ERASMUS UNIVERSITY ROTTERDAM
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Short-term IPO Performance Amidst Fear of Covid-19: Evidence From China

The Effect of Covid-19 Related Fear on IPO Underpricing in China

ABSTRACT

This paper is set out to test if there is a difference in the level of IPOs initial first day returns, underpricing, during the covid-19 pandemic compared to that of IPOs in the pre-covid-19 period in China. As well as to examine the impact of fear associated with covid-19 on IPO underpricing in China. Underpricing is quantified using two measures, the initial first day return and the market adjusted initial return. With the help of student's t-test for the difference in means between the pre-covid-19 and covid-19 period and multivariate regression to examine the impact of covid-19 related fear on IPO underpricing. This study provides potent empirical evidence that underpricing in covid-19 times is significantly higher than in the pre-covid period. As well as that the amount of fear related to covid-19 significantly increases the level of underpricing.

Keywords: Initial Public Offering, first day returns, underpricing, fear, global fear index, COVID-19, China

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The views stated in this thesis are those of the author and not necessarily those of the supervisor, second assessor, Erasmus School of Economics or Erasmus University Rotterdam.

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1 Introduction

The World Health Organisation (WHO) declared on March 11, given the number of reported cases for the preceding two weeks, covid-19 as a global health pandemic. At the time of writing the coronavirus (covid-19) has infected a total of 527.60 million people and led to 6.29 million deaths globally. The outbreak of covid-19 had a serious impact on the lives of many people in almost all countries in the world and has resulted in an global economic meltdown. In the United States the S&P 500 index fell by as much as 33 percent from mid-February to late March. The quickly increasing number of new cases and deaths around the globe related to covid-19 created a tangible fear and uncertainty among investors and analysts. A growing number of research has been conducted on fear and commodity price returns (Lyócsa, Baumöhl, Vy̆rost, & Molnár, 2020), reactions of stock prices in the airline and tourism industry during the covid-19 period (Carter, Mazumder, Simkins, & Sisneros, 2022), and the importance of social trust on firm performance during the pandemic (Mazumder, 2020), among others.

A common manner for a company to raise new equity from public investors is to sell shares on the stock market. The process of offering shares to the public for the first time in a new stock exchange is referred to as an initial public offering (IPO). When shares are offered in an IPO a common trait is that they are underpriced to the market. IPO underpricing is the difference between the share offer price and the price at which the shares trade in the secondary market. When the close price of a stock is above the offering price at the end of the first trading day, the stock is considered underpriced. And thus, the offering price could have been increased. There has been vast literature regarding IPO underpricing. Loughran, Ritter, and Rydqvist (1994) concluded that underpricing was higher in markets in developing countries compared to more developed markets. The underpricing ranges from a few percent for intermediaries in the United States to about 50% for hot issue in the 1980s (Ritter, 1984) and even 289% for the developing Shanghai market (Mok & Hui, 1998).

In past decades there has been a lot of research conducted regarding IPOs, mainly focusing on developed markets such as American and European markets. Less research has been conducted in developed markets such as Asian Markets. To some extent this might be due to the fact that the Chinese Equity market is relatively new, compared to the developed markets, and has undergone fast developments and a transition from socialism to a more modern market economy over the last 30 years. Fundamentally, the Chinese IPO and stock market also have different institutional characteristics than those of other countries and as such research results from other countries can not be directly applied to China.

Very few studies have analyzed the impact of fear of a pandemic on IPO underpricing. How much investors' fear related to the pandemic affects underpricing is prone to further investigation. This study aims to examine the impact of fear associated with the covid-19 pandemic on IPO underpricing in China. And also examine the difference in underpricing before and during the covid-19 pandemic in China. This study contributes to the prevailing IPO underpricing and quickly evolving covid-19 literature from the perspective that fear related to the covid-19 pandemic has explanatory power in explaining the underpricing anomaly.

The share price at the time of the IPO is determined by the issuing company and the underwriter. The share price in the primary market and the share price in the secondary market is most of the times not equal. If the price on the secondary market on the first day of trading (close price) is higher than the share price determined in the primary market (offer price), the share is considered underpriced. The degree of underpricing of an IPO issue can be calculated as the return on the first trading day. The underpricing of IPOs during the pandemic will be compared to the level of underpricing before the pandemic.

To examine the impact of covid-19 related fear associated with initial IPO returns, the global fear index (GFI) will be utilized The GFI measures the daily concerns and motions on the spread and severity of covid-19. Fear associated with covid-19 could have significant implications on investment sentiment and decisions and thereby affect prices. The GFI is a composite index of, reported cases and deaths on a scale of zero to 100. Indicating the presence of extreme fear or panic. Te examine the effect that covid-19 related fear has on the initial IPO returns, the daily returns will be regressed on the fear index at lag IPO day and a number of control variables.

The required data sample will be collected from Thomson One, Eikon Datastream and Zephyr and will consist of companies listed on both the The Shanghai Stock Exchange and the Shenzhen Stock Exchange in 2019 and 2020. Since on December 31, 2019, China reported a string of pneumonia like cases in Wuhan. Although globally the first covid-19 cases were confirmed much later and there officially was no pandemic declaration before march 2020, the fear related to covid-19 prevailed long before March. The IPOs which took place in 2019 will be viewed as pre-covid-19.

The remainder of this thesis is organized as follows. Section 2 will discuss the theoretical framework with an overview of the most relevant literature and the developed hypotheses. In section 3 the research methodology will be discussed, where the collected data sample, defined variables and research method will be explained. Section 4 describes the empirical results and section 5 concludes.

2 Theoretical Framework

2.1 Initial Public Offering

In the life of a modern company the process of going public marks an important milestone. It gives access to the public equity market and may result in a lower cost of funding for the company's operations and investments. It also enables the existing shareholders to diversify their investments and to monetize their capital gains since the company's shares are traded on the market. Most companies that go public do so via an initial public offering (IPO) of the companies shares to investors.
An IPO is the process of selling existing shares (secondary shares), held by private investors, or newly issued shares (primary shares) to the public for the first time. Through the process, the company receives cash for the primary shares sold and existing shareholders are able to monetize on their investment by selling the secondary shares.

The question that arises here, is: what motivates companies to go public? Zingales (1995) proposed one of the first theories of the decision to undertake an IPO. He noticed that for an potential acquirer it is much easier to spot a potential takeover target when the target is public. Also, in an acquisition it is easier to pressure targets on pricing concessions than to pressure outside investors. In a way the entrepreneur helps to facilitate the acquisition of the company for a higher price than the would receive from an outright sale. A firm in the pre-IPO phase acquires its capital from angel investors or venture capitalist. They hold undiversified portfolios and because of that demand a risk-premium opposed to a diversified investor, for example an investor in the public-market. The owners of the firm can sell part of their shareholdings, in the IPO, in exchange for cash enabling them to use the proceeds for other expenditures or to diversify their portfolio. IPOs thus allow more dispersion of ownership (Chemmanur & Fulghieri, 1999). Furthermore, when public, a firm can access public equity capital, less expensive funding for new investments, business expansion, and repay outstanding loans (Ljungqvist, 2007). Moreover, when a firm goes public it can reap other indirect benefits such as increased publicity and attracting a different caliber of skilled employees (Demers & Lewellen, 2003).

While going public has certain advantages, there are also disadvantages associated with the decision. First, firms that make the decision to go public have to bear the direct costs of public listing, which include listing, underwriter, legal, and accounting fees together with the indirect costs such as more extensive annual financial reports (Loughran & Ritter, 2002). Another consequence of the firm being public is a loss of control for the firms founders (Smart & Zutter, 2003). As the shareholders base becomes wider after going public, the voting rights of the existing shareholders might be diluted due to new shareholders gaining voting rights (Dolvin & Jordan, 2008).

In the early stages of the life cycle of a company it is optimal for the firm to be private but as it grows sufficiently large, going public becomes more appealing. However, public trading itself also has its costs and benefits. Public trading can add value to the firm in the form of faith from other investors. A high public price can also attract product market competition (Maksimovic & Pichler, 2001). Stock prices may also signal, information spillovers, to firms management, investors, customers and suppliers. High prices signal increased growth opportunities to the firms management or investors and signal stability and dependability to customers, and suppliers. Despite these disadvantages associated with going public, access to the public equity capital market remains a worthwhile and efficient option as Jenkinson and Ljungqvist (2001) argue, to obtain sustainable sources of financing and quick access to liquidate part of their holdings.

When the decision to go public is made, the IPO process begins. There are three major offering mechanisms: Auction, Fixed price offering and book-building. Book-building is the most commonly used around the world. The issuing firm obtains the assistance of an underwriter, in most cases an investment bank. In the first phase the issuer chooses the underwriters that form a syndicate. Next, the appointed investment banks organize the IPO timetable and acquires various information regarding the issuer. The investment bank prepares the so called prospectus which contains all the information regarding the description of the company, the issuers financial statements, management, expected future operations, etc. During the next phase the issuer has the opportunity to present the investment case. With this the investment bank will prepare the pre-deal report, containing the equity story of the issuer. Next, the investment bank analyses the potential investors with the purpose of determining the reaction to the equity story and assess the valuation. Next, in the roadshow the issuers management meets with potential investors and the investment bank "build a book" of offers from potential investors before pricing the shares. The potential investors can indicate the quantity and price of the shares they are interested in buying. With this information the underwriters construct the demand and can price the offering accordingly. During the price meeting, which typically takes place one day before trading, the offer price will be set at the most recent price range (Ritter, 2003).

The most applied offering method in China is the on/offline book-building introduced in 2005. For on/offline book-building the issuers set the price range, then the investors subscribe online and offline. With the amount of subscription and the suggested price the issuers set the final offering price. In China, an individual investor has to participate in the bidding enquiry online, strategic and institutional investors bid in the offline bidding enquiry. Investors bid for fixed quantities. The new offerings are allocated to the subscribers through the electronic trading system.

2.2 Underpricing

The IPO stock price on the secondary market has a tendency to exceed the initial offering price leading to high first day returns. This phenomenon is empirically known as underpricing. Underpricing is costly to the issuing firm, they left money on the table, i.e. the offer price is set too low and is sold below market value. Ibbotson (1975) is one of the first to document the high first day returns when companies go public. IPO underpricing is constantly present over time, the amount of underpricing however fluctuates a great deal. Ritter (1984) found that in the U.S. during the period 1960-1980 the average first day return was 19%. Loughran and Ritter (2004) found that in the 1980s, the average first day return on initial public offerings (IPOs) was 7%. The average first day return doubled to almost 15% during 1990-1998, before jumping to 65% during the internet bubble years of 1999-2000 and then reverting to 12% during 2001-2003 (Loughran & Ritter, 2004).

The presence of underpricing on almost every financial market in the world has been widely documented by empirical research (Loughran et al., 1994). The amount of underpricing also differs considerably between countries. Loughran et al. (1994) concluded that underpricing was higher in markets in developing countries compared to more developed markets. For a sample of Shanghai IPOs listed in the period 1990-1993 Mok and Hui (1998) report an underpricing of 289%. Su and Fleisher (1999) find an average initial return in China before 1996 as high as 948.6%. G. L. Tian (2003) finds an average level of underpricing of 267% in the period 1991-2000 in China. Clearly, these reported levels of underpricing in the Chinese market are much higher than the levels of underpricing in the United States.

The Chinese IPO market in particular has drawn considerable attention over the past decades. It has gone through a number of regulatory reforms and used a variety of allocation mechanisms and types of shares. In addition, the Chinese IPO market is known for its high underpricing, much higher in comparison to other developed and developing countries, which also attracted attention. Loughran et al. (1994), and updated throughout the years, ranks the equally weighted average initial returns for 54 countries and China has one of the highest initial returns of the ranking. The Chinese stock market differs a great deal from markets in other developed and merging markets due to the specific market system and its governance arrangements (G. Chen, Firth, & Kim, 2004). One of the reasons behind the extreme high initial returns in China is the extreme inequality in the demand and supply of IPOs. Chi and Padgett (2005), using 668 new issues in the period 1996-2001, argued that the high initial returns can be explained primarily by the inequality of supply and demand. They note that in the 1990s there was a limited number of investment opportunities and a large supply of capital which resulted in high demand in the IPO market.

Also, the allocation mechanism plays a role in explaining initial returns since it is related to mispricing and minimizing the information asymmetry. Guo and Brooks (2008) found that the offering mechanism a firm uses impacts the initial return. Chiou, Li, Cheng, and Chang (2010) looked at the relationship between pricing rules, allocation mechanisms and underpricing. They argue that the adoption of new mechanisms reduces the initial returns by making the IPO market more stable and market-oriented. Book-building is currently the most popular and effective allocation mechanism since it lowers underpricing and offers more efficient prices. As stated earlier, the Chinese IPO market has been marked by government regulatory interference which affected underpricing. L. Tian and Estrin (2008) found that government imposed listing quota and pricing caps are major determinants of underpricing. Kao, Wu, and Yang (2009) looked at IPO regulations in the period 1996-1999 and find that pricing regulations induced issuers to inflate pricing-period earnings and accounting performance which contributes to underpricing.

Auditors and underwriters operating in developed countries are in general more heterogeneous than in developed countries. Underwriters are a popular proxy for explaining underpricing in China. A number of studies argue that an underwriter deliberately underprice offerings and benefit by allocating these underpriced offerings to favored clients (Ritter & Welch, 2002). Guo and Brooks (2008) argue that the involvement of a prestigious underwriter shows a lower range of under performance and the under performance in the short run is less severe. Sherman and Titman (2002) also argue that the more prestigious the underwriter minimizes the magnitude of the initial returns.

2.3 Differential explanations underpricing

Empirical evidence of IPO underpricing provides differential theoretical models and determining factors to explain the variation in underpricing across IPO markets globally. Numerous studies provide explanations based on competitive theories such as information asymmetry, institutional theories, ownership and control reasons, and behavioural explanations as Jamaani, Alidarous, et al. (2019) point out. The next sub-chapters will highlight on the main theories, since a complete review of all theories is outside of the scope of this study.

2.3.1 Information Asymmetry

Information asymmetry is one of the primary identified determinants for underpricing by the majority of studies performed. Two different levels of information asymmetry are identified, that is asymmetry between the issuer and underwriter and information asymmetry among investors. Baron and Holmström (1980) assume underwriters have superior information to the issuer leading to information asymmetry between the underwriter and the issuer. They argue that the underwriter are better informed about the market demand and take advantage of this by inducing the degree of underpricing in an effort to diminish their distribution efforts. The issuer is forced to take the lower price since they have the information disadvantage. This price however will still be higher then the price anticipated by the issuer. With the help of the principle-agent problem the relationship between the underwriter and issuer is explained where the underwriter uses underpricing to minimize their distributional effort. This is in line with the agency argument that underwriters use underpricing to their advantage (Loughran & Ritter, 2002). From this one could argue that in IPOs where firms underwrite their own offerings the divergence of objectives between the underwriter and the issuer is no longer present since there no longer is the concern of asymmetric information and the principal-agent model can be refuted. Muscarella and Vetsuypens (1989) questioned the principal-agent model by examining the difference in underpricing between self-underwritten IPOs and IPOs with an external underwriter. They found no evidence of a difference in underpricing between self-underwritten IPOs and IPOs with an external underwriter, thus refuting the principal-agent model. The principal agent theory only takes into account the information asymmetry between the underwriter and issuer and does not capture the information asymmetry between underwriters and investors, the issuer and investor, and among investors.

Information asymmetry between issuer and investors leads to ex-ante uncertainty which can include matters related to age, size, type of firm, and use of the proceeds of the IPO of the issuer as Jenkinson and Ljungqvist (2001) demonstrate. Ritter (1984) and Rock (1986) show that the ex-ante uncertainty decreases with the age of the issuer. Relative young issuers have a higher ex-ante uncertainty about the value of the company, which leads to a higher demand of underpricing by investors. Autore, Boulton, Smart, and Zutter (2014) report that the level of underpricing investors seek is negatively related to the size of the proceeds of the IPO. Ritter (1991) similarly report that smaller issues tend to have higher initial returns since smaller size issues face higher information asymmetry. Also, disclosure on how the IPO proceeds are used reduces ex-ante uncertainty since investors are better informed on why the issuer goes public Beatty and Ritter (1986). The ex-ante uncertainty is empirically tested and verified in modern established markets, but fails to explain the substantial underpricing particularly in developing markets (Loughran & Ritter, 2002). furthermore, ex-ante uncertainty only captures the problem of information asymmetry between issuer and investor, ignoring the information asymmetry between investor and underwriter, investor and issuer and informed and uninformed investors.

The book-building theory argues for asymmetric information between issuer and institutional investor. It assumes institutional investors have superior information over both underwriters and issuer. In the process of book-building institutional investors reveal valuable information about the issuer for the underwriter. The underwriter reward the institutional investors for the revealed favorable information by allocating a larger portion of shares. Loughran and Ritter (2002) support the book-building theory for revealing valuation information about the issuer. But in turn argue that book-building has only a small portion in explaining underpricing in well established markets and can not explain the underpricing in developing markets. Brau and Fawcett (2006) also question the validity of the book-building rationale in explaining underpricing. They surveyed U.S. CFOs and find little support for the book-building being able to explain underpricing. Moreover, the book-building theory does not capture information asymmetry between issuers and investors and among investors since it only takes into account the asymmetry between issuer and investor and underwriter and investor.

Signalling models argue that in order to ”leave a good taste in investors' mouths” firm's deliberately underprice IPOs. Issuing firms posses private information about their operations and future cash flows and know their own present value while the private information is not disclosed to the investors leading to an asymmetric information problem between investors and issuers (Jamaani et al., 2019). Issuers with low quality are unwilling to bear the cost of the signal, while high quality issuers are expected to recoup on their losses from underpicing by increased market value (Jenkinson & Ljungqvist, 2001). As firms in high technology industries have generally projects with higher cost involved, and these projects also come with a higher level of uncertainty in terms of success. High tech companies also posses a high level of comprehensive information only available to insiders. For insiders to reproduce their information and signal quality to the public they demand a compensation which reflects in a higher level of underpricing (Chemmanur, 1993).

Rock (1986) argues that information asymmetries among investors leads to underpicing in IPOs and introduced the ”winners curse” hypothesis. The role of the underwriter and issuer is assumed to be the same and no principal-agency conflict is present between the two. Investors would like to acquire as much meaningful and objective information about the company and the issue as possible, which is difficult and costly. The entire group of investors suffers from a varying degree of information asymmetry which divides the group of investors into informed investors and uninformed investors. The informed investors, primarily institutional investors, benefit from their economies of scale which lowers their cost of acquiring additional information. The information surplus enables the informed investors to bid only for underpriced IPOs while uninformed investors, with their limited information, bid for both underpriced and overpriced IPOs. The information gap causes the uninformed investors to receive full allocation in overpriced offerings and create an adverse selection problem. Rock (1986) therefore argues that for uninformed investors to participate, issuers must provide compensation for the adverse selection by underpicing. The winners curse enjoyed empirical support documented by, among others, Barry and Jennings (1993) who argue that investors of securities in the IPO itself benefit from the underpricing, opposed to the investors in the aftermarket. However, other empirical testing questioned the validity of the model. Loughran and Ritter (2002) argue it does not have enough power to explain the high degree of underpricing in developing markets. It is also unclear how the informed investors are differentiated from uninformed investors. Furthermore, the model does not capture an understanding of information asymmetry between issuer and underwriter, investor and underwriter and issuer and investor since it only takes into account the the information asymmetry between informed and uninformed investors.

2.3.2 Institutional Theories

In addition to the information asymmetry based models the consideration of institutional explanations as a determinant for underpicing led to three institutional-based theories which can be categorized into lawsuit avoidance, price stabilization and tax advantage hypotheses.

Lawsuit avoidance argues that U.S. issuers deliberately underprice offerings to avoid litigation risk from disappointed investors due to poor post-IPO performance. A lawsuit does not only represent a direct cost for the issuer, in the form of financial damages, but also indirectly by affecting its reputation (Jamaani et al., 2019). However, it is important to note that the lawsuit avoidance theory is a U.S. centric model. While Lowry and Shu (2002) show the empirical validity of lawsuit avoidance in the U.S. it fails to explain underpicing around the world. Studies conducted in other countries such as the U.K, Switzerland, Finland, Sweden, Australia, and Japan show empirical evidence refuting the litigious effect lawsuit avoidance has on explaining underpricing.

The prize stabilization hypothesis notes the fact that underwriters offer price support services to stabilize the post IPO price. To reduce potential price drops in the days or weeks after listing underwriters intervene in the aftermarket, by repurchasing shares and in doing so pushing the price of shares upwards.

Trade-off between tax benefits and underpricing arises as a third institutional explanation of underpricing. In case the tax rate on employee income is higher than that of capital gains, underpriced shares are a form of appreciating assets. Creating a inducement to pay employees by allocating shares, the appreciating assets, rather than paying wages. Clearly, if the tax-rate on underprice related gains is treated as income from employment, the individual tax for wage will apply and the tax hypothesis is questionable.

2.3.3 Ownership and Control Theories

Based on the misalignment between managers and shareholders the ownership and control theories emerged. They argue that in order to prevent the outside investors from intervening in managing the firms once they are publicly listed, underpricing is used as a mechanism to shape the shareholder base. This led to the development of ownership and control separation principle control theories.

The first hypothesis, the entrenchment of managerial control argues that underpricing is used as a tool by owners or managers of the IPO firm to increase ownership dispersion (Shleifer & Vishny, 1989). External monitoring, that leads to management entrenchment within the company, can be reduced by a widely dispersed shareholder base.

Contrarily the agency cost hypothesis argues that due to a separation of ownership and control, misalignment might be present between non-managing shareholders and managers, which contradicts the entrenchment of managerial control hypothesis. Underpricing serves as an incentive to attract large block-holders who function as an internal monitor for managers (Stoughton & Zechner, 1998). The minimized agency problems between managers and shareholders will lead to an increased shareholders value in the long run (Brennan & Franks, 1997).

2.3.4 Behavioural Theories

The previous mentioned explanations are based on competitive theories. Existing studies predominantly ignore outside factors or exogenous shocks that may affect the initial IPO returns. A growing stream of research advocates behavioural explanations to explain underpricing. Negative sentiment and mood amongst investors affect decision-making as well as asset pricing. Schmeling (2009) looked at consumer confidence as a proxy for investor sentiment and found that it can predict stock return. When investor sentiment is high more firms go public as issuing firms tend to time the market (Lee, Shleifer, & Thaler, 1991). Y. Chen, Goyal, Veeraraghavan, and Zolotoy (2020) study the impact of media coverage on pricing of IPOs around the world and find that higher media coverage in the pre-IPO period leads to lower initial returns. Not only media coverage but also media tone influence the initial return, where investors are more sensitive to coverage with a negative tone as Zou, Li, Meng, and Wu (2020) find in China's stock market from 2009 to 2016. Even Twitter sentiment in the days leading up to the IPO is positively related to IPO returns (Liew & Wang, 2016).

2.4 Covid-19, Fear and the Financial Market

Several studies document how black swan events, composed of economic events, social events, acts of terrorism, natural disasters, pandemics and epidemics impact the global economy. China has experienced a number of black swan events in its financial markets over the past decades. Toxic infant formula, milk powder, toxic capsules, ineffective vaccines all massively impacted the financial market. Previous pandemics and epidemics such as the 1918 H1N1 virus, the H2N2 virus in 1957 and 1958, the H3N2 virus in 1968, the swine flu in 2009 and 2010, the 2014-2016 Ebola virus, and the 2012 MERS virus also greatly impacted the financial market.

In 2003 Asia was the epicenter of the deadly severe acute respiratory syndrome (SARS) which disrupted the lives of millions in China and its neighbours. In a couple of months it had spread to 29 countries with more than 8098 cases and 774 deaths [1]. The outbreak of SARS weakened the economy. Nippani and Washer (2004) examined the impact of SARS on the stock market. They looked at the leading stock indices of China, Hong Kong, Indonesia, Philippines, Singapore, Thailand, Vietnam and Canada during the SARS outbreak and compared these to a non-SARS period. They argue SARS only adversely impacted the economy of China and Vietnam. However, M.-H. Chen, Jang, and Kim (2007) looked at the impact of the SARS outbreak on Taiwanese hotel stock performance and found that it clearly dampened the Taiwan stock market. On the day after the outbreak, hotel stocks prices showed a negative cumulative mean abnormal returns which shows the impact of the SARS outbreak. They also argue that due to the widespread panic that results from intensive media coverage, the effect can also be transferred to other stocks in related industries. C.-D. Chen, Chen, Tang, and Huang (2009) also confirm that the SARS outbreak brought negative impact on tourism and wholesale and retail sectors. However, they note that the value effect of the SARS outbreak might by asymmetrical since in the biotechnology sector they

[1] According to the World Health Organization. https://www.who.int/health-topics/severe-acute-respiratory-syndrome

observed positive shocks from the impact of SARS. Hai, Zhao, Wang, and Hou (2004) argued SARS indirectly impacted sectors other than tourism through the multiplier effect. They estimated that SARS caused a total loss of 25.3 billion USD for the Chinese economy in 2003. Underpricing of IPOs in Hong Kong also dropped drastically during the SARS outbreak (Ng, 2016). Ng (2016) Argues that SARS provides lower quality and a lower volume of information that makes valuation of IPO offer prices in combination with future prospects challenging.

While SARS was a real threat for China, Hong Kong and Taiwan and these countries suffered great losses it is also necessary to remember that for many countries SARS did not become more than a potential threat. The global death toll from SARS is below thousand and most countries had fewer than ten, in many cases even zero. Unlike for example covid-19 which had a much more devastating global effect with more cases and deaths worldwide.

Ichev and Marinč (2018) focused on the Ebola outbreak in 2014-2016 and analyzed whether the geographic proximity of information disseminated combined with media coverage by the Ebola events affected stock prices in the United States. They find that the Ebola outbreak is followed by negative returns in the financial markets. They argue that the media coverage related to the Ebola outbreak can enhance anxiety, fear, risk aversion, and pessimism among investors which can significantly influence investors' decision making. Which is in line with earlier research arguing that events with large consequences and low probability are overemphasized in the media and that this creates sentiment effects. Funck and Gutierrez (2018) examined the impact of Ebola headline news days on media-highlighted stocks. They find that while in aggregate negative Ebola news days have no impact on securities in the disaggregate several industries were impacted by Ebola news, both positive and negative news days.

In December 2019 Wuhan became the epicenter of the later formally named covid-19. Due to the high rate of infection, more infectious than the previously mentioned pandemics and epidemics, of covid-19 it has a more far-reaching global impact. The growing public concern of the pandemic due to rapid spread,the increasing cases, and related deaths quickly affected the financial market. Stock price indexes experienced a sharp decline and GPD growth of many countries fell. The volatility in the U.S. stock market sharply increased in late February and the Dow Jones declined by 28% in a month from an all time high. In China, after the Spring festival (i.e. Chinese New Year) the Shanghai Composite Index fell by 8.5% and and the Shenzhen Composite Index by 7.7%.

The impact covid-19 has on economic and financial markets has been analyzed by a growing stream of research. For example, fear and global stock market performance (Lyócsa et al., 2020) , fear and commodity price returns (Salisu & Akanni, 2020), U.S. equity market performance (Baig, Butt, Haroon, & Rizvi, 2021), tourism and airline stock prices (Carter et al., 2022), the effect of social trust on firm performance (Mazumder, 2020), cryptocurrencies (Conlon, Corbet, & McGee, 2020), and the pricing of global syndicated loans (Hasan, Politsidis, & Sharma, 2021). Analysis of IPOs during the covid-19 is less found.

This study aims to examine how the impact of fear associated with covid-19, a pure exogenous shock affects the initial return (underpricing) of an IPO during the pandemic. The growing public concern of the pandemic due to the large number of cases and deaths, widely covered in the media causes fear and uncertainty which shape investors' sentiment. According to Engelhardt, Krause, Neukirchen, and Posch (2021) the increasing covid-19 cases that are announced lead to higher volatility on the financial market. Public health hazards in the past such as SARS and Ebola affect market sentiment and fear is negatively associated with portfolio returns (Shang et al., 2022). Investors are more sensitive to coverage with a negative tone (Zou et al., 2020). C. Chen, Liu, and Zhao (2020) found that the pandemic raised investors fear of uncertainty and Salisu and Akanni (2020) argued that fear leads to a decline in the stock prices.

Accordingly it is hypothesized that the covid-19 pandemic raised investors fear of uncertainty and in line with public health hazards in the past affects market sentiment. Leading to a difference in the level of initial first day returns between the pre-covid-19 and the covid-19 period:

Hypothesis 1: *There is a significant difference in the level of IPOs initial first day returns, underpricing, in China in covid-19 times compared to that of IPOs in pre-covid-19 period.*

Furthermore, it is hypothesized that the level of panic will increase as the reported cases and deaths increase and returns will decrease, initial returns will decrease leading to a lower level of underpricing:

Hypothesis 2: *The higher the amount of covid-19 related fear, the lower the IPO underpricing.*

3 Data and Methodology

The required data sample is collected from Eikon Datastream, Zephyr and China Stock Market & Accounting Research Database (CSMAR) and consists of companies who successfully issued IPOs listed on both the Shanghai Stock Exchange and the Shenzhen Stock Exchange in 2019 and 2020. Since on December 31, 2019, China reported a string of pneumonia like cases in Wuhan. Although globally the first covid-19 cases were confirmed much later and there officially was no pandemic declaration before march 2020, the fear related to covid-19 prevailed before March. The IPOs which took place in 2019 will be viewed as pre-covid-19.

The sample contains information on issue price, first day closing prices from which the return of the first trading day will be calculated. Information on founding dates, issue size, revenue from the last accounting period before listing, industry-specific SIC codes[2] retrieved from Eikon Datastream and Industry classification based on the CSMAR. Information related to covid-19 fear, deaths and confirmed cases, and data on the Global fear index will be collected form Mendely Data together with the situation reports from the World Health Organisation.

In case of missing, or incomplete crucial information in any of the variables the firm is excluded from the sample. In some cases however the missing data is filled with information available provided from one of the other databases.

[2]The Standard Industrial Classification (SIC) is a system for classifying industries by a four-digit code

In line with previous research the extend of underpricing of an IPO issue will be measured as the difference between the closing price on the first trading day and the issue price, the return on the first trading day:

$$IR_i = \frac{P_{i,1} - P_{i,0}}{P_{i,0}} \quad (1)$$

Where IR_i is the return on the first trading day of the IPO, $P_{i,1}$ is the closing price of stock i on day 0 and $P_{i,0}$ is the offering price of stock i.

This measure only determines if an issue is overpriced or underpriced but doesn't allow a statement about if the issue was "too cheap" or "too expensive" since it considers price difference only. To value the extend of the underpricing (or overpricing) the initial return is adjusted by the return of the market, so there is a standard of comparison. The market adjusted returns for the first trading day will be calculated as follows:

$$MAIR_i = IR_i - \frac{P_{m,1} - P_{m,0}}{P_{m,0}} = \frac{P_{i,1} - P_{i,0}}{P_{i,0}} - \frac{P_{m,1} - P_{m,0}}{P_{m,0}} \quad (2)$$

Where $MAIR_i$ is the market-adjusted return of the IPO on day 0, $P_{m,1}$ the closing price on the first trading day of the market index on the first trading day of the issue and $P_{m,0}$ the closing price of the market index on the offering day of the issue. The index in this case will be the SSE or SZSE A-share composite index.

Since there is no theoretical upper limit for positive returns on the first trading day while negative initial returns are limited to -100% it is reasonable to assume, due to the nature of mathematics, the distribution of the data could be skewed with a large right tail by large positive outliers. These upper extreme values have a great impact on the mean of initial returns. To deal with the skewness, the initial returns are winsorized. Winsorizing sets the extreme values to the value of observation at a certain percentile.

To examine the variances of the initial returns in both the pre-covid-19 and the covid-19 period Levene's test of variances is performed. Levene's test of variances is a two-sample variance comparison test using groups, in this case the first group will be 2019, the pre-covid-19 group, and 2020, the covid-19 group.

Since Levene's test is sensitive to the assumption of normally distributed data, and as noted earlier the data might be affected by skewness, a robust version of Levene's test will also be performed which uses a test statistic that has been found robust for non-normality (Levene, 1960). In addition to the robust test statistic the robust test will also examine if the results differ if the mean is replaced with the median, which as Brown and Forsythe (1974) note is useful in cases of non-normality.

In order to test the first hypothesis, whether the level of underpricing on Chinese issues in the pre-covid-19 period differs from the issues in the covid-19 period, the sample is separated into two groups. The IPOs which took place in 2019 will be viewed as pre-covid-19. Both IR_i and $MAIR_i$ will be included in the analysis. By using the Student's t-test for difference in means the hypothesis whether the return on the first trading day and the market adjusted return on the first trading day between the pre-covid-19 and the covid-19 group is significantly different.

Next the analysis is extended to examine the impact of fear associated with the covid-19 pandemic on IPO underpricing in China. For the impact of fear associated with the initial IPO returns, the global fear index (GFI) will be utilized (Salisu & Akanni, 2020). For the Global Fear Index (GFI) the data will be retrieved from the published data set by Salisu, Akanni, and Raheem (2020) from Mendely Data together with the situation reports from the World Health Organisation. The fear index is an equally weighted measure of reported cases and reported deaths. The GFI measures the daily concerns and motions on the spread and severity of covid-19. Fear associated with covid-19 could have significant implications on investment sentiment and decisions and thereby affect prices.

The GFI is a composite index of, reported cases and deaths on a scale of zero to 1. Indicating the presence of extreme fear or panic. According to Salisu et al. (2020): "RCI measures how far people's expectations on reported cases in the preceding 14 days period (incubation period) veered from the present days' reported cases." The second part of the fear index, the reported Death index (RDI) measures how peoples' expectations from reported deaths in the 14 days prior deviates from present day's reported deaths. The fear index is created by assigning equal weights to both the RCI and RDI. The higher the index, the greater the fear about the pandemic. For a given period, t, the RCI is computed as:

$$RCI_t = \frac{Reportedcases_t}{Reportedcases_t + Reportedcases_{t-14}} \tag{3}$$

Similarly, RDI is computed as:

$$RDI_t = \frac{Reporteddeaths_t}{Reporteddeaths_t + Reporteddeaths_{t-14}} \tag{4}$$

The fear index measures the daily concerns and motion on the spread and severity of covid-19 on a scale of 0 to 1 where 0.5 signifies a moderate amount of fear and the level of fear increases as the index tends to 1. The Fear index assigns equal weight to both the RCI and RDI, so the fear index is computed as follows:

$$FearIndex_t = \frac{1}{2} * (RDI_t + RCI_t) \tag{5}$$

In order to test the second hypothesis an Ordinary Least Squares (OLS) regression model will be used consisting of relevant variables based on previous research. OLS is a method for estimating the unknown parameters in a linear regression model. It minimizes the sum of squared distances between the observed responses in the data and the predicted response of the linear approximation.

The model will be estimated using the hierarchical approach. Since our main interest is the fear associated with the covid-19 pandemic on underpricing the model will be estimates step wise. i.e. the control variables will be added in steps, to be able to analyze if the effect exists without control variables, if and how the control variables change the magnitude and or sign of the effect.

The returns on the first trading day are regressed on the fear index and control variables by the the following model:

$$\begin{aligned} Underpricing_i \quad = \quad \beta_0 \quad + \beta_1 Fear_{t-1} \quad + \beta_2 OfferSize_i \quad + \beta_3 Revenue_i \quad + \\ \beta_4 DurationTime_i \quad + \beta_5 Age_i \quad + \beta_6 Exchange_i \quad + \beta_7 HighTech_i \quad + \\ \sum_{j=1}^{J} \beta_j Industry_i \quad + \epsilon_i \end{aligned} \tag{6}$$

Where $underpricing$ is measured by both IR_t, the initial returns and $MAIR$, market adjusted initial returns, of the IPO at the first day listed, $Fear_{t-1}$ is the fear index of equally weighted new cases and reported deaths related to covid-19 at lag IPO day, $OfferSize_i$ the natural logarithm of the total proceeds of the IPO, $Revenue_i$ the natural logarithm of total revenue of the firm in the operating process, $DurationTime_i$ the number of days elapsed between offering and listing, Age_i is the firms age measured as the number of years from setting date to IPO date, $Exchange$ indicating if the issue took place at the SSE of SZSE, $HighTech_i$ a dummy which takes value 1 for certain SIC codes and 0 otherwise, $Industry_i$ the fixed effect industry dummy which takes value 1 if the issuer is active in a certain industry normalized to the Public utilities industry, and ϵ the white noise when standard errors are heteroscedasticity-consistent robust. See Table 1 for an overview of the variables and their measurement.

The correlation between all variables in the regression will be analyzed by constructing Pearson's correlation matrix. It is important to investigate the correlation between the independent variables, as high correlation between independent variables could indicate signs of multicollinearity. In addition to Pearson's correlation matrix the Variance Inflation Factor is used to check for multicollinearity.

In addition to multicollinearity, the presence of heteroskedasticity in the model is analyzed. With heteroskedasticity the error terms do not have constant variance. Since constant variance is one of the assumptions of the OLS-regression, the presence of heteroskedasticity can lead to biased standard errors and variances do not vary with the modelled effects. The Breusch-pagan test and White-General test are performed to check for heteroskedasticity.

Table 1: Overview of Definition and Measurements of the Variables Used.

Variable	Abbreviation	Measurement
Age	age	The difference between the founding year of the company and the year the IPO took place. $(firstTradeYear_i - companyFoundingYear_i)$
Duration Time	$durationTime$	Number of days that elapsed between the listing date and date of offering $firstTradeDay_i - issueDate_i$
Offer Price	$offerPrice$	Price (USD) at which the issue is offered.

Variable	Abbreviation	Measurement
First trade day closing price	$closingPriceFirstTradeDate$	Closing price (USD) at the end of the first trading day.
Initial Return	IR	The initial first day return, change between the offer price and the first day closing price. $\frac{(closingPrice_{firstTradeDate} - offerPrice)}{offerPrice}$
Market Return	M	Change of the SSE or $SZSE$ index at the first trade date depending on which exchange the issue is listed.
Market Adjusted Initial Return	$MAIR$	The initial first day return, adjusted by the return of the market. $IR_i - M_i$
Fear Index	$fear$	Measure of daily concerns and motion on the spread and severity of covid-19 on a scale of 0 to 1. Equally weighted index of new cases (RCI) and reported deaths (RDI) related to covid-19 at lag IPO day.
Offer Size	$offerSize$	Natural logarithm of total proceeds of the IPO calculated based on total offered shares and pre-ipo offer price. $LN(sharesOffered * offerPrice)$
Total Operating Revenue	rev	Natural logarithm of total revenue of firm in the operating process. $LN(totalOperatingRevenue)$
Exchange	SSE	Dummy variable indicating if the issue is listed on the Shanghai Stock Exchange(SSE) or the Shenzhen Stock Exchange (SZSE). Normalized to the the Shenzhen Stock Exchange.
High Tech	$HighTech_i$	Dummy variable equaling 1 for firms with SIC-codes 357, 367, 382, 384 or 737, and 0 otherwise (see (Loughran & Ritter, 2004))
Industry	$CSMAR\_Division$	The industry in which the firm is active. Based on the CSRC Industry Classification 2012. Consisting of Finance, Public Utilities, Real Estate, Congomerate, Industry and Commerce.
First Trade Year	$firstTradeYear$	The year in which the IPO took place.
first Trade Month	$firstTradeMonth$	The month in which the IPO took place.

4 Results and Discussion

4.1 Univariate Analysis

In order to determine if there is a difference in the level of IPOs initial first day returns in the covid-19 period compared to that of IPOs in the pre-covid-19 period the possible skewness of the data set has to be considered. As described in section 3 the initial returns are winsorized at a 2.5% winsorization fraction, implying that observations in the bottom 2.5% are set to the first value after the 2.5% region and observations above the 97.5% set to the value below the 97.5% region. As can be seen in Table 2 the upper extreme values greatly impacted the mean of initial returns.

Table 2: Descriptive Statistics - Univariate Analysis.

		mean	sd	p5	p25	median	p75	p95	N
Pre-covid-19									
	IR	0.7358	0.6957	0.2690	0.4399	0.4401	0.8743	2.1774	192
	IR, Winsorized	0.7380	0.6617	0.2690	0.4399	0.4401	0.8743	2.1774	192
	MAIR	0.7373	0.6974	0.2717	0.4339	0.4467	0.8901	2.1808	192
	MAIR, Winsorized	0.7398	0.6623	0.2717	0.4339	0.4467	0.8901	2.1808	192
Covid-19									
	IR	1.2952	1.4188	0.4393	0.4400	0.5243	1.7612	3.8317	386
	IR, Winsorized	1.2238	1.1251	0.4393	0.4400	0.5243	1.7612	3.8317	386
	MAIR	1.2935	1.4178	0.41.08	0.4388	0.5246	1.7508	3.8238	386
	MAIR, Winsorized	1.2222	1.1244	0.4108	0.4388	0.5246	1.7508	3.8238	386
Total									578

For the winsorized data set the average level of initial return, underpricing, is 73.80% in 2019 and 122.38% in 2020. The median for both 2019 and 2020, 44.01% and 52.43% is substantially lower than the mean, indicating that the mean is highly impacted by several high first day returns.
With the winsorized initial returns the skewness is lowered and the effect of skewness could have on the power of the student's t-test is not great enough for the t-test to lose its practicality as student's t-test does not require normality in larger samples. Even in cases where data could exhibit patterns of non-normality, t-tests are argued to be valid as discussed earlier.

Levene's test of variance, variance ratio test, is performed to test if the variances of initial returns in the pre-covid-19 group, the IPOs that took place in 2019, and the variances of initial returns in the covid-19 group, the IPOs that took place in 2020, are equal or not. The results of the variance ratio test can be seen in Table A1. For both IR and MAIR, the p-values implies the null hypothesis of equal variances is rejected. Thus the Levene's test shows unequal variance of the two groups.

As noted earlier Levene's variance test is sensitive to the assumption of normality and since the distribution of the observations is somewhat skewed (skewness coefficient$_{IR}$ 1.835 and skewness coefficient$_{MAIR}$ 1.831) the result of the variance ratio test are checked using Levene's robust test for equality of variances. The robust test, as can be seen in Table A2, indicates that for both IR and MAIR the null hypothesis of equal variances can be rejected at 0.05 level of significance. Also when looking at the median-centered tests, which replaces the the mean with median to calculate variance, the null hypothesis of equal variances can be rejected. This implies that IR and MAIR in both groups, pre-covid-19 and covid-19, have unequal variances.

To compare the level of IPOs initial first day returns in the covid-19 period and the pre-covid-19 period the test of mean was performed using student's t-test with unequal variances. Table 3 compares the mean of the initial first day return (IR) and the market adjusted returns (MAIR) between the pre-covid-19 and the covid-19 sub-samples.

Table 3: Univariate Test for Changes in Mean Underpricing

Variable	Pre-covid-19 period	covid-19 period	t-Stats(P-value)
Initial Return (IR)	0.7380	1.2238	-6.516 (0.000)
Market Adjusted Initial Returns (MAIR)	0.7398	1.2222	-6.470 (0.000)

With a T-statistics of -6.516 for IR and corresponding p-value 0.000, which is lower than 0.05 for IR leads to the conclusion that the difference in means is statistically different from 0. Looking at MAIR, with a T-statistic of -6.470 and corresponding p-value 0.000, which is lower than 0.05 leads to the conclusion that the difference in means is statistically different from 0. These results indicate that there is a significant increase in mean for both initial returns and market adjusted returns, both measuring underpricing, subsequent to covid-19.

4.2 Multivariate analysis

Multiple regression analysis was undertaken, with initial return and market adjusted initial returns, both measuring underpricing, as the dependent variable. Descriptive statistics of all variables used in the regression can be seen in Table 4.

In Table 4 can be seen that there is a large difference in the level of underpricing, for IR as measurement for underpricing, ranging from 0.27 to 4.50 with mean 1.06, making the standard deviation relatively high. For MAIR can be seen that the range and mean are close to those of IR. The age of issuing firms varies from 2 for the youngest firm and 61 for the oldest firm in the sample. Duration Time is on average 16 days.

Table 4: Descriptive Statistics - Multivariate Analysis

	mean	sd	p5	p25	p50	p75	p95	min	max	N
IR	1.062	1.021	0.409	0.440	0.440	1.3029	3.488	0.269	4.505	578
MAIR	1.062	1.020	0.400	0.437	0.456	1.2966	3.473	0.272	4.495	578
Fear Index	0.332	0.262	0.000	0.000	0.492	0.5196	0.573	0.000	0.916	578
offerSize	18.465	0.656	17.631	18.019	18.344	18.8113	19.641	16.579	22.206	578
revenue	20.010	1.472	18.400	19.380	19.993	20.6608	22.133	0.000	25.739	574
durationTime	16.548	6.718	11	13	14	17	35	10	43	578
age	15.339	6.224	7	11	15	19	26	2	61	578

Pearson's correlation between all used variables in the regression is shown in Table 5. The Pearson's correlation is used to analyse the coefficients between initial return, market adjusted initial return and the independent variables. The correlations provide predictive relationships in the table but yet say nothing about the outcome of the regression. It is important to investigate the correlation between the independent variables, as high correlation between independent variables could indicate signs of multicollinearity. As shown in Table 5 due to the fact that the majority of the variable correlations are below 0.32, indicating that the issue of multicollinearity is not seriously present.

Table 5: Pearson's Correlation Matrix

	IR	MAIR	fear	offerSize	revenue	durationTime	age	SSE	highTech	finance	realEstate	industry	commerce
IR	1.00												
MAIR	0.99	1.00											
fear	0.19	0.19	1.00										
offerSize	-0.09	-0.09	-0.00	1.00									
revenue	-0.17	-0.17	-0.02	0.14	1.00								
durationTime	-0.15	-0.15	-0.09	0.03	0.18	1.00							
age	-0.05	-0.05	0.07	-0.10	0.15	0.04	1.00						
SSE	0.08	0.08	-0.04	0.25	-0.06	0.02	-0.02	1.00					
highTech	0.13	0.13	-0.01	0.01	-0.13	-0.15	-0.05	0.03	1.00				
finance	-0.08	-0.08	-0.11	0.10	0.10	0.23	0.08	-0.01	-0.10	1.00			
realEstate	-0.01	-0.01	-0.01	-0.03	0.05	0.27	0.10	-0.04	-0.08	-0.01	1.00		
industry	0.09	0.06	0.07	-0.04	-0.06	-0.12	-0.01	0.08	0.31	-0.22	-0.17	1.00	
commerce	-0.07	-0.07	0.03	-0.05	0.15	0.23	-0.05	-0.01	-0.11	-0.02	-0.01	-0.25	1.00

In addition to the Pearson's correlation for investigating multicollinearity the Variance Inflation Factor (VIF), widely used for multicollinearity detection, is calculated. As can be seen in Appendix B, all values in the VIF test statistic are lower than 1.5, which indicates multicollinearity is not seriously present as the rule of thumb is that multicollinearity could only play a role if the VIF test statistic is higher than 10 (Chatterjee & Hadi, 2006). Following the correlation coefficients from the Pearson's correlation matrix and the VIF test statistics all variables are retained in the model.

The presence of heteroskedasticity, in addition to multicollinearity, in the model has to be analyzed. With heteroskedasticity the error terms do not have constant variance. Since constant variance is one of the assumptions of the OLS-regression, the presence of heteroskedasticity can lead to biased standard errors and variances do not vary with the modelled effects. The Breusch-pagan test and White-General test are performed to check for heteroskedasticity.

The Breusch-pagan test, as shown in Table C1, suggests the presence of heteroskedasticity. For fitted values of both the model with IR as the dependent variable and the model with MAIR as the dependent variable the null hypotheses of constant variance among the residuals should be rejected indicating the data is affected by heteroskedasticity. The White-General test shown in Table C2 also indicates signs of heteroskedasticity for both the model with IR as the dependent variable and the model with MAIR as the dependent variable.

Since both the Breusch-pagan test and White-General test indicate signs of heteroskedasticity, which implies that the standard errors could be biased. The null hypothesis of constant variance should be rejected as the explanatory variables effect the variance of the error term. To deal with the possibly biased standard errors robust standard errors are included in the model.

In order to examine whether the amount of fear associated with covid-19 affect underpricing both the initial returns and market adjusted initial returns are regressed on all explanatory variables. Both Initial returns and market adjusted initial return measure the level of underpricing. Regression results with robust standard errors of the models, 1 to 8, with initial return (IR) as the dependent variable are shown on the left side of Table 6.
On the right side of Table 6 the regression results with robust standard errors of the models with market adjusted initial return ($MAIR$) as the dependent variable are shown.

For both regressions with IR and $MAIR$ as the dependent variable, the models are estimated using the hierarchical approach, i.e. control variables are added step wise. In the initial regression the dependent variable is regressed on the independent variable $fear$. In the second model the independent variable $offerSize$ is added to the model and so on for the other models.

In the first model where underpricing is regressed on $fear$ it can be seen that fear has a positive effect on underpricing and significant at the 0.01 level. This relationship exists for both the variables IR and $MAIR$ measuring underpricing. Implying that if fear related to covid-19 increases, the level of underpricing increases. When $offerSize$ is added to the model the positive effect of the $fear$ remains significant for both the variables measuring underpricing at the 0.01 level and the coefficient doesn't show a major change compared to model 1. Offer size is negatively related to underpricing, and significant at a 0.05 level. The result indicates that the larger the the offer size, i.e. the more capital a firm raises in their IPO, the less the level of underpricing.

Table 6: Regression Results With Robust Standard Errors

	IR								MAIR							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
fear	0.77***	0.76***	0.74***	0.70***	0.72***	0.74***	0.74***	0.76***	0.76***	0.76***	0.74***	0.70***	0.71***	0.73***	0.74***	0.75***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
offerSize		-0.13**	-0.10	-0.10	-0.11	-0.15**	-0.15**	-0.16**		-0.13**	-0.10	-0.10	-0.11	-0.15**	-0.15**	-0.16**
		(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)		(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
revenue			-0.11**	-0.10*	-0.09*	-0.08*	-0.08*	-0.07			-0.11**	-0.10*	-0.09*	-0.08*	-0.08*	-0.07
			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)			(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
durationTime				-0.02***	-0.02***	-0.02***	-0.02***	-0.02***				-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)				(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
age					-0.01	-0.01	-0.01	-0.01					-0.01	-0.01	-0.01	-0.01
					(0.01)	(0.01)	(0.01)	(0.01)					(0.01)	(0.01)	(0.01)	(0.01)
SSE						0.22**	0.22**	0.22**						0.22**	0.22**	0.22***
						(0.09)	(0.09)	(0.09)						(0.09)	(0.09)	(0.09)
highTech							0.21**	0.22**							0.21**	0.22**
							(0.09)	(0.10)							(0.09)	(0.10)
Public utilities								0.00 (.)								0.00 (.)
finance								-0.01								0.00
								(0.16)								(0.16)
realEstate								0.32								0.32
								(0.30)								(0.29)
industry								-0.05								-0.05
								(0.11)								(0.11)
commerce								-0.27								-0.26
								(0.21)								(0.21)
constant	0.81***	3.26***	4.82***	4.82***	4.99***	5.51***	5.29***	5.38***	0.81***	3.25***	4.81***	4.81***	4.98***	5.51***	5.29***	5.38***
	(0.05)	(1.14)	(1.24)	(1.21)	(1.21)	(1.22)	(1.23)	(1.24)	(0.05)	(1.14)	(1.24)	(1.21)	(1.21)	(1.22)	(1.23)	(1.24)
Observations	578	578	574	574	574	574	574	574	578	578	574	574	574	574	574	574
R^2	0.04	0.05	0.07	0.08	0.08	0.09	0.10	0.10	0.04	0.05	0.07	0.08	0.08	0.09	0.10	0.10
Adjusted R^2	0.04	0.04	0.06	0.07	0.07	0.08	0.09	0.09	0.04	0.04	0.06	0.07	0.07	0.08	0.09	0.09

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. All standard errors are robust.

In model 3 $revenue$ is added to the model. $revenue$ shows to have a negative effect for both the variables measuring underpricing, and significant at a 0.05 level. This implies the higher the revenue the company realised the year before listing, the lower the level of underpricing. The effect of the $fear$ slightly decreases once $revenue$ is added to the model, for both IR and $MAIR$, but remains significant at a 0.01 level.

Duration time, depicted by the variable $durationTime$ added in model 4, shows a significant, at 0.01 level, negatively effect on both variables measuring underpricing once added to the model. This indicates that as the number of days that elapse between the listing date and the offering date increases, the level of underpricing decreases. The positive effect of $fear$ remains significant at a 0.01 level and its coefficient does not change drastically with $durationTime$ added to the model.

In model 5 Age is added to the model. Age shows to have a negative relation toward both variables measuring underpricing. This indicates that older firms have a lower level of underpricing compared to young firms. The older the firm, the more information is available which can be taken into account in the decision making of investors and thus lowering the information asymmetry. However, Age is not found to have a significant relationship on underpricing and due to this fact it is not possible to draw a conclusion of the effect age has on initial returns. The positive effect of $fear$ remains significant at a 0.01 level and for both variables measuring underpricing, its coefficient does not change drastically.

Regarding the control for exchange, depicted in the variable SSE, the result indicates a significant difference (for both IR and $MAIR$) in underpricing depending on the exchange at which the firm is listed. The added exchange dummy SSE has been normalized to the Shenzhen Stock Exchange. The model shows a positive effect on underpricing for a listing taking place at the Shanghai Stock Exchange, significant at a 0.05 level. The positive effect of $fear$ remains significant at a 0.01 level and its coefficient for both models does not change drastically.

In model 7 the dummy variable $highTech$ is added indicating if the issuing firm is active in a high tech industry sector. The model shows a positive relationship of issuing firms active in high tech industries and both variables measuring underpricing, significant at a 0.05 level. Indicating that firms active in high tech industries have a higher level of underpricing compared to other firms. The positive effect of $fear$ remains significant at a 0.01 level and its coefficient does not change drastically.

In model 8 the control for industries are added using four industry dummies. The model is normalized to the Public utilities industry since it represents the mean of initial return and market adjusted returns in this industry the best relative to other industries. $commerce$ and $industry$ show a negative effect on the level of underpricing, $finance$ shows a slightly negative effect on IR while having no effect on $MAIR$ while $realEstate$ shows a positive effect on the level of underpricing. However, none of the coefficients are significant and thus it is not possible to draw a conclusion.

When looking at the value of R-squared for the different models, as can be seen in the bottom row of Table 6, for the first model the value for R-squared is 0.04, implying that the model explains 4% of the variance IR. By adding $offerSize$ to the model it increases to 0.05. And R-squared continues to increase from 0.04 to 0.10 while adding the variables in model 3 to 7. In model 7 the model explains 10% of the variance in IR.

In conclusion, model 7 is the most relevant to analyze. All variables that were significant initially stay significant on at least the 0.1 level. The impact of covid-19 related fear and duration time on both variables measuring underpricing can be proven at a 0.01 level of significance. the impact of offer size, exchange and firms active in high tech on underpricing can be proven at a 0.05 level of significance (both for IR and MAIR) and the impact of revenue in the year before listing can be proven at a 0.1 level of significance. Age is not found to have a significant effect.

The fear related to covid-19 is positively related to initial returns, if the level of fear increases the level of underpricing increases. Offer size is negatively related to initial returns, is the size of the offer, i.e. the more capital a firm raises in its IPO, the lower is the underpricing. This indicates that larger offerings do not have a lower level of information asymmetry in line with findings of Autore et al. (2014) and Ritter (1991) who also report that the level of underpricing is negatively related to the size of the proceeds of the IPO. Revenues realised the year before listing is negatively related to the level of underpricing. IF in the year before listing the firm realized high revenues, the underpricing decreases.

Duration time is negatively related to initial returns, the more days that elapse between offering and listing lower the level of initial return. Former research often treat duration time as a proxy for the level of informed demand. If the level of informed demand is high, the issue can be finished more quicker and there is no need to underprice the issue in order to attract uninformed investors. The negative relationship found is in line with the findings of (Mok & Hui, 1998).

Age is negatively related to underpricing, indicating that older firms have lower underpricing. Older firms have a track record and there is more public available information for investors to take into account when making investment decisions, which could lead to a decreased level of underpricing. However, this result should be interpreted with caution since in contrast with previous research Age is not found significant (Jenkinson & Ljungqvist, 2001).

High tech is positively related to underpicing. Indicating that issues of firms active in high tech industries have a higher level of underpricing. This result is in line with the findings of Chemmanur (1993) who also finds high tech firms issues to have a higher degree of underpricing.

5 Conclusion and Recommendations

This paper set out to test if there is a difference in the level of IPOs initial first day returns, underpricing, in the covid-19 period compared to that of IPOs in the pre-covid-19 period in China. As well as to examine whether the amount of fear associated with covid-19 affects underpricing in China. IPO underpricing has been widely investigated in the past decades and its presence has been documented by empirical research on almost every financial market around the world. With numerous studies providing explanations based on information asymmetry, institutional theories, ownership and control reasons, and behavioural theories. These explanations are based on competitive theories and predominantly ignore outside factors or exogenous shocks that may affect the initial IPO returns. Although some studies document the effect of previous pandemics and epidemics such as Ebola and SARS on underpricing, these pandemics and epidemics did not have the same devastating global effect that the covid-19 pandemic had. This study contributes to the prevailing IPO underpricing literature from the perspective that fear associated with the global covid-19 pandemic, a pure exogenous shock, affects the initial return of an IPO and thus has explanatory power in explaining underpricing.

In order to examine the level of underpricing on Chinese issues in the pre-covid-19 period compared to Chinese issues in the covid-19 period a sample of 578 IPOs that successfully listed on either the Shanghai Stock Exchange and the Shenzhen Stock Exchange in 2019 and 2020 was separated into two groups. A total of 192 issues that took place in 2019 are viewed as the pre-covid-19 group and a total of 386 IPOs which took place in 2020 are viewed as the covid-19 group. Both Initial returns (IR) and market adjusted returns (MAIR) are used to measure the level of underpricing. In order to test whether there is a difference in the level of underpricing between the pre-covid-19 period and the covid-19 period the test of difference in means was performed using student's t-test with unequal variances.

This paper hypothesized that there is a significant difference in the level of underpricing in China in covid-19 times compared to that of IPOs in the pre-covid-19 period. By comparing the means of IR and MAIR between the pre-covid-19 and the covid-19 sub samples using student's t-test with unequal variances, this study presented potent empirical evidence in favour of the null-hypothesis that the level of IPO underpricing, measured by IR and MAIR, in covid-19 times is significantly, at the 0.01 level, higher compared to the level of IPO underpricing in the pre-covid-19 period.

To examine whether the amount of fear associated with covid-19 affects underpricing in China multiple regression was undertaken with both IR an MAIR measuring underpricing as the dependent variable. The fear associated with covid-19 is measured using the global fear index, a composite index of reported cases and deaths. The returns on the first trading day are regressed on fear controlling for firm, exchange and industry characteristics.

This paper hypothesized that the higher the amount of covid-19 related fear, the lower the IPO underpricing. Initial regression tests where both IR and MAIR as measures of underpricing are regressed on fear produced a positive estimate for this coefficient, significant at the 0.01 level.

Controlling for offer size, revenue, duration time, age, exchange, high tech and industry in subsequent regression models, the impact of covid-19 related fear on both variables measuring underpricing can be proven at the 0.01 level of significance. The fear related to covid-19 is positively related to initial returns, if the level of fear increases the level of underpricing increases. And thus presenting evidence to reject the null hypothesis.

Limitations of this study have to be considered. The first limitation in relation to the variables in the regression is the measurement of the variable revenue. Total operating revenue, in the last accounting period before listing, has a high volatility and can vary substantially from year to year. Ratios can be a good alternative but due to database limitations are not included in this study. With more specific data the explanatory variables can be measured more accurately. A recommendation for future research could be to include more company-specific measurements for the performance of the company such as the quick ratio or book to market ratio. When combining more figures for one specific company, these ratios make it a more company-specific variable.

This study only takes into account the short-term underpricing since it only examines the initial returns on the first trading day and does not include post IPO performance. In addition, the sample period in this study is relatively short. A recommendation for future research could be to distinguish between short-term and long-term underpricing. The short term performance could be extended and defined in months and the long-term in years. As Ritter (1991) suggests IPOs during high volume years perform poorly in the long run.

For future research it could also be relevant to consider controlling for regional effects, on a state/province or a city level. Since the effect of covid-19 could vary a great deal depending on the region and due to government interventions some regions could be in lockdown, which results in closing the operation locations of the issuing companies. Although this poses a challenge since for many issuing companies not the entire company is in one city or one state. Often the issuing firms' headquarter is located in a different place then their operation locations. Operation locations could even be distributed among various locations.

Future research could also include the uncertainty due to government policy in response to pandemic. Government restrictions such as stay-at-home requirements could potentially contribute to IPO underpricing and volatility as it can harm the stability and quality of the financial markets by the increased information uncertainty.

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Appendices

A Variance-comparison Tests

Table A1: Variance Ratio Test

IR				MAIR			
Group	N	Mean	Sd	Group	N	Mean	Sd
2019	192	0.7380	0.6617	2019	192	0.7398	0.6623
2020	386	1.2238	1.1251	2020	386	1.2222	1.1244
F-statistic = 0.3459				F-statistic = 0.3470			
p-value = 0.0000				p-value = 0.0000			

H_0 : Equal variances

Levene's test of variance, variance ratio test, for both IR and MAIR tests if the variances of initial returns in the pre-covid-19 group, the IPOs that took place in 2019, and the variances of initial returns in the covid-19 group, the IPOs that took place in 2020, are equal or not. For the initial return the F-statistic is 0.3459 and the p-value implies the null hypothesis of equal variances is rejected. For the market adjusted return the F-statistic equals 0.3470 and the p-value implies the null hypothesis of equal variances is rejected. Thus the Levene's test shows unequal variance of the two groups.

Table A2: Levene's Robust Test for Equal Variances

IR				MAIR			
Group	N	Mean	Sd	Group	N	Mean	Sd
2019	192	0.7380	0.6617	2019	192	0.7398	0.6623
2020	238	1.2238	1.1251	2020	386	1.2222	1.1244
$W_0 = 66.5773$		Pr > F = 0.0000		$W_0 = 66.0097$		Pr > F = 0.0000	
$W_{50} = 31.9935$		Pr > F = 0.0000		$W_{50} = 31.1022$		Pr > F = 0.0000	
$W_{10} = 51.9523$		Pr > F = 0.0000		$W_{10} = 51.5586$		Pr > F = 0.0000	

H_0: Equal Variances

Levene's robust variance test for IR and MAIR tests if the variances of initial returns in the pre-covid-19 group, the IPOs that took place in 2019, and the variances of initial returns in the covid-19 group, the IPOs that took place in 2020, are equal or not. For the initial return, with a test statistic W_0 of 66.58 and corresponding p-value below 0.05 the null hypothesis of equal variances can be rejected at 0.05 level of significance. Also, for the market adjusted initial return, with a test statistic W_0 of 66.01 and corresponding p-value below 0.05 the null hypothesis of equal variances can be rejected at 0.05 level of significance.

Also when looking at the median-centered tests, illustrated in the W_{50} statistic, which replaces the the mean with median to calculate variance, the null hypothesis of equal variances can be rejected as both for IR and MAIR the p-values are below 0.05. Thus, levene's robust variance test shows unequal variances of the two groups.

B Multicollinearity Tests

Table B1: The Variance Inflation Factor

Variable	VIF	1/VIF
industry	1.29	0.78
durationTime	1.27	0.79
commerce	1.19	0.84
finance	1.17	0.867
realEstate	1.14	0.87
highTech	1.14	0.88
offerSize	1.14	0.88
revenue	1.13	0.89
SSE	1.09	0.91
Age	1.07	0.93
fear	1.04	0.96
Mean VIF	1.15	

The Variance Inflation Factor (VIF), used for multicollinearity detection, for each variable included in the regression. The Variance inflation factor, calculated for each individual variable, is equal to the ratio of the overall variance of the model to the variance of the model that includes just one independent variable. Multicollinearity is considered to play a role if the VIF test statistic is higher than 10 (Chatterjee & Hadi, 2006). All values in the VIF test statistic are lower than 1.5, which indicates multicollinearity is not seriously present as the rule of thumb is that multicollinearity could only play a role if the VIF test statistic is higher than 10.

C Heteroskedasticity Tests

Table C1: Breusch-Pagan Test for Heteroskedasticity

Variable: Fitted values of IR			Variable: Fitted values of MAIR		
Chi2(1)	=	65.35	Chi2(1)	=	64.77
Prob > Chi2	=	0.0000	Prob > Chi2	=	0.0000

H_0 : Constant variance

The Breusch-pagan test is used to determine whether heteroskedasticity is present in the regression model. With a P-value of 0.00 for fitted values of the model with IR as the dependent variable suggests the null hypotheses of constant variance among the residuals should be rejected and the data is affected by heteroskedasticity. The same holds for the fitted values of the model with MAIR as the dependent variable, with a p-value of 0.00 the null hypothesis of equal variance among the residuals should be rejected. Thus, the Breusch-pagan test indicates signs of heteroskedasticity.

Table C2: White's Test for Heteroskedasticity

IR			MAIR		
Chi2(60)	=	84.58	Chi2(1)	=	64.77
Prob > Chi2	=	0.0200	Prob > Chi2	=	0.0188

H_0: Homoskedasticity

H_a: Unrestricted heteroskedasticity

The White-General test examines whether the variance of the errors in the model are constant and thus checks for heteroskedasticity. With a p-value of 0.020 the null hypothesis of homoskedasticity should be rejected at 0.05 level of significance for model with IR as the dependent variable. For the model with MAIR as the dependent variable the null hypothesis of homoskedasticity should also be rejected at 0.05 level of significance since the p-value is 0.018. Thus, the White-General test indicates signs of heteroskedasticity.