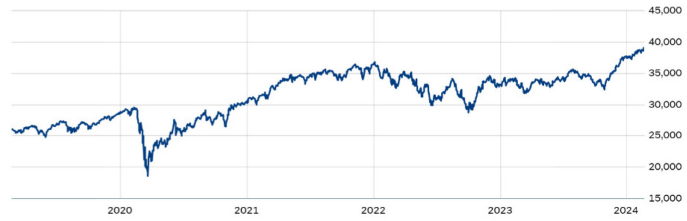
The year showed mixed trends across market sectors. Sectors traditionally considered safer, such as Utilities, Defensive Consumer Goods, and Energy, were particularly affected by high-interest rates and the devaluation of oil, with declines of up to 10 percent. In contrast, the Communications Services and Consumer Discretionary sectors saw significant increases. The former saw a 54 percent increase, led by companies such as Meta (up 194 percent), Netflix, and Alphabet; the latter a 41 percent increase, benefited from strong retail sales and record demand in the travel sector, with companies such as Amazon, Tesla, and Royal Caribbean showing exceptional returns.

The technology sector then drove the economy in 2023, registering a 56 percent increase, with companies such as Nvidia, Apple, and Microsoft making significant gains. This can also be attributed to the great potential of artificial intelligence. Nvidia in particular grew 239 percent, driven by increased demand for AI chips. This suggests that artificial intelligence has increased investor interest, but mainly in established companies, leaving new entrants to the industry perplexing.

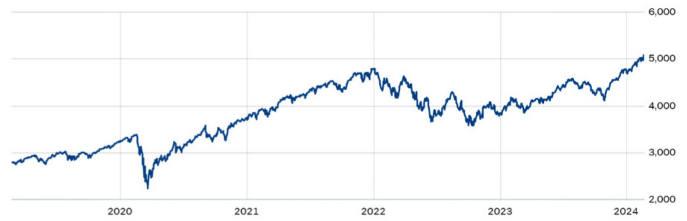
Analyzing the three major market indexes, there is a uniform trend, with great volatility throughout 2022 that reflected economic uncertainty and the impact of external factors. The year 2022 ended in losses for all three indices, which hit annual lows between September and October. The Nasdaq Composite was the hardest-hit index, having started the year at 16,000 points to close it at 10,000 (-35 percent). Despite the volatility, 2023 was a year of recovery for all three indexes, with an acceleration in recent months that brought the indexes back to late 2021 levels (*figure 4*).

Linking these observations to the research findings, a clearer picture emerges of investor behavior in the IPO market, especially concerning artificial intelligence. The approach of companies mentioning AI, adjusting the prices of their IPOs upward, reflects a differentiated perception of the value of artificial intelligence in the IPO market. This perception, however, while observable, does not reach the intensity of that manifested toward major companies in the technology sector.

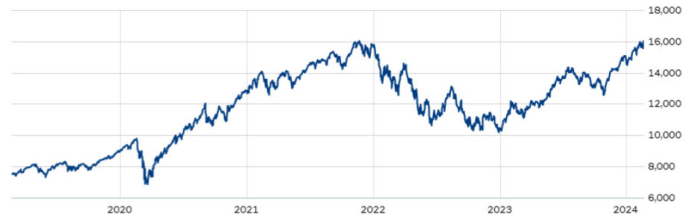
The mention of AI exerts a complex impact on the underpricing of IPOs: tending to be negative, revealing investors' scepticism toward new companies entering the sector. However, this effect becomes positive for companies that started mentioning AI after the launch of ChatGPT, i.e., since late 2022, a period when the technology sector has been recovering. This demonstrates a market response that values AI adoption positively, in line with the evolution of the technology landscape, while maintaining some caution toward smaller companies.



Dow Jones Industrial Average (DJIA) - 5-year overview



S&P500 - 5-year overview



NASDAQ Composite - - 5-year overview

Figure 4 *- 5-year overview of the 3 main US Stock Index*

This distinction becomes even more evident when analyzing the treatment of AI as an external risk versus its integration as an internal factor. An investor assessment of risk emerges clearly: the negative effect of AI on underpricing is mitigated when companies take a transparent approach regarding associated risks, suggesting that clarity and awareness of potential dangers can mitigate investor concerns. Moreover, this negative effect is intensified in firms that do not adopt AI but recognize it as a risk, and reduced in those that actively integrate it into their operations, thus underscoring the importance of AI adoption in managing perceived risk.

