STOCKHOLM SCHOOL OF ECONOMICS
MASTER THESIS IN FINANCE

IPO Stock Performance and the Financial Crisis

Emmet King* and Luca Banderet†

Abstract

This paper takes the first opportunity to study the impact of the recent financial crisis on the stock price performance of initial public offerings (IPOs) in the short and long run. We conduct an analysis of 588 firms newly listed on the U.S. stock markets over the period 2003-2010. We find little evidence of the crisis having affected the average level of underpricing. Measuring 3-year buy-and-hold abnormal returns by benchmarking IPOs against portfolios of matched control firms, our results show the crisis to have had a strong positive impact on long-term performance. While firms that go public during non-crisis years are shown on average to underperform by 22%, crisis IPOs significantly outperform the benchmark by 26%. This effectively results in an average difference of 48% in abnormal returns between the two periods after 3 years. We conclude from our analysis that the market is prone to severe overreactions, caused by investor optimism/pessimism and herding behaviour. Our findings thus provide evidence against the Efficient Market Hypothesis in its semi-strong form.

JEL Classification: G12, G14, G32

Key Words: Initial Public Offering, Underpricing, Long-Term Performance, Market Efficiency, Financial Crisis

We would like to thank our tutor, Assistant Professor Ramin Baghai, for his advice and guidance throughout the process of writing this paper.

* 40375@student.hhs.se
† 40405@student.hhs.se

0. Table of Contents

1. Introduction

The performance of initial public offerings (IPOs), both in the short and longer term, is important for several reasons. From the perspective of the issuer, the IPO is a significant event in the life and development of the firm. For the entrepreneur, it may represent the culmination of years of hard work building the company, while for existing private shareholders or venture capitalists, it may be an opportunity to exit the company and make a significant gain on investment. Factors affecting the process of going public as well as the subsequent stock price performance are of particular concern. Launching on the stock market is therefore a central issue within corporate finance, and the subject has garnered much attention in the literature, with a number of important empirical patterns having been shown to persist.

One anomaly that has consistently been proven to exist and is one of the most studied within the field of financial economics, is the underpricing of IPOs, or to put it another way, the presence of positive first-day returns. First highlighted by Ibbotson's (1975) seminal paper, and due to the magnitude of the phenomenon, extensively researched ever since, issuing firms have frequently been found to achieve significant positive first-day returns. Loughran and Ritter (2004) find the average level of underpricing in the U.S. stock market to have ranged from 7% to 65% across different periods. Another phenomenon is the long-run underperformance of IPO firms, relating to the observation that in the 1-5 year period after going public, firms underperform relative to some specified performance benchmark. Loughran and Ritter (1995) for example, report underperformance of up to 50% in the five years after going public.

In addition to these phenomena, it is widely acknowledged that initial public offering activity can vary significantly across time-periods, with the existence of 'hot' and 'cold' IPO markets well documented in a number of studies. Hot IPO markets are characterized by a high volume of offerings, high levels of underpricing and oftentimes oversubscription of offerings (Helwege and Liang, 2004), while cold markets, by contrast, are associated with low IPO volume, reduced underpricing, and a reduced tendency for oversubscription of offerings. Bear markets, witnessed in almost all major economies, were a feature of the global financial crisis of 2007-2009, and were witnessed in almost all major economies. In the United States, the stock market was seen to suffer from falling security prices and widespread investor pessimism, with the years 2008-2009 corresponding to a period of extremely low IPO activity. Due to the severity of the fall in both volume and optimism during this period, we argue that the crisis transcends the normal definition of a cold period, and is in fact a rare and unique event. As a result we argue that the phenomena of underpricing (positive first day returns) and subsequent long-term underperformance of IPO firms have, until now, never been studied under such market conditions.

This study seeks to contribute to the body of literature by analysing the effect of the financial crisis on the stock price performance of IPO firms listing on the United States stock markets. Using a three-year post-IPO period in order to measure long-term performance, this research paper takes the first opportunity to study the performance of firms that went public during and in the immediate aftermath of the crisis, and will establish the basis for further research into the effects of the crisis on IPO firms and their subsequent performance. In addition, through the use of a more recent sample of data, this paper will add to the literature by updating previous findings.

Evaluating the extensive body of prior research, we formulate two competing arguments that seek to predict the impact of the crisis on the average level of IPO underpricing. Similarly, we formulate two competing arguments in order to predict the impact of the crisis on the three-year post-IPO performance of issuing firms. After thorough consideration of the issues involved in choosing and creating a suitable benchmark, we select two benchmarking methodologies that enable our analysis to overcome the main sources of misspecification; we measure stock price performance by calculating buy-and-hold returns and benchmarking against either matched portfolios or single control firms based on firm-specific characteristics. We run multivariate regressions in order to test our hypotheses on a dataset containing 588 U.S. IPOs across the period 2003-2010.

Although the beginning of the wider financial crisis may be tracked back to August 2007, in our analysis we define the crisis as the years 2008-2009. We argue that by taking a retrospective look at IPO activity we can isolate the period during which the U.S. stock market seems to be affected most. The results of the study show the crisis to have no significant effect on the level of IPO underpricing. The results do however reveal an economically and statistically significant impact of the crisis on the three-year post-IPO performance of firms. Firms that go public during the crisis years achieve on average high positive abnormal returns in the three years after issuing, while firms that go public in non-crisis years are found to have negative abnormal returns. The analysis identifies differences in investor optimism and herding behaviour in the two periods as the key factor in explaining stock price performance. According to the Efficient Market Hypothesis (EMH), which rose to prominence as a theory through the works of Fama (1965) and Samuelson (1965), stock prices reflect all relevant information about the firm, thus stocks always trade at their fair value. In its semi-strong form, the EMH claims that prices adapt almost immediately to any new or additional information about a stock, and markets do not overreact or underreact to this new information. Reflecting on our results, we argue that our findings provide clear evidence that market efficiency assumptions do not hold for IPOs.

The rest of the paper is structured as follows: Section 2 reviews the previous literature regarding the identified IPO market phenomena. Section 3 presents the hypotheses that we wish to test. Section 4 provides a review of the competing methodologies in the literature, presents our chosen methodology and explains how we test our hypotheses. Section 5 details our process of data collection and describes the dataset. Section 6 presents the results of our statistical tests and analyses our findings and their economic implications. Section 7 presents our conclusions and areas of further research.

2. Theoretical Foundation and Previous Research

This section will more deeply examine the three IPO market phenomena relevant to the current study, namely underpricing, long-term underperformance, and the existence of hot and cold IPO markets. Within each subsection we review the main findings from the previous literature and the many competing theories that seek to explain them.

2.1 Underpricing

The pricing of IPOs has been extensively researched, as the continued finding of positive first-day returns leads to a number of important questions about the behaviour of issuers, investors, and underwriters during and after the IPO process.

The interpretation of positive first-day returns will differ depending on how efficient one assumes the market to be. Assuming that the efficient market hypothesis holds in at least a semi-strong form, then the first day closing price will represent the true value of the firm's stock, as by then the market will have priced it correctly. If the stock achieved some positive returns in order to reach this closing price, the initial price not only represents underpricing, but also an undervaluation of the firm. If we relax the efficient market hypothesis to some extent, and believe as many proponents of behavioural finance do, that the market takes longer to correctly price a stock, then positive first day returns may not necessarily indicate initial undervaluation at the offering. This is because despite the initial rise, by the time the market correctly prices the security, the price may have fallen back to the offer price or even below. In this case the first day return would only represent underpricing (as a higher price could have been asked) and not undervaluation.

As detailed in Ritter and Welch (2002), the typical method of measuring IPO underpricing is to take the percentage difference between the offer price and the first day closing price, and thus it represents the first-day return for the newly listed stock. The simple calculation is as follows:

$$Underpricing = \frac{First\ day\ closing\ price - Offer\ price}{Offer\ price}$$

The first day closing price is an indicator of what value investors place on the firm: if it is higher than the offer price, then the IPO is considered to have been underpriced. Underpricing, then, is an indirect cost of going public that is borne by the issuing firm. It represents a wealth transfer from issuing firm shareholders to new investors, the magnitude of which has been proven to vary across IPOs depending on issue characteristics, market conditions, and underwriter reputation, among other factors.

The finding that IPO firms achieve positive initial returns, and therefore display a degree of underpricing, was first revealed by Ibbotson (1975) who found an average positive initial performance of 11.4%. Jenkinson and Ljungqvist (2001) compile 38 IPO studies across 35 countries, and find that, with the exception of tender offers in Great Britain, IPOs are underpriced in all markets. They do, however, conclude that the level of underpricing differs across markets, estimating that industrialised countries exhibit underpricing of around 15% while for emerging economies the phenomenon is far stronger at 60%. Loughran and Ritter (2004) find that, within the US market, the level of underpricing has changed over time. Beginning with relatively low underpricing of 7% in the 1980s, they document that the average level doubled in the 1990s before jumping to 65% during the Internet bubble years in 1999-2000. During the years 2001 to 2003 underpricing was seen to revert to a lower level of 12%.

2.1.1 Theories Explaining Underpricing

Having established that newly listed firms are on average underpriced, the literature seeks to explain this phenomenon, and a variety of theories have been developed. Most of these theories rely in some way on asymmetric information between the agents involved, be they the issuers, investors, or underwriters. Most of the theories are also not mutually exclusive and one may have a more significant explanatory role in some IPOs than others.

Adverse Selection Theory

Rock (1986) provides the first explanation for the existence of underpricing. He considers a market where investors can be grouped as either ‘informed’ with superior information to that of the issuing firm, or ‘uninformed’ with inferior information and random investing habits. Then, if the IPO price is below or reflects the true value of the firm, informed investors will crowd out the uninformed investors when a ‘good’ firm comes to market. Similarly, informed investors will withdraw from the market if they know that the offer price is above the true value. As a result, this causes a 'winner's curse' for the uninformed investors, who will only ever be allocated the least desirable new issues, and thus only ever break-even or make a loss. It is a so-called winner's curse for the uninformed investors because, if they get all the shares that they demand, it is because the informed investors do no want them (Ibbotson, Sindelar, and Ritter, 1994). They will soon choose not to participate in the IPO market and this will consequently lead to reduced demand for IPOs and some issuing firms being undersubscribed. In order to combat this then, firms must provide a discount upon issuing, i.e. underprice the stock, so that uninformed investors can at least break even.

Signalling

A number of theories of underpricing focus on signalling and its effect on the issue price. These theories begin with the assumption that the issuing firm has superior information about its true value than that held by investors and other uninformed entities. As a result, rational investors fear a 'lemons' problem, whereby only low-quality issuers will be willing to sell their shares at the average price. Allen and Faulhaber (1989) argue that, in order to distinguish themselves, the 'best' firms with the most positive prospects will benefit by underpricing their shares. This is because investors will know that only the best firms can afford to absorb the cost of such a signal and recoup it in the future in the belief that such action would be too costly for lower quality firms. By deliberately underpricing themselves, higher quality firms can signal their status to outside investors. Welch (1989) and Chemmanur (1993) present signalling models to support this, with the idea that high quality firms underprice themselves at the IPO in order to obtain a higher price at a future seasoned offering. Thus, the greater the level of underpricing, the stronger the signal of higher firm quality.

Similar to this is the practice of 'grandstanding' an IPO, whereby firms intentionally price their new issue below true value in order to achieve large first-day returns and the positive attention that follows. Through this strategy, firms can gain extensive media exposure and publicity while at the same time providing proof of their true value to investors. Gompers (1996) and Lee and Wahal (2004), among others, have shown the level of grandstanding to be higher for IPO firms backed by venture capital. Due to the publicity associated with high initial returns, grandstanding behaviour will allow Venture Capital (VC) firms to raise future capital more easily. Lee and Wahal (2004) show that future commitments of capital to VC firms are positively related to the first-day returns achieved by VC-backed firms.

IPO Allocations

Benveniste and Spindt (1989), Benveniste and Wilhelm (1990), Booth and Chua (1996), and Mello and Parsons (1998), among others, explain underpricing through models based on IPO allocations. Underpricing is one method to insure against under-subscription, and creating excess demand can allow the issuing firm some discretion in the allocation of shares to investors. The value lies in the fact that some shareholders are less desirable than others. In addition, it may be to the benefit of the issuing firm to disperse allocation among a greater number of investors so as to reduce the block size of new shareholdings (Brennan and Franks, 1997).

2.2 Long-term Performance of IPOs

Since Ritter (1991) and Loughran and Ritter (1995) first documented severe underperformance of IPOs in the long-run, the behaviour of stocks in the years following their initial offering has been widely researched and remains intriguing. Loughran and Ritter (1995) report that, in the five years following an IPO, shareholders typically earn a 16 per cent buy-and-hold return, while those holding shares in comparable size-matched firms, which have been listed for a considerably longer period, earn 66 per cent over the same timeframe. The authors interpret their findings as evidence that investors are too optimistic about the prospects of first-time issuers.

Similar results have been reported for IPOs in a number of other markets. Levis (1993) finds IPO firms in the UK to underperform by -23% three-years after issuing. Aggarwal, Leal and Hernandez (1993) analyse the IPO markets in Brazil, Mexico, and Chile, and report three-year underperformance of -47%, -19.6%, and -23.7% respectively.

2.2.1 Theories Explaining Long-Term Underperformance

A number of papers, including Ritter (1991), Loughran and Ritter (1995), Lerner (1994), Hirshleifer (2001), and Baker and Wurgler (2000), use behavioural theories in an attempt to explain underperformance subsequent to issuing equity. In contrast to the efficient market hypothesis, which states that stocks always trade at fair value, they suggest that stock prices periodically deviate from their fundamental value. Issuing firms and investment bankers are able to take advantage of these deviations and periods of overpricing by issuing stock to overly optimistic investors. The rest of this section is dedicated to an overview of the theories explaining long-term underperformance of IPO firms.

Excessive Optimism and Windows of Opportunity

One theory to explain the long-run underperformance of IPOs is based on the idea of excessive optimism amongst investors. It argues that the investors that are most optimistic about an IPO will be the buyers (see Miller (1977) and Ibbotson, Sindelar and Ritter (1994)). If the value of an IPO firm is particularly uncertain, the valuations of optimistic investors are likely to be far higher than those of the most pessimistic investors. However, there will be a narrowing of the divergence of opinion between optimistic and pessimistic investors, as more information on future performance becomes known. Consequently, as the marginal investor's valuation converges to the mean valuation, the market price will drop and in the long-run firms will be seen to underperform. Simply put, it would appear that investors overweigh the growth prospect of IPO firms, and underestimate mean-reverting trends in the long run. Daniel, Hirshleifer, and Subramanyam (1998) develop a theory based on investor overconfidence and the tendency of the market to overreact to new private information and underreact to new public information, while Rajan and Servaes (1997), Ljungqvist, Nanda, and Singh (2006), and Cornelli, Goldreich, and Ljungqvist (2006) conclude that long-term underperformance of IPOs is caused by the presence of over-optimistic and irrationally exuberant investors. Ritter (1991) and Loughran and Ritter (1995) lend their support to the *windows of opportunity* theory as an explanation for the poor aftermarket performance of IPO firms. The hypothesis is based on a prediction that excessive investor optimism and overvaluation of issuing firms is more likely in periods of high IPO volume. The implication is that high-volume periods should correspond with the worst aftermarket performance and lowest returns.

Teoh, Welch, and Wong, (1998) find that 'IPO underperformance is also positively related to the size of discretionary accruals in the fiscal year of the IPOs.' They argue that investors overvalue the new issues after misinterpreting the high reported earnings at the time of offering. When these high earnings cannot be sustained, investors are forced to revalue the firm downwards. This supports a theory whereby firms time their going public decision to coincide with abnormally high operational performance and obtain the highest possible initial valuation. Aggarwal and Rivoli (1990) also argue that high initial abnormal returns, and subsequent underperformance in the long-run, is due in some part to the failure of the aftermarket to be immediately efficient in valuing newly issued securities.

"Impresario" or Fads Hypothesis

The "Impresario" or Fads Hypothesis gives another explanation for the widely discussed long-run underperformance of IPO's. Within this theory, investment bankers are the impresarios, underpricing the IPO in order to create the appearance of excess demand (Shiller, 1988). The prediction is that the greater the level of underpricing, i.e. the greater the initial return, on the first day of trading, the greater the subsequent correction of overpricing and thus the lower the subsequent returns.

2.3 'Hot' and 'Cold' Issue Markets

A third anomaly of the IPO market that has been well documented is the existence of hot and cold issue markets. In other words, both the volume of new issues and the magnitude of first-day returns have been shown to be highly cyclical and subject to variation. In addition, whether a firm goes public in a hot or cold market has been proven to have some impact on subsequent long-term performance. Ibbotson and Jaffe (1975), and Ritter (1984) document the dramatic variation in issuance within the IPO market. Hot IPO markets are characterized by a high volume of offerings, high levels of underpricing and oftentimes oversubscription of offerings (Helwege and Liang, 2004). Cold markets, by contrast, are associated with low IPO volume, reduced underpricing, and a reduced tendency for oversubscription of offerings. Loughran, Ritter, and Rydqvist (1994) note that periods of high IPO volume tend to coincide with stock market peaks. Firms attempt to time their IPO to coincide with periods of high optimism and excessive valuations (Baker and Wurgler, 2000), with more firms going public when investor sentiment is high (Lee, Shleifer, and Thaler (1991).

The present study aims to identify the impact of the financial crisis years on the IPO market and in particular the aftermarket performance of IPO firms. As the crisis years and analogous bear market represent an extreme cold period at least in terms of IPO volume, the findings in this area of the literature are of particular relevance to the formation of our hypotheses. Within the IPO literature, a number of models and theories have been developed in order to predict how those firms that go public within hot or cold periods may differ. Although Helwege and Liang (2004) find that the characteristics of firms going public are actually unchanged across the two market types, we present some of these theories below.

Industry Differences

It has been observed that in hot periods of IPO activity, offerings may be concentrated within particular industries. A number of models take the view that the IPO process is particularly informative about the firm's industry, and thus firms within the same industry are incentivized to go public at the same time. This leads to the prediction that in hot markets it should be possible to observe industry clustering of IPOs. Benveniste, Busaba, and Wilhelm (2002) argue that when one firm goes public, other firms within the same industry learn about their own valuations. If firms learn that industry prospects are high, the costs of staying private will increase, and a number of those firms will go public also, leading to industry clustering.

Differences in Firm Quality

There is mixed evidence on the quality of firms that issue equity in hot or cold periods. Allen and Faulhaber (1989) predict a hot market when firms' expected profits increase, while Choe, Masulis, and Nanda (1993), looking at seasoned equity offerings, link new issues to the business cycle. These papers, then, associate hot IPO markets with higher quality firms. Loughran and Ritter (1995), and Lerner (1994), however, argue that hot market IPO firms are of lower quality because they appear to perform worse in the long run than firms that issue in cold markets. These papers acknowledge the existence of windows of opportunity, as described earlier, which allow managers to take advantage of over-optimism amongst investors.

3. Hypotheses

In order to achieve our research aims and analyse the impact of the financial crisis on the U.S. IPO market, and specifically the performance of IPO firms in the short and long-term, we formulate two hypotheses.

3.1 Underpricing

We set up two competing arguments for the effect of the crisis on underpricing: i) provides a theory for underpricing being lower, while ii) provides a theory for underpricing being higher during the crisis years.

i) Rock (1986) argues that uninformed investors suffer from a winner's curse and firms must provide a discount through underpricing in order to keep them in the market and avoid a reduction in demand. During the financial crisis retail investors have less cash and so the number of active, uninformed investors is reduced, thus the proportion of active investors within the market that are informed is higher. As a result, the need for firms to provide a discount is lower, resulting in less underpricing.

ii) An alternative take on the adverse selection theory proposed by Rock (1986) yields an opposing conclusion. The theory states that uninformed investors suffer from a winner's curse and firms must provide a discount through underpricing in order to keep them in the market and avoid a reduction in demand. During the financial crisis retail investors have less cash and thus will either become inactive or require a higher return in order to remain in the market. Firms will then have to more aggressively underprice their stocks in order to keep demand high. In addition, the signalling effects may be stronger and the practice of grandstanding an IPO may take on a more significant role during the crisis. Firms going public during a bear market, and knowing the low level of investor confidence, will recognize the benefits of sending a strong signal to the market by way of achieving high initial returns. This is also in line with the impresario hypothesis whereby investment banks will underprice IPOs in order to create the appearance of excess demand – an appearance that may be of particular value during a crisis. Thus, there will be a high incentive to set a low offer price, and underpricing will be seen to increase.

Hypothesis 1: The level of underpricing will be ***different*** *during the crisis years of 2008 and 2009 than in non-crisis years.*

3.2 Long-term Performance

Similarly to our hypothesis 1, we set up two competing arguments for the effect of the crisis on long-term performance: i) provides a theory for long-term performance being higher, while ii) provides a theory for long-term performance being lower during the crisis years.

i) A number of theories combine to suggest that the long-term performance of firms going public during the crisis years of 2008-2009 will be better than that of firms going public in non-crisis years. One theory proposed by Ibbotson, Sindelar, and Ritter (1994) that seeks to explain the observed long-run underperformance of IPOs is based on the idea of some investors being excessively optimistic about an IPO firm's prospects. These optimistic investors will be the buyers of the stocks and their valuation of the company will be far higher than the valuation held by more pessimistic investors. The theory states that in time after going public, the divergence of opinion between investors will narrow, as more information on future performance becomes known. The market price will fall as the marginal investor's valuation converges to the mean valuation. During the crisis years, however, the level of optimism can be expected to be significantly lower than in non-crisis years, as overall investor confidence is reduced. As a result, even for IPO firms with uncertain valuations during the crisis, the divergence in valuation between optimistic and pessimistic investors will be less than in non-crisis years, and any consequent mean-reversion in the years after going public will be much less. Thus, long-term stock performance of firms going public during the crisis will be better, caused by initially relatively lower prices.

In line with the above theory, when non-crisis years foster excessive optimism amongst investors, windows of opportunity emerge for managers to take their firm public. As a result, some 'worse' firms can take advantage of the excessive optimism and general overvaluation. During the crisis, no such windows exist, as optimism is very low, thus worse firms are unable to go public and the average quality of IPO firms is higher. A set of firms with higher average quality should perform better against some form of benchmark in the long run.

ii) Using similar arguments to those outlined 3.1 ii), it may be expected that the level of underpricing will be higher during the crisis years. If initial performance is abnormally high in the short-run then in the long-run we may expect to see worse returns as the subsequent mean-reversion of the stock price will be more extreme. An additional theory for worse long-term performance of crisis IPOs is that stocks of newly public firms may be less frequently traded as risk averse investors with less cash seek to avoid investing in firms with little or no trading history. As a result, the stock performance of newly listed firms will suffer.

Hypothesis 2: Three-year buy-and-hold abnormal returns will be ***different*** *for firms that go public during the crisis years of 2008 and 2009 than for firms that go public in non-crisis years.*

4. Methodology

In this section we first explore best practises in the existing literature to measure abnormal returns. In the second part we explain in detail the methodology we apply. Section 5, which follows, then describes the specific dataset that we use to test our hypotheses.

4.1 Methodology Within the Literature

As discussed in Section 2, the standard measure of underpricing is equal to the calculation of first day returns, and as such there is little need for additional explanation. There is, however, considerable variation within the literature when it comes to the methods implemented to measure long-run abnormal returns. Barber and Lyon (1996) 'analyse the empirical power and specification of test statistics in event studies designed to detect long-run (one to five-year) abnormal stock returns.' Brav and Gompers (1997) and Kothari and Warner (1997) also argue that the size and power of statistical tests is largely dependent on the choice of performance methodology. Using their findings and other best practices found in the literature, the first part of this section explores in more detail the various merits and issues relating to the different methods.

4.1.1 Measuring Performance

Defining R_{it} as the raw return of a sample firm in month t and $E(R_{it})$ as the expected return for the sample firm in month t, monthly abnormal return is calculated as:

(1) $$AR_{it} = R_{it} - E(R_{it})$$

Where $E(R_{it})$ is given by the chosen benchmark. In this study this is either 1) the equally weighted return of a portfolio of companies matched on observable characteristics, or 2) the return of a single control firm matched on observable characteristics.

Cumulative abnormal returns (CARs) are then calculated by cumulating across τ periods:

(2) $$CAR_{i,\tau} = \sum_{t=1}^{\tau} AR_{i,t}$$

A second measure of abnormal returns is through the calculation of buy-and-hold abnormal returns (BHARs). BHARs measure the total return from a buy-and-hold strategy, from the purchase date until the end of the measurement period. The calculation is as follows:

(3) $$BHAR_{i,\tau} = \prod_{t=1}^{\tau}[1 + R_{it}] - \prod_{t=1}^{\tau}[1 + E(R_{it})]$$

Barber and Lyon (1996) find that various biases and sample misspecifications have different impacts on the test statistics yielded by either cumulative abnormal returns or buy-and-hold abnormal returns. While for CARs the effect is positively biased test statistics, BHARs yield negatively biased test statistics. Barber and Lyon (1997) argue that CARs can lead to incorrect inferences regarding long-horizon return performance, and as such advocate the use of buy-and-hold abnormal returns. Lyon, Barber, and Tsai (1999) further confirm that the use of BHARs is most appropriate if the research focus is on abnormal returns earned by a sample of firms over a particular horizon of analysis. It is with this in mind that we take the BHARs as our measure for the purpose of testing our hypotheses and analysing our results.

4.1.2 Benchmarking Performance

As abnormal returns are calculated by finding the difference between individual firm returns and their expected return, a well-specified benchmark is fundamental to the analysis of IPO firm performance. Barber and Lyon (1996) empirically evaluate the performance of different approaches to developing benchmarks for long-term stock returns. They find that when a reference portfolio, such as a market index, is used to calculate abnormal returns, test statistics are misspecified. On the other hand they demonstrate that by matching sample firms to control firms based on some observable characteristics, the same misspecifications can be corrected.

There are three sources of misspecification that can be identified in the use of reference portfolios such as a market index for calculating abnormal returns. The *new listing bias* occurs when the long-term return of the benchmark portfolio, or market index, includes newly listed firms. While the sample of IPO firms is tracked for a long post-IPO period, the market index or reference portfolio may include firms that have gone public subsequent to the IPO month (Barber, Lyon and Tsai, 1999). By matching with a benchmark portfolio that does not exclude subsequent new listings, abnormal returns of sample firms would be biased upward. This is because new listings tend to have lower returns than other stocks with longer trading histories, and thus their inclusion in the benchmark portfolio would lower the benchmark returns.

The second identified bias is the *rebalancing bias,* which arises when using an equally weighted market index as a benchmark portfolio. The compound returns of such an index are typically rebalanced monthly. The returns of individual sample firms, however, are calculated without rebalancing. The effect is to push upward the long-term benchmark returns, which then biases the measure of abnormal returns for sample firms downward.

Lastly there exists a *skewness bias,* which arises due to the fact that long-run abnormal returns are positively skewed (Barber and Lyon, 1996). While it is rare to observe a return on the market index of greater than 100%, it is common to observe such returns for a sample firm. As such, and due to the fact that abnormal returns are calculated by subtracting the market return from the sample firm return, abnormal returns are positively skewed.

Barber and Lyon (1997) show that abnormal returns calculated by creating matched portfolios or using the control firm approach eliminate the new listing and rebalancing biases. By matching each sample IPO firm with a portfolio of similar listed firms, it is possible to eliminate the new listing bias, since it can be ensured that firms in the matched portfolio have been listed for at least five years prior to the IPO in question. It is also possible to eliminate the rebalancing bias, as neither the sample firm returns, nor those of the matched portfolio, are calculated with rebalancing. The matched portfolio approach is also capable of significantly reducing the level of skewness bias, however in order to completely overcome this misspecification it is necessary to benchmark sample firms with a single control firm. The use of a single control firm as a benchmark eliminates the skewness bias, as the sample and control firms are equally likely to experience large positive returns.

Despite these findings, Barber and Lyon (1997) demonstrate that standard tests based on the reference portfolio approach have greater power than those based on the control firm approach. This is due to the fact that the use of control firms is a noisier way of controlling for expected returns, and the power of the test is reduced by this additional noise. This can be seen by the fact that the variance of the difference between a single security's return and the return of a portfolio is generally much lower than the variance of the difference between the returns of two individual securities (Markowitz, 1952). Thus, even if the control firm is well specified, large samples are required in order to yield powerful tests.

Benchmarking against a single control firm is the preferred method highlighted in the analysis of Barber and Lyon (1997), as it fully eliminates the skewness bias, and we therefore include this approach in our analysis in order to further test the strength of our results. Our foremost method, however, is the matched portfolio approach, which eliminates the new listing, rebalancing, and to a large extent, skewness biases, while also giving increased power of the test due to the reduction in the variance of the measure of abnormal return.

In light of the many considerations that must be made in measuring long-term abnormal stock performance, we take the lessons from the literature and use them to develop our methodology for testing our hypotheses. The rest of this section explains in detail the methodology that we apply.

4.2 Applied Methodology

In order to evaluate the long-term performance of initial public offerings previous studies in the literature take either a three or five-year period for measuring returns, with little argument to suggest a preferred length of the post-IPO window. In line with Ritter (1991) we evaluate performance over the three years following an IPO, and are thus able to take a first look at firms that went public from 2003 until the end of 2010. We are thus able to analyse IPO activity throughout the financial crisis of 2008-2009 and during one year post-crisis. Basing our approach and methodology on the findings of Barber and Lyon (1996), and (1997) and other best practices found in the literature, we implement a similar methodology to that of Ritter (1991), and Loughran and Ritter (1995), among other studies.

We use buy-and-hold abnormal returns (BHARs) to measure the abnormal returns, and two approaches to benchmark performance: 1) the return on a matched portfolio of firms based on observable characteristics, and 2) the return of a single control firm matched on observable characteristics. We follow the literature and match IPO firms with US listed companies sharing similar observable characteristics at the time of the IPO. We base the criteria used to match firms on Lie (2001), using market size, industry, book value of assets and return on assets (ROA). We require a matching procedure that is precise while avoiding a considerable loss of observations.

For the reasons outlined in the first part of this section, our primary and preferred method is to measure three-year buy-and-hold returns for IPO firms and benchmark performance against matched portfolios of control firms rather than a single control firm approach. This methodology is used for the testing of our hypotheses and the majority of our analysis.

We compute three-year buy-and-hold returns using monthly prices from The Center for Research in Security Prices (CRSP). In order to avoid a survivor bias in our sample, we retain all IPO firms, regardless of whether or not they delist before the end of the three-year measurement period. If a firm delists prior to the end of the period, the buy-and-hold abnormal return at that point in time is computed as the three-year return. This is because, at the point of delisting, investors would be able to switch their investment from the IPO firm to the matched portfolio and achieve normal returns (no abnormal returns) for the remainder of the period.

Thus, our measurement of buy-and-hold returns for the three-year period represents the total return from a buy-and-hold strategy where a stock is purchased at the end of the day of its initial listing and held until the earlier of (i) 36 months, or (ii) its delisting.

4.2.1 Matching Procedure Details

We create for each IPO a portfolio with up to ten benchmark securities, each of which must fulfil our criteria. The criteria are structured as follows: Year of observation, minimum two-digit SIC code and the condition that a benchmark company has been listed for at least 5 years are ineluctable to be considered as a match. These three key criteria then ensure that all benchmark firms are, at the time of the IPO in question, within the same industry (at a minimum of the two-digit SIC code level) and have been listed for a long enough period so as not to be considered 'newly listed' themselves. Once these criteria are fulfilled we match market value, book value of assets, and ROA, normalizing each characteristic based on the matching sample. Although all matched firms must share the same two-digit SIC code as the IPO in question, in order to obtain greater precision, matches are made to the three-digit level where possible. An SIC dummy variable is created that penalizes matches for only being matched at the two-digit level. The weighted sum of the absolute value of the normalized deviations, together with the SIC dummy value, is minimized, whereby market value has the highest weighting and ROA the lowest. Applying a maximum cut-off value to ensure the quality of each match, we obtain an average portfolio size of 9.0, with an SIC 3-digit match in 67% of the cases. (See Table I in the Appendix for matching procedure statistics).

We calculate the buy-and-hold raw return of each control firm for the period of 1 to 36 months. The portfolio's buy-and-hold raw return then equals the equally weighted average. Then we apply the previously presented definitions for the calculation of BHARs. When matching sample firms with a single control firm, we simply select the closest match from the portfolio. This naturally leads to a match that is at least as precise as the portfolio firms on average.

4.2.2 Testing Our Hypotheses

In order to test the hypotheses that were formed and explained in Section 3 of this paper, we implement the chosen methodologies on our dataset and run a number of statistical tests. The time window that we chose to test the impact of the crisis on the stock performance is based on a retrospective look at the IPO activity. Although the beginning of the wider financial crisis may be tracked back to August 2007, in our analysis we define the crisis period as the years 2008-2009. By looking at the monthly IPO activity we identify these years as most affected by the crisis. While the last months of 2007 still consist of hot months, with October, November and December each bringing 14,16, and 11 companies public respectively, the activity drops rapidly thereafter. From January 2008 throughout the end of 2009 there are never more than 4 IPOs per month with the exception of November 2009, when a first positive trend appears in the IPO activity. The trend clearly persists from the beginning of 2010 and hence we chose January 2008 to December 2009 as the crisis period. Figure I in the Appendix shows the monthly IPO activity.

The remainder of this section describes the regressions and statistical tests that we use and how they relate to the hypotheses. In our regression analysis we control for the overall level of IPO volume at the time of a firm going public, by including whether the firm went public in a hot or cold period. We define hot and cold periods, and create dummy variables for each, following the procedure applied by Helwege and Liang (2004).[3]

Underpricing

Let U_i denote the first day returns (level of underpricing) for IPO firm i. Our variable of interest is $Crisis_I$, a dummy variable denoting whether or not a firm went public during the crisis. In order to reduce the omitted variable bias we control for observables by including the following covariates: $Post_i$ is a dummy variable denoting whether or not a firm went public after the crisis, $MktCap_i$ is the firm's market capitalization (in $bn) immediately after the IPO, $Assets_i$ is the firm's total assets (in $bn) at the end of the fiscal year relating to the IPO date, ROA_i is the firm's return on assets at the end of the fiscal year relating to the IPO date, VC_i is a dummy variable denoting whether or not a firm is backed by venture capital at the time of going public, and $HotPeriod_i$ and $ColdPeriod_i$ are dummy variables denoting whether or not a firm went public during a hot or a cold period respectively. α_i is the constant. ε_i is the residual. The equation includes no time index due to the fact that there is only one observation per firm. In order to correct for heteroscedasticity and the lack of normality in our sample, we run our regression models estimating the standard errors using the Huber-White Sandwich Estimator (hereafter 'robust' standard errors). This method is widely acknowledged and based on initial research by Huber (1967). We use student t-statistics to reject or accept our hypotheses.

Then, in order to test our hypothesis regarding the level of underpricing, we run the following regression:

$$U_i = \alpha_i + \beta_1 Crisis_i + \beta_2 Post_i + \beta_3 VC_i + \beta_4 ROA_i + \beta_5 MktCap_i + \beta_6 Assets_i + \beta_7 HotPeriod_i + \beta_8 ColdPeriod_i + \varepsilon_i$$

[3] Over our sample period we count the number of IPOs for each month and rank each month accordingly. The months in the top quartile are considered hot months and the months in the lowest third are cold months, with those in between ignored for the purpose of this analysis. A hot period is then defined as a period with at least three consecutive hot months. The same applies for cold periods.

$$H_0: \beta_1 = 0$$
$$H_1: \beta_1 \neq 0$$

Hypothesis 1: The level of underpricing will be ***different*** *during the crisis years of 2008 and 2009 than in non-crisis years.*

Long-Term Performance

Then we test our hypothesis regarding three-year post-IPO performance. Let BHAR_i denote the three-year buy-and-hold abnormal returns for IPO firm i. All other variables are used as defined above, with the addition of *Underpricing$_i$*, which is the first day return for firm i. We run the following regression:

$$BHAR_i = \alpha_i + \beta_1 Crisis_i + \beta_2 Post_i + \beta_3 VC_i + \beta_4 ROA_i + \beta_5 MktCap_i + \beta_6 Assets_i + \beta_7 HotPeriod_i + \beta_8 ColdPeriod_i + \beta_9 Underpricing_i + \varepsilon_i$$

$$H_0: \beta_1 = 0$$
$$H_1: \beta_1 \neq 0$$

Hypothesis 2: Three-year buy-and-hold abnormal returns will be ***different*** *for firms that go public during the crisis years of 2008 and 2009 than for firms that go public in non-crisis years.*

5. Data

The initial sample includes all US IPOs completed between January 1, 2003 and December 31, 2010 as reported by Thomson Financial's Securities Data Company (SDC) database. The starting date for the period was selected with the intention of analysing the US IPO market from a point sufficiently distant from the dot-com bubble that characterized the stock market in the late 1990s and early 2000s. In order to measure three-year post IPO performance, with pricing data up to the end of 2013, the end date for the period is naturally limited to 2010. Following a similar approach to that implemented in other studies such as Ritter (1991) and Helwege and Liang (2004), we exclude all unit offers, spin-offs, closed-end funds, Real Estate Investments Trusts (REITs) and financial firms as described by SDC. IPOs with an offer price of less than $1.00 are also removed from the sample.

From SDC we obtain identifying information such as company name and CUSIP, as well as the SIC code, nation of origin and date of issue. For each IPO we also obtain the offer price, first day closing price, market capitalization after the offering, and a VC flag that identifies whether or not a company is backed by a venture capital firm at the time of the IPO.

For each IPO firm with a matching CUSIP in the Compustat database, we then retrieve data on total assets and net income for the fiscal year relating to the IPO year. A small number of firms with insufficient data, either relating to the IPO or necessary for the matching procedure, were removed from the sample. Trading price histories are obtained from the Centre for Research in Security Prices (CRSP). The resulting dataset is a sample of 588 IPO firms used for the analysis of underpricing. Where matching quality could not be assured, some firms are removed, resulting in 570 IPOs for the long-term performance analysis. The average number of observable months for our IPO firms is 33.4, with 81.6% of firms remaining listed for the entire 36-month period.

The creation of a second dataset is required in order to formulate the matching portfolios as a benchmark for abnormal stock price performance. We retrieve annual data for all US listed companies from the merged CRSP/Compustat database for the period 2003 to 2013. For each company we obtain company name, CUSIP, market value, net income, total assets, and to some extent IPO date. For those companies with no visible IPO date, we use a proxy from the CRSP/Compustat database, namely the 'First Effective Date of Link Variable Name' (LINKDT). This allows us in the portfolio matching procedure to ensure that IPO firms are not matched to a US listed firm that has only gone public itself within the five years prior to the IPO in question. Companies for whom market value, total assets, or net income data are missing are removed. Lastly, we winsorise the top and bottom 0.5% of all observations for each of market value, total assets, and return on assets independently. This allows us to obtain a more accurate mean and standard deviation for the use in the matching procedure. The result is 58,893 data years that can be matched to the IPO firms.[4] Trading price histories are again obtained from CRSP.

[4] 7,809 different US listed companies contribute to this aggregate total of data years.

6. Results and Empirical Analysis

We begin with descriptive statistics illustrating the nature of IPO activity across the measurement period. We then turn to the tests of our hypotheses regarding underpricing and long-term performance. We report the empirical results and refer to the relevant theories in order to analyse and explain our findings while considering their wider economic implications.

6.1 IPO Activity – Descriptive Statistics

Analysing IPO activity over the years 2003 to 2010 we find that the number of IPOs is not evenly distributed over the period. The value of IPOs, measured by average proceeds, as well as the size of firms going public, measured by average market capitalization, are also seen to fluctuate over the period. Closer inspection, by looking at the median market capitalization of IPO firms in each year, shows firm size to fluctuate to a lesser degree, indicating that in some years the average is affected by a small number of very large firms. Issuance clearly varies with the economic cycle, and the financial crisis years of 2008-2009 are characterized by significantly reduced IPO activity. The 12 IPOs in 2008 account for only 1.34% of the total proceeds across the entire period, while in the previous year we see the peak in IPO volume with 119 new issues in 2007. The average size of deals in 2008 is seen to be particularly small at $152m. Also worth noting is the high average money left on the table in 2009. Money left on the table can significantly impact on potential wealth gains as essentially the shareholders of the issuing firm could have sold fewer shares at a higher price in order to raise the same amount of capital, resulting in greater retention of ownership, or a lesser number of shares at a higher price, in order to raise more capital. The level of money left on the table in 2009 is thus an indication of the increased cost of going public during the crisis. Table II shows the IPO sample statistics for each individual year, as well as the average over the crisis and non-crisis period.

Table II
IPO Sample Activity

The table presents results for the initial performance of our sample of IPO firms, for all years. For each year we report the number of IPOs (and the average per period in brackets), average and aggregate proceeds, and average and aggregate money left on the table and average and median market capitalization after the offering. Proceeds are defined as the number of shares issued multiplied by the offer price. Money left on the table is defined as the difference between the offer price and first day closing price, multiplied by the number of shares sold. The *total averages* are the equally weighted average of the years' equally weighted averages.

Cohort Year	Number of IPOs, (Average)	Average Proceeds ($m)	Aggregate Proceeds ($m)	Average Market Cap ($m)	Average Money Left on Table ($m)	Aggregate Money Left on Table ($m)	Average Market Cap ($m)	Median Market Cap ($m)
2003	27	129.4	3494.1	1519.9	18.4	497.4	1519.9	335
2004	117	157.1	18376.2	2476.1	18.5	2169.5	2476.1	310.3
2005	90	198.5	17863.9	631.6	19.6	1763.8	631.6	392.15
2006	105	173.6	18229.1	739.2	17.3	1819.8	739.2	342.8
2007	119	180.5	21483.1	1047.0	28.3	3364.4	1047.0	433.4
2008	12	152.0	1824.1	593.8	16.2	194.5	593.8	422.55
2009	33	308.0	10163.6	1850.0	53.1	1753.6	1850.0	724.9
2010	85	326.7	27772.5	1990.1	23.7	2016.9	1990.1	477.9
Total	*Aggregate*	*Average*	*Aggregate*	*Average*	*Average*	*Aggregate*	*Average*	*Average*
Non-Crisis	543 (91)	194.3	107219.0	1400.7	21.0	11631.9	1400.7	381.9
Crisis	45 (22)	230.0	11987.7	1221.9	34.7	1948.1	1221.9	573.7
Overall	588 (74)	203.2	119206.8	1356.0	24.4	13579.9	1356.0	429.9

6.2 Underpricing

In order to measure the effect of the crisis on underpricing and test our first hypothesis, we run the regression $U_i = \alpha_i + \beta_1 Crisis_i + \beta_2 Post_i + \beta_3 VC_i + \beta_4 ROA_i + \beta_5 MktCap_i + \beta_6 Assets_i + \beta_7 HotPeriod_i + \beta_8 ColdPeriod_i + \varepsilon_i$ on the 588 IPOs. We control for the impact of venture capital backed IPOs, return on assets, market capitalization, total book value of assets, and through the use of dummy variables for hot and cold periods, the overall level of IPO activity.

Testing the Hypothesis

The results show that the coefficient for the crisis dummy figures at 5.2% and is statistically not significantly different from zero. The constant is statistically significantly greater than zero at a level of 1% and figures at 8.2%. (See Table III in the Appendix for full results).

Hypothesis 1 $H_0\colon \beta_1 = 0$ cannot be rejected at any reasonable level. The p-value figures at 0.309

Our results thus show that statistically there is no significant difference in underpricing between the crisis and non-crisis years.

6.2.1 The Non-Crisis Period

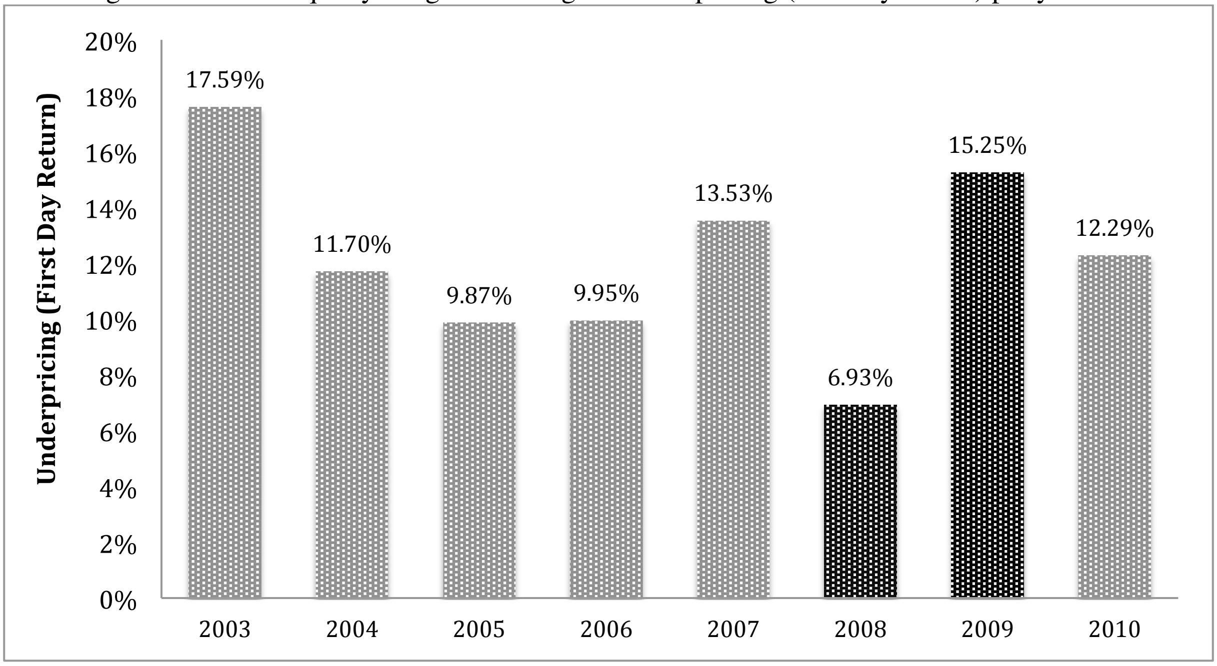
Looking separately at the non-crisis years, defined as 2003 to 2007, and 2010, we find evidence of underpricing and that the average level is 12.49%[5]. The observation that the phenomenon persists during these years is not a surprising one, and our results show that in terms of factors relating to underpricing, these years display no extraordinary differences and are largely in line with the findings of Ibbotson (1975), Loughran and Ritter (2004), and Jenkinson and Ljungqvist (2001) among others.

6.2.2 The Effect of the Crisis

We then investigate in more depth the difference between underpricing in the non-crisis and the crisis years. The estimated coefficient $\hat{\beta}$ is positive and on average, ceteris paribus, an IPO during the crisis is 5.2% more underpriced (see Table III in the Appendix). This stands in favour of our argumentation that retail investors have less cash at hand and require a higher return to participate in the offer. Newly issuing firms thus have to more aggressively underprice their stocks, and initial returns are seen to be greater. Despite the lack of a statistically significant difference between the crisis years and the non-crisis years, looking at the two crisis years individually does suggest that some mechanisms may have been acting on the IPO market during the years 2008 and 2009 to affect the level of first day returns. Underpricing in 2008 is seen to be at the lowest level of the whole period at 6.93%, however in the second half of the crisis, 2009, we observe average underpricing of 15.25%, which is higher than all but one year of our overall sample. Thus, it is not immediately obvious how the mechanisms of the crisis may have impacted on underpricing. Figure II exhibits these results graphically.

[5] The average is the equally weighted average of the equally weighted average per year of our sample

Figure II
Underpricing of IPOs
The figure shows the equally weighted average of underpricing (first-day-return) per year of IPO.



6.2.3 The Impact of Firm Characteristics

Adding to our analysis, we look at the impact of the four firm-characteristic control variables over the entire period (all results in Table III in the appendix). Of these, the VC dummy and the return on assets are statistically significantly different from zero, at a level of 1% and 5% respectively. The coefficient for the ROA is however, very low, as for 1% more in ROA a company's expected first day returns will increase by only 0.03%. Venture capital backing, on the other hand, appears to play a more predominant role. Across the entire period, an issuing firm backed by a venture capitalist results, on average, in 7.9% more underpricing. This is contrary to the empirical findings of Megginson and Weiss (1991). One explanation for our results is the practice of grandstanding an IPO whereby the venture capitalist influences the IPO issue price downward in order to achieve high first day returns and consequently gain greater publicity and media exposure. See Lee and Wahal (2004) for a detailed study of this theory.

In order to deepen our analysis of the effect of the crisis we look to identify whether these firm-specific characteristics differ between firms that go public in crisis or non-crisis years.

We report averages for both periods and run separate regressions for the variables VC, Market Capitalization, Book Value of Assets, and ROA as dependent variable and the crisis dummy as explanatory variable. These simplistic regressions aim to detect whether there are statistically significant differences between the crisis and the non-crisis years. (See Table V for regression results and Table VI for averages, both in the Appendix). The results show interesting differences between the two periods for the level of venture capital backing. Venture capital-backed companies represent a lower proportion of all IPOs during the crisis. Only 31% are VC backed during the crisis years, compared to 49% during the non-crisis years. As suggested by Brav and Gompers (1997), and Lerner (1994b), these results show that venture capitalists may try to time the market in order to take firms public at stock market peaks. Over the whole period, venture capitalist backing has the effect of increasing underpricing by 7.9%, which represents more than 50% of the total average underpricing. This means that on average a venture capital backed IPO has a first day return more than twice as great as a non-venture capital backed IPO. It could be expected then, that the lower level of venture capital participation in the IPO market during the crisis years would contribute to a reduction in underpricing. However, as discussed above we find slightly higher underpricing during the crisis as a whole. Thus, there must be other forces acting on the level of underpricing and pushing it higher during the crisis period.

Our results and the different levels of underpricing observed in 2008 and 2009 (first 6.93%, then 15.25%), support a story whereby in the first half of the crisis, uninformed investors fled the IPO market, while venture capital firms held back from taking their portfolio companies public, leading to a reduction in underpricing. As uninformed investors gained some confidence and returned, although with caution in 2009, their requirement of higher initial returns forced the level of underpricing upward in the second half of the crisis.

6.3 Long-term Performance

In order to measure the effect of the crisis on the 36-month stock performance of IPO firms, we run the regression $BHAR_i = \alpha_i + \beta_1 Crisis_i + \beta_2 Post_i + \beta_3 VC_i + \beta_4 ROA_i + \beta_5 MktCap_i + \beta_6 Assets_i + \beta_7 HotPeriod_i + \beta_8 ColdPeriod_i + \beta_9 Underpricing_i + \varepsilon_i$ on the 570 IPOs. We control for the impact of venture capital backed IPOs, return on assets, market capitalization, total book value of assets, the overall level of IPO activity (using dummies for hot and cold periods), and the level of underpricing.

We report both the results from our method of benchmarking IPO firms against portfolios of up to 10 matched listed companies, and the results when we use only one control firm per IPO as a benchmark (see Table VII in the Appendix). It is important to note, that the results from the two methodologies largely agree with each other, and the same findings and trends are found with both. For the reasons explained in Section 4, for the purposes of forming our analysis, we mainly refer to the results obtained through the matched portfolio method of benchmarking.

6.3.1 Testing the Hypothesis

The results found through the portfolio matching methodology show that the coefficient for the crisis dummy figures at 38.2% and is statistically significantly different from zero (see equation (1) of Table VII in the Appendix). The single control firm approach results in a coefficient for the crisis dummy of 64.0%, also statistically significantly different from zero. We thus find very strong statistical significance in favour of our Hypothesis 3, that the long-term performance of firms that went public during the crisis is higher than the long-term performance of firms that went public in other years.

Hypothesis 2 $H_0: \beta_1 = 0$ can be rejected at a level of 5%. The p-value figures at 0.019

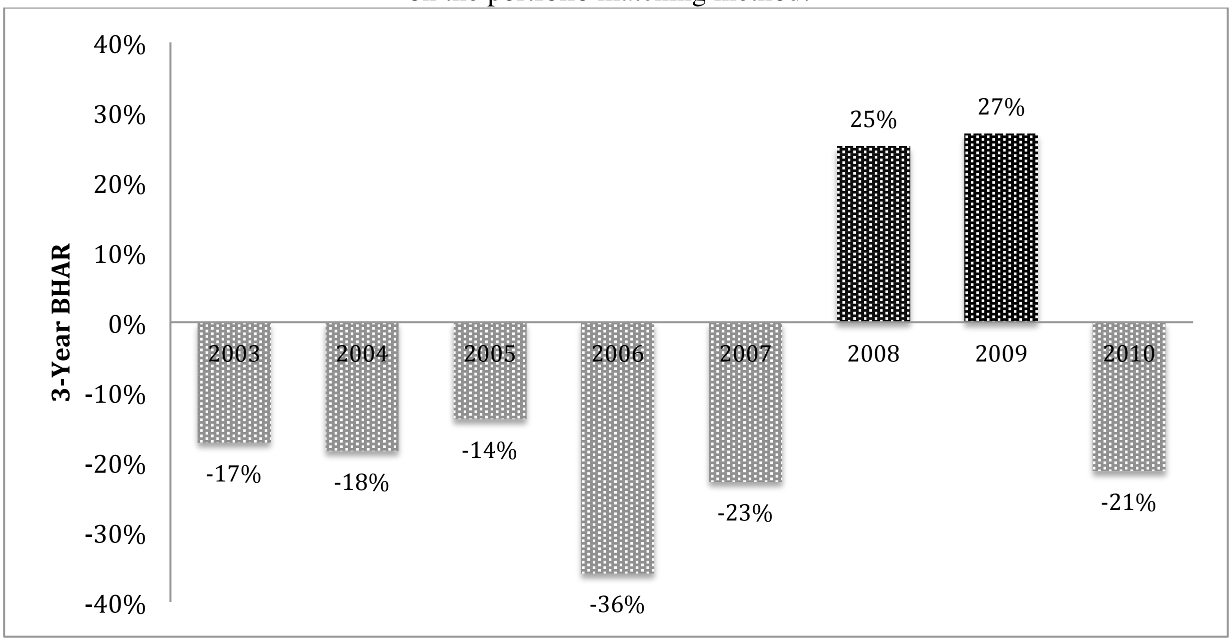
Economically, these results imply that in the three years after issuing, a company that went public during the crisis years of 2008 and 2009, on average and controlling for firm-specific characteristics, outperformed companies that went public during the years 2003 to 2007, and 2010, by 38.2%.

6.3.2 The Effect of the Crisis

Figure III displays the average three-year abnormal returns of IPO firms for each individual year, and visually confirms our statistical findings while illustrating the magnitude of the crisis effect. The three-year abnormal returns of IPO firms for the two crisis years 2008 and

2009 are positive at 25% and 27% respectively, which means that on average these firms outperformed the benchmark during the subsequent 3 years after the IPO. These results stand in stark contrast to the abnormal returns of all other years, which in accordance with the previous literature, are negative and hence display underperformance against the benchmark (Ritter (1991), and Loughran and Ritter (1995) for example). Over the whole period the average three-year BHAR for IPO firms is -13%. The average is +26%, and -22% in the crisis and non-crisis years respectively. Looking to see if the crisis may also have a lagged effect and cause post-crisis IPOs to perform differently to pre-crisis IPOs, we break the non-crisis years down into these subsets. We find there to be no statistical difference between the two (Table VII equation (1) in the Appendix), meaning that the significant impact on BHARs is contained to the crisis years. These findings are graphically illustrated in Figure III.

Figure III
Long-Term Performance of IPOs
Average over IPOs in each Year, 2003-2010
The table shows the average 3-year Buy-and-Hold-Abnormal Return (BHAR) per year of IPO, based on the portfolio matching method.



In formulating our Hypothesis 2, one argument was that firms that went public during the crisis years would achieve higher three-year buy-and-hold abnormal returns than newly issuing firms in other periods. Understanding that IPO firms are widely found in other studies to underperform in the three years subsequent to going public, one may have expected the limit to any such improvement to be that those crisis firms would merely underperform to a lesser extent. What is remarkable from these results, however, is that firms going public during the crisis exhibit higher three-year buy-and-hold abnormal returns to such an extent as to significantly outperform the benchmark. In fact, over a period of three years, crisis IPOs achieve on average an annual return of approximately 8%[6] higher than the benchmark firms.

6.3.3 The Effect of Underpricing on Long-Term Performance

One explanation in the literature for the commonly observed long-term underperformance of IPOs relies on the level of underpricing. Ljungqvist, Nanda and Singh (2006) suggest that firms with higher first day returns will on average perform worse in the long run. This is in line with the idea of excessively optimistic investors overvaluing issuing firms and causing high initial returns, before optimism abates and there follows a mean reversion of the firm value, leading then to a lower stock price and underperformance of the firm against the benchmark. Our results (see Table VII, equation (1) and (2) in the Appendix) show that over the entire period this relationship between underpricing and long-term performance appears to hold on average: A 1% increase in underpricing leads to a 1.17% decrease in BHARs with low statistical significance and a p-value at 11% when we use portfolio matching, while the single firm matching approach similarly shows a 1% increase in underpricing to result in a 2.0% decrease in BHARs, with a p-value of 2%. If we were to observe lower underpricing during the crisis years, this theory could then provide some explanation for the greater long-term performance of crisis IPO firms. However our earlier results with regards to underpricing found the level of first day returns to be around 1.5% higher during the non-crisis years, with figures of 11.1% and 12.5% during the crisis and non-crisis respectively. The theory would then imply that three-year buy-and-hold returns should be around 2% higher for these firms. Hence, in practice there is a minor effect of the underpricing on the long-term performance, it is however negligible.

By including the dummy variables for hot and cold periods, and thereby controlling for the overall level of IPO activity in the three months around each IPO, we can show that the effect of the crisis is not simply due to there being a low number of new issues during this period. The lack of significance for these dummy variables means that there are other factors

---

[6]The average initial 3-year abnormal return for IPOs during the crisis is 26.0%. The average annual return can be calculated as follows: $r_{1year\_return} = \left(1 + r_{3year\_return}\right)^{(1/3)}$.

related to the crisis period that can explain the higher long-term performance of crisis IPO firms. This finding supports our initial view that the crisis represents more than just a severe cold period.

6.3.4 The Impact of Firm Characteristics

Ruling out the level of underpricing and overall level of IPO activity as determining factors in the significantly higher long-term performance of crisis IPO firms, we deepen our analysis by looking at firm-specific characteristics and whether the firms that went public during 2008 and 2009 are significantly different in some observable way to those IPO firms in other years. Ritter and Welch (2002) state, “It is conventional wisdom among both academics and practitioners that the quality of firms going public deteriorates as a period of high issuing volume progresses.” Due to the reduction in investor demand for IPOs during the crisis, one could argue that only ‘good’ firms would be capable of issuing stock without being undersubscribed. Or from another angle, with investor optimism particularly low during the crisis, ‘worse’ firms that may be looking for a window of opportunity to go public will choose not to, given the market environment. From either direction the implication is the same: firms that go public during the crisis may be better in some way, and this would explain their high abnormal returns in the subsequent three years. One firm-specific characteristic that exhibits obvious differences between the crisis and non-crisis periods is the average return on assets (ROA). During the non-crisis years, newly issuing firms have average ROA of -3.86%, while during the crisis this is found to be even lower, at -13.15% (See Table VI in the Appendix). ROA provides an indicator of a firm’s operational performance and efficiency, and although it is necessary to be careful in comparing such measures, a higher ROA would generally be associated with better firm performance. Thus, the finding that crisis IPO firms had lower ROA on average does little to suggest that these firms are better than non-crisis IPO firms.

Another firm-specific characteristic worth examining more closely is the VC dummy, and whether firms backed by venture capital at the time of going public achieve higher long-term abnormal returns. Having found in our earlier analysis that the percentage of IPO firms backed by venture capital is only 31% during the crisis, compared to 49% in the non-crisis years, any effect of VC backing would be of interest. Our results show that on average and across the whole period, if a newly issuing firm is backed by venture capital, its three-year

BHAR will be 8.2% lower than a non-backed firm (see Table VII equation (1) in the Appendix). Although the effect is not proven to be statistically significant, the relationship is still noteworthy, and it could be that the lower participation of venture capitalists in the IPO market during the crisis years contributes to the improved average long-term performance of crisis IPOs.

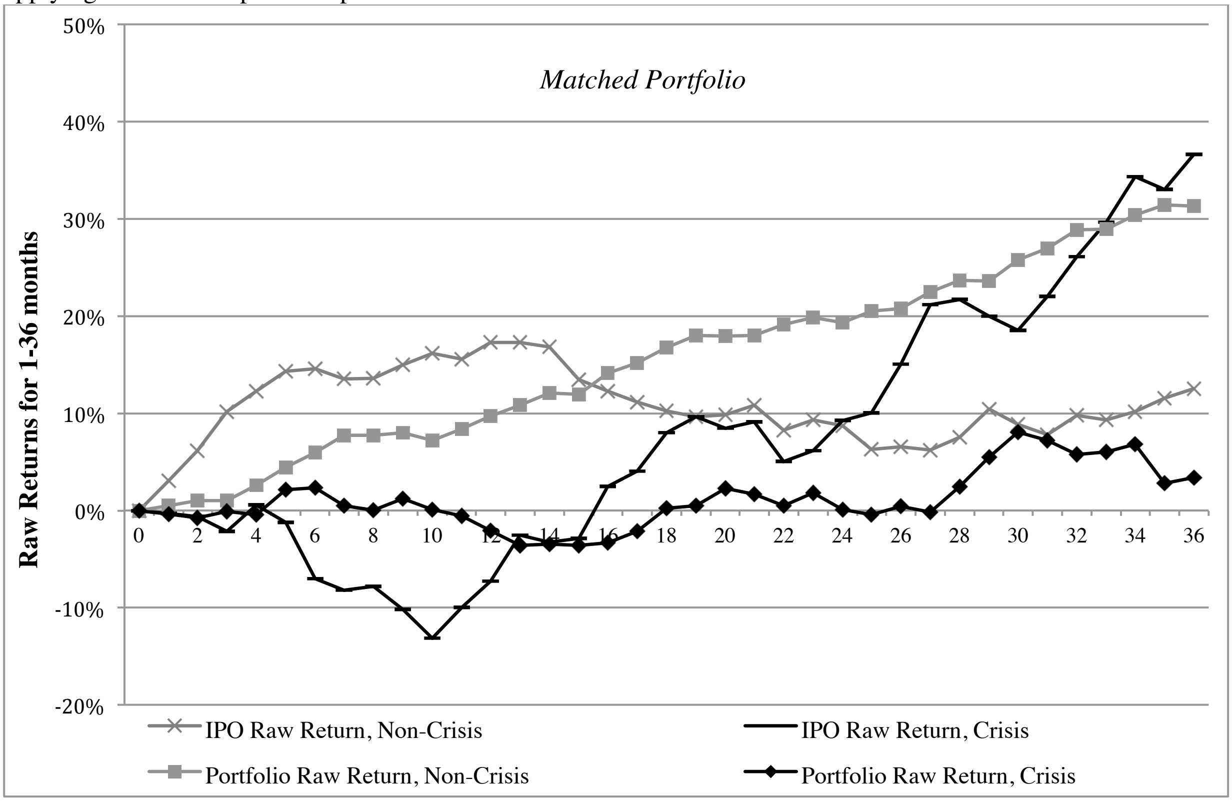
Other firm-specific characteristics are not found to have a significant effect on three-year buy-and-hold abnormal returns across the period. This is not particularly surprising given that our matching procedure aimed to control for these variables, and these results are a further indication that sample firms are well matched to the benchmark. Deepening our analysis, we look to see whether there are significant differences in the coefficients of these variables between the crisis and non-crisis periods (see Table VII, equation (3), (4), (5), and (6)). In other words, we look to see whether a variable that does not appear to affect long-term performance in non-crisis years, suddenly has an impact during the crisis. We find that most of the variables do not significantly affect long-term performance. One exception is the level of total assets. While in non-crisis years total assets at the time of going public are not shown to affect subsequent three-year performance, for firms that IPO during the crisis, a $1bn increase in total assets results on average in a 17.9% increase in long-term performance, with statistical significance at 1%. A potential explanation for this could be that companies with more tangible value and hence with a higher amount of assets on the balance sheet are less sensitive to the bear market conditions during the crisis than companies with more intangible value. In consequence, these companies have performed better during the crisis, while during non-crisis years this plays less of a role. This is further in line with the fact that the market capitalization is not statistically significant. However, we have to bear in mind that during the matching procedure, assets and industries have been controlled for and thus this argument must be considered with prudence.

6.3.5 The Significance of the Abnormal Returns

In further attempting to explain our results we acknowledge two opposing schools of thought in the research of long-term IPO performance. On one side stand the behavioural theorists arguing that investor optimism and sentiment cause any observed abnormal performance, and on the other side stand those arguing that abnormal performance is only observed as a result of poor benchmarking, and if returns are benchmarked correctly, IPO firms will be shown to in fact perform normally. This study stands within the first group, and after thorough considerations of which methodology to use, hopes to have avoided problems of poor benchmarking. In order to further test the quality of our benchmarks, we look at their raw returns. The raw returns for IPO firms and their benchmarks over the 36-month observation period are shown in Figure IV using the portfolio matching procedure and in Figure V in the Appendix applying the single firm match method. We observe clear linearity and a smoother trend in the benchmark returns; for the non-crisis period, the benchmark using either method shows a linear trend with the sort of returns one would perhaps expect on the stock market. The IPO firms in the non-crisis period however, do not follow the same trend in the development of their raw returns, and rather we observe high initial returns for the first months before returns begin to fall in month 14. Thus, it very much appears that the negative abnormal performance observed in non-crisis IPO firms is not due to a misspecification in the benchmark, and is in fact due to factors relating to the IPOs. When looking at the crisis period, we again see evidence of smoother trends in the benchmarks while the IPOs' performance has a clear non-linear pattern. We attempt to provide an explanation for this pattern in the text below.

Figure IV
Initial IPO Long-Term Performance

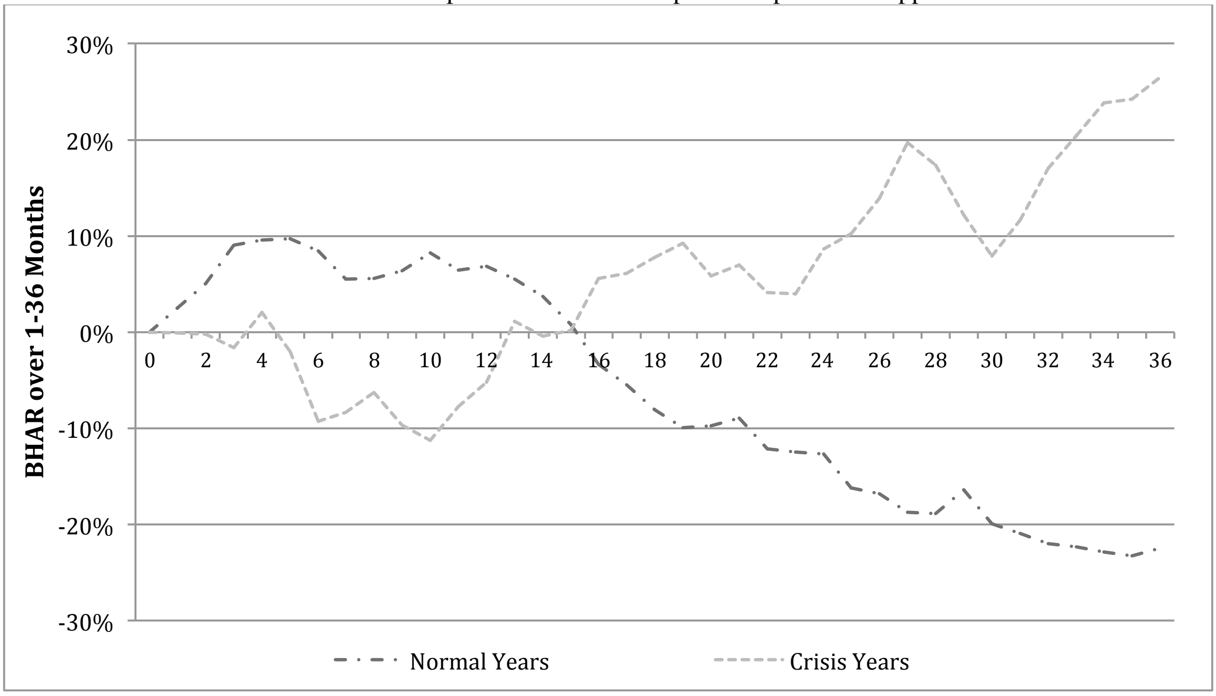
This figure shows the development of the raw buy-and-hold returns over the periods of 1 to 36 months when applying the matched portfolio procedure.



6.3.6 IPO Performance Pattern over 36 Months

In order to further understand our results we look at the development of abnormal returns over the three-year measurement period. We display the average BHAR for a monthly time span between 1 and 36 months. The comparison between crisis and non-crisis IPO firms is displayed in Figure VI. As touched upon in the text above we observe an interesting pattern for a number of reasons. Crisis IPO firms, although significantly outperforming the benchmark by the end of year three, do not begin to achieve positive abnormal returns until month 15. On the other hand, and with remarkable symmetry, non-crisis IPO firms are shown to outperform the benchmark at first, sustaining such performance for the first 15 months after going public, before falling into underperformance and negative abnormal returns. This observation lends support to the theory that excessive investor optimism and temporarily inefficient stock markets are key factors in explaining long-term stock price performance.

Figure VI
Initial IPO Long-Term Performance
3-year Buy-and-Hold-Abnormal-Return (BHAR) over 1 to 36 months
This figure shows the development of the buy-and-hold abnormal returns (BHAR) returns over the periods of 1 to 36 months for the non-crisis and crisis period. The matched portfolio procedure applies.



In ordinary, non-crisis years, the stock market is subject to periods of excessive investor optimism and subsequent overvaluation of newly issuing firms. These periods of market inefficiency create windows of opportunity for firms to go public. After a firm goes public in such a window, the stock price is pushed upwards by excessively optimistic investors overvaluing its growth prospects. Fearing missing out on a good investment, more investors gravitate towards purchasing the same stock, exhibiting herding behaviour and further raising the stock price. This explains the positive abnormal returns achieved by non-crisis firms for the first months after going public. Over time, however, and as the market learns more about the growth prospects and true value of the firm, optimism is reduced and the stock price begins to fall in comparison to the benchmark, and again, investor herding behaviour may create additional momentum and exacerbate this effect. On the other hand, firms going public during the crisis years have no available windows of opportunity to take advantage of, as investors remain relatively pessimistic about investments. Thus, in the first months after issuing, firms' growth prospects are not fully recognised and they are undervalued. As the market begins to learn more about the true value of the firm, however, investors recognise the opportunity of investing in the undervalued stocks and the stock price rises so as to outperform the benchmark and achieve positive abnormal returns. This last analysis strongly supports the argument that the market is not fully efficient, as defined by the semi-strong form of the Efficient Market Hypothesis, but rather driven by cyclical investor sentiment.

7. Conclusion

In this paper we study two prominent and persistent anomalies within financial economics by looking specifically at an extraordinary period of financial market activity. The phenomena of underpricing (positive first day returns) and subsequent long-term underperformance of IPO firms have been widely studied over a range of periods and variety of markets. The financial crisis and analogous stock market crisis of 2008-2009 is however, a rare and unique event, and one would argue that the two phenomena have never been studied under such market conditions. Requiring a three-year post-IPO window in order to measure long-term performance, we take the first available opportunity to study the performance of firms that went public from 2003 to 2010, including the unique event of the financial crisis and the immediate aftermath. Recognising the issues inherent in the study of abnormal stock returns, we measure stock price performance using buy-and-hold returns and implement two benchmarking methodologies that enable our analysis to overcome the main sources of misspecification. Taking the theory and results from the previous literature and applying it to our unique period, we form competing arguments for the impact of the crisis on stock performance. We test our hypotheses, that the crisis has an impact on both underpricing and long-term performance, on a dataset of 588 U.S. IPOs across the period 2003-2010.

Our results find the crisis period as a whole to not have a significant impact on the level of underpricing. However, when we break the crisis period down, we find some evidence that the extreme market conditions had an effect. In 2008 we observe very low, below average, underpricing of 7%, while in 2009 the level is much higher and above average at 15%. We argue that strong effects on underpricing developed over the course of the crisis period, with the fleeing of retail investors and venture capitalists from the market causing initial low underpricing, before their cautious return forced underpricing upward in 2009. Our results with regard to the impact of the crisis period on the subsequent long-term performance of IPO firms are much clearer. We find significant evidence that firms going public during the crisis have three-year returns between 38% and 64% higher on average than other IPO firms ceteris paribus. We argue that the key factor behind this result is the effect of investor optimism and herding behaviour on stock prices, and thus find evidence in opposition of the efficient market hypothesis. We find that the market should be more cautious in valuing the growth prospects of firms in normal non-crisis years, as initial over-optimism appears to lead to poor long-term performance. On the contrary, during the crisis investors within the IPO market overreact to the worse market conditions and initially undervalue newly issuing firms, leading to high growth of the stock in the long-term. The crisis of 2008-2009 is an extraordinary event, but the IPO market has been consistently proven to fluctuate over time and experience hot and cold periods of activity. In analysing such an extreme case, it is possible to shed light on changing investor behaviour and IPO performance in other periods of fluctuation. The results strongly support the argument that investor sentiment and herding effects, rather than efficient market assumptions, drive the stock performance of newly public firms.

The question of what IPO underpricing represents remains unanswered. Put simply, do we observe first day returns because the issue price was below the true value of the firm? Or are the first day returns a result of over-optimistic investors pushing the price up above true value? By valuing issuing firms through corporate valuation such as comparable firm multiples and discounted cash flow analysis, these questions could be better answered. It would also then be possible to further test our theory that investor over-optimism and subsequent herding behaviour is a key cause of the improved long-term performance observed in crisis IPOs.

Further research could look to go deeper into testing the idea that firms issuing during the crisis are inherently better in some way, and that this is the main reason for their higher long-term performance. This research could be conducted in a number of ways. More variables describing firm-specific characteristics at the time of going public could be studied, in order to better determine firm quality at the IPO date. Operational performance measures could be studied over the three-year post-IPO period in order to determine how closely the stock price movements of IPO firms are correlated to their own performance, and in doing so try to separate any investor sentiment effects from actual performance variations. Additional further research may look to study whether the crisis had similar effects in other stock markets. As this is the first study of this issue, it is important to replicate and test the results in different settings. The U.S. is the most developed stock market, and replicating the research in other developed stock markets around the world would be highly interesting. Equally enlightening would be to test whether the crisis had a different impact in less-developed economies. If, as we conclude, investor optimism and herding behaviour is largely responsible for the differences in long-term IPO firm performance, then cultural differences between stock markets may also lead to alternative results. We would also find it interesting to update the study in a few years time, so as to have a longer post-crisis period and thus better measure whether the effects of the crisis continue in the subsequent years. It could then be determined whether the two-year crisis period is a contained extraordinary event, or whether it has had a lasting effect on stock price performance in the IPO market.

References

Aggarwal, R., Leal, R., Hernandez, L. (1993). The aftermarket performance of initial public offerings in Latin America. *Financial Management*, 22(1), pp.42--53.

Aggarwal, R., Rivoli, P., 1990. Fads in the initial public offering market. *Financial Management*, (Winter), pp.45--57.

Baker, M. and Wurgler, J. (2000). The equity share in new issues and aggregate stock returns. *The Journal of Finance*, 55(5), pp.2219--2257.

Barber, B. and Lyon, J. (1996). Detecting abnormal operating performance: The empirical power and specification of test statistics. *Journal of Financial Economics*, 41(3), pp.359--399.

Barber, B. and Lyon, J. (1997). Detecting long-run abnormal stock returns: The empirical power and specification of test statistics. *Journal of Financial economics*, 43(3), pp.341--372.

Benveniste, L. and Spindt, P. (1989). How investment bankers determine the offer price and allocation of new issues. *Journal of Financial Economics*, 24(2), pp.343--361.

Benveniste, L.M., Busaba, W.Y. and Wilhelm, W. J. (2002). Information Ex- ternalities and the Role of Underwriters in Primary Equity Markets, *Journal of Financial Intermediation*, 11, pp.61--86.

Benveniste, L.M., Wilhelm, W.J. (1990). A comparative analysis of IPO proceeds under alternative regulatory environments. Journal of Financial Economics 28, 173-207.

Booth, J. and Chua, L. (1996). Ownership dispersion, costly information, and IPO underpricing. *Journal of Financial Economics*, 41(2), pp.291--310.

Brav, A. and Gompers, P. (1997). Myth or Reality? The Long-Run Underperformance of Initial Public Offerings: Evidence from Venture and Nonventure Capital-Backed Companies. *The Journal of Finance*, 52(5), pp.1791--1821.

Brennan, M. and Franks, J. (1997). Underpricing, ownership and control in initial public offerings of equity securities in the UK. *Journal of Financial Economics*, 45(3), pp.391--413.

Chemmanur, T. (1993). The pricing of initial public offerings: A dynamic model with information production. *The Journal of Finance*, 48(1), pp.285--304.

Choe, H., Masulis, R., N, and a, V. (1993). Common stock offerings across the business cycle: Theory and evidence. *Journal of Empirical Finance*, 1(1), pp.3--31.

Cornelli, F., Goldreich, D., Ljungqvist, A. and er, (2006). Investor Sentiment and Pre-IPO Markets. *The Journal of Finance*, 61(3), pp.1187--1216.

Daniel, K., Hirshleifer, D. and Subrahmanyam, A. (1998). Investor psychology and security market under-and overreactions. *the Journal of Finance*, 53(6), pp.1839--1885.

Fama, E. (1965). The behavior of stock-market prices. *Journal of Business,* 38(1), pp.34--105.

Franklin, A, and Faulhaber, G. (1989), Signaling by underpricing in the IPO market. *Journal of Financial Economics,* 23, pp.303--324.

Gompers, P. (1996). Grandstanding in the venture capital industry. *Journal of Financial economics*, 42(1), pp.133--156.

Helwege, J. and Liang, N. (2004). Initial public offerings in hot and cold markets. *Journal of Financial and Quantitative Analysis*, 39(03), pp.541--569.

Hirshleifer, D. (2001). Investor psychology and asset pricing. *The Journal of Finance*, 56(4), pp.1533--1597.

Ibbotson, R. and Jaffe, J. (1975). "Hot issue" markets. *The Journal of Finance*, 30(4), pp.1027--1042.

Ibbotson, R. G. (1975). Price performance of common stock new issues, *Journal of Financial Economics,* 2, pp.235--272.

Ibbotson, R., Sindelar, J. and Ritter, J. (1994). The market's problems with the pricing of initial public offerings. *Journal of Applied Corporate Finance*, 7(1), pp.66--74.

Jenkinson, Tim and Alexander Ljungqvist, 2001, Going Public: The Theory and Evidence on How Companies Raise Equity Finance (2nd edition), *Oxford University Press*.

Kothari, S. and Warner, J. (1997). Measuring long-horizon security price performance. *Journal of Financial Economics*, 43(3), pp.301--339.

Lee, C., Shleifer, A. and Thaler, R. (1991). Investor sentiment and the closed-end fund puzzle. *The Journal of Finance*, 46(1), pp.75--109.

Lee, P. and Wahal, S. (2004). Grandstanding, certification and the underpricing of venture capital backed IPOs. *Journal of Financial Economics*, 73(2), pp.375--407.

Lerner, J. (1994). Venture capitalists and the decision to go public. *Journal of financial Economics*, 35(3), pp.293--316.

Lerner, J. (1994). Venture capitalists and the decision to go public. *Journal of financial Economics*, 35(3), pp.293--316.

Levis, M., 1993. The long-run performance of initial public offerings: The UK experience 1980-1988. *Financial Management*, 22(1), pp.28--41.

Lie, E. (2001). Detecting Abnormal Operating Performance: Revisited, Financial Management, 77-91.

Ljungqvist, A., Nanda, V. and Singh, R. (2006). Hot Markets, Investor Sentiment, and IPO

Pricing*. *The Journal of Business*, 79(4), pp.1667--1702.

Loughran, T. and Ritter, J. (1995). The new issues puzzle. *The Journal of Finance*, 50(1), pp.23--51.

Loughran, T. and Ritter, J. (2004). Why has IPO underpricing changed over time?. *Financial Management,* Autumn, pp.5--37.

Loughran, T., Ritter, J. and Rydqvist, K. (1994). Initial public offerings: International insights. *Pacific-Basin Finance Journal*, 2(2), pp.165--199.

Lyon, J., Barber, B. and Tsai, C. (1999). Improved methods for tests of long-run abnormal stock returns. *The Journal of Finance*, 54(1), pp.165--201.

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance,* 7(1), pp.77--91.

Megginson, W. and Weiss, K. (1991). Venture capitalist certification in initial public offerings. *The Journal of Finance*, 46(3), pp.879--903.

Mello, A. and Parsons, J. (1998). Going public and the ownership structure of the firm. *Journal of Financial Economics*, 49(1), pp.79--109.

Miller, E. (1977). Risk, uncertainty, and divergence of opinion. *The Journal of Finance*, 32(4), pp.1151--1168.

Rajan, R. and Servaes, H. (1997). Analyst following of initial public offerings. *The Journal of Finance*, 52(2), pp.507--529.

Ritter, J. (1984). The" hot issue" market of 1980. *Journal of Business*, pp.215--240.

Ritter, J. (1991). The long-run performance of initial public offerings. *The Journal of Finance*, 46(1), pp.3--27.

Ritter, J. and Welch, I. (2002). A review of IPO activity, pricing, and allocations. *The Journal of Finance*, 57(4), pp.1795--1828.

Rock, K. (1986). Why new issues are underpriced. *Journal of Financial Economics*, 15(1), pp.187--212.

Samuelson, P. (1965). Proof that properly anticipated prices fluctuate randomly. *Industrial management review*, 6(2), pp.41--49.

Shiller, R. J. (1988). Initial Public Offerings: Investor Behavior and Underpricing. Working Paper No. 2806, National Bureau of Economic Research, Cambridge.

Teoh, S., Welch, I. and Wong, T. (1998). Earnings management and the long-run market performance of initial public offerings. *The Journal of Finance*, 53(6), pp.1935--1974.

Welch, I. (1989). Seasoned offerings, imitation costs, and the underpricing of initial public offerings. *The Journal of Finance*, 44(2), pp.421--449.

Appendix

Figure I
Monthly IPO activity

The figure shows the number of IPOs per month from the bottom. On the top hot and cold periods are signalled. A 'Hot Period' and a 'Cold Period' are defined as a period with at least three consecutive 'Hot' and 'Cold Months' respectively. The top quartile of our sample in terms of number of IPOs is considered a „Hot Month" and the lowest third a „Cold Month".

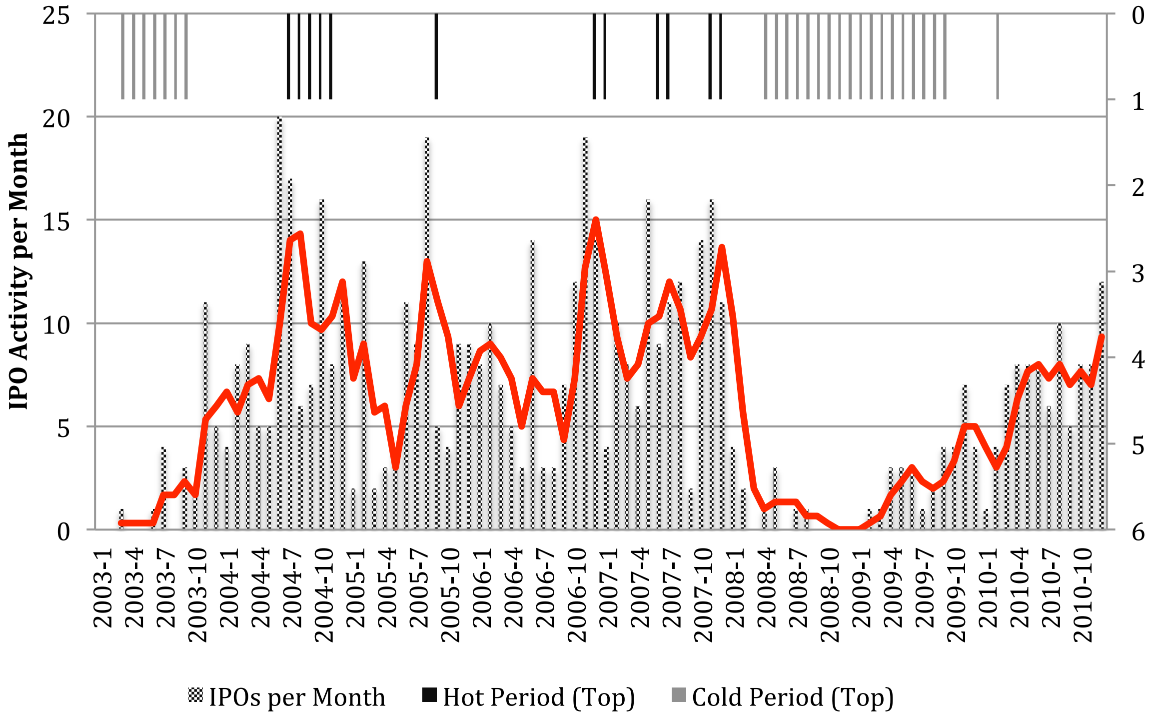


Table I
Matching Procedure Statistics

The table exhibits the average of the market capitalization (Mkt. Cap.) and total assets (Assets) in our sample, the average and the median of the deviation between the sample IPO firms and their matched portfolio firms, for market size, the return on assets and the total assets. Delta SIC3 represents the ratio of matches per portfolio that are not matched to three-digit SIC code. The Relative Deviation is the ratio between the respective median delta and the sample average.

	Mkt. Cap.	ROA	Assets		
Average in Sample	2312.4		3378.6		
Relative deviation	13%	6%	8%		
	delta MktCap	delta ROA	delta Assets	delta SIC3	Porfolio Size
Average	508	11%	663	37%	9.0
Median	292	6%	263	30%	10.0

Table III
The Effect of the Crisis on Underpricing

This table reports the inferential statistics for the following regression $Underpricing_{i,} = \alpha_i + \beta_1 Crisis_i + \beta_2 Post_i + \beta_3 VC_i + \beta_4 ROA_i + \beta_5 MktCap_i + \beta_6 Assets_i + \varepsilon_i$ where $Underpricing_i$ denotes the first day return for IPO firm i. *Crisis* is a dummy variable denoting whether or not a firm went public during the crisis. *Post* is a dummy variable denoting whether or not a firm went public during 2010. VC_i is a dummy variable denoting whether or not a firm is backed by venture capital at the time of going public. $MktCap_i$ is the firm's market capitalization ($bn) immediately after the IPO. $Assets_i$ is the firm's total assets ($bn) at the end of the fiscal year relating to the IPO date. ROA_i is the firm's return on assets at the end of the fiscal year relating to the IPO date. $HotPeriod_i$ and $ColdPeriod_i$ are dummy variables denoting whether or not a firm went public during a hot or a cold period respectively. (A 'Hot Period' and a 'Cold Period' are defined as a period with at least three consecutive 'Hot' and 'Cold Months' respectively. The top quartile of our sample in terms of number of IPOs is considered a „Hot Month" and the lowest third a „Cold Month"). The values in *italic* are the p-values for each coefficient. The t-Stat and the confidence interval are based on a Student's t-Distribution. ***, **, and * denote statistically significant difference from zero at a level of 1%, 5%, and 10% respectively.

	Underpricing
	Overall
Period	2003-2010
Equation	(1)
N	588
R2	5.44%
Prob > F	0.03%
Constant	8.16%
	*0.000****
Crisis	5.19%
	0.309
Post	0.27%
	0.918
VC	7.93%
	*0.000****
ROA	3.34%
	*0.013***
MktCap	0.11%
	0.453
Assets	-0.11%
	0.171
HotPeriod	0.48%
	0.818
ColdPeriod	-3.26%
	0.435

Table V
The Effect of the Crisis on Firm Characteristics

This table reports the inferential statistics for four generic regressions $FirmCharacteristic_i = \alpha_i + \beta_1 Crisis_i + \varepsilon_i$ where $FirmCharacteristic_i$ stands for either VC, ROA, MktCap or Assets. The t-Stat and the confidence interval are based on a Student's t-Distribution. The values in *italic* are the p-values for each coefficient using robust standard deviations. ***, **, and * denote statistically significant difference from zero at a level of 1%, 5%, and 10% respectively.

	Firm Characteristics during the Crisis			
	(1)	(2)	(3)	(4)
Independent	VC	ROA	Mkt Cap