These elements, along with stricter regulation, contribute to a climate of greater awareness and information among investors, unlike what has happened in the past with other technological innovations that have triggered asset bubbles. The current situation, therefore, does not seem inclined to generate yet another speculative bubble fueled by technological innovation, reflecting a more mature and thoughtful approach to artificial intelligence in the context of IPOs.

In the years following the 2008 financial crisis, the global regulatory landscape witnessed significant reforms aimed at increasing transparency, minimizing systemic risks, and consolidating financial stability. Among the most notable regulatory initiatives are the Basel III and Basel IV international agreements, focused on banking supervision. These agreements aim to intensify regulation, supervision, and risk management in the banking sector through the introduction of more stringent requirements regarding high-quality capital and leverage to ensure that banks hold adequate levels of liquidity.

In the United States then, the adoption of the Dodd-Frank Wall Street Reform and Consumer Protection Act marked a turning point in increasing the supervision and regulation of financial institutions. The Dodd-Frank Act introduced stricter regulations for over-the-counter derivatives and led to the creation of specialized bodies to identify risks to the financial system (the Financial Stability Oversight Council FSOC) and to protect consumers in financial markets (the Consumer Financial Protection Bureau CFPB).

Adding to the increase in regulations in key sectors of the economy is a recent focus on technology, particularly artificial intelligence. There is regulatory strengthening underway that aims not only to preserve financial stability but also to drive responsible and safe innovation, particularly in high-impact sectors such as technology, underscoring the importance of regulatory maturity in response to emerging challenges.

The European Union introduced 2023 the AI Act, the first comprehensive AI law globally, which aims to regulate the use of AI by ensuring fertile ground for the responsible development and application of this technology. The AI Act categorizes AI systems according to the level of risk to users, imposing specific rules for each category, including prior and ongoing assessment for high-risk uses, and prohibiting practices such as the creation of facial recognition biometric databases or the use of emotion recognition technologies in work or education settings.

In the United States, the regulatory debate has materialized through initiatives such as that of the National Institute of Standards and Technology (NIST), which has proposed a framework for managing the risks associated with AI, evaluating the various types and uses of artificial intelligence based on the risks presented. AI regulation has also become a recurring theme in prominent national contexts, such as presidential elections, with predictions for 2024 to adopt executive orders that are likely to be favorable to the AI industry.

China has also announced plans to introduce artificial intelligence regulations but has opted for a more fragmented approach to regulating specific products and services based on their emergence and relevance in the market.

These regulatory developments highlight a growing global awareness of the importance of guiding AI development responsibly and safely, balancing innovation and the protection of users' rights and safety.

Increased vigilance on the part of global regulators, in recognizing the importance of a regulated approach to the development and use of artificial intelligence that is safe, transparent, and traceable, is a key support in moderating unwarranted optimism that may be manifesting in the market. This regulatory effort, which is also aimed at monitoring corporate statements and ensuring that valuations are based on realistic expectations for growth and profit, helps maintain a realistic approach for both companies and investors.

Finally, unlike some previous waves of technological innovation, artificial intelligence stands out for its broad applicability, influencing almost every sector of the economy. This cross-cutting integration promotes sustainable growth and brings tangible added value, rather than fuelling speculation based on unfounded expectations. The expanded use of AI in critical areas such as healthcare, transportation, finance, and education helps generate tangible value, reducing the risk of a speculative bubble.

In conclusion, although enthusiasm for artificial intelligence is high, evidence suggests that the market for AI-related IPOs is developing in an environment of greater maturity, both from a regulatory and investor awareness perspective. The adoption of prudent economic policies, along with strict regulations, an informed and cautious approach, a critical assessment of AI-related risks and opportunities, and its cross-cutting impact on the real economy, can help prevent the formation of an AI-related speculative bubble. This marks a transition toward a more sustainable and integrated adoption of technological innovation in the economy. However, the challenge remains to maintain constant monitoring and balance in exploring the opportunities and risks presented by AI, navigating its ever-changing landscape with caution.

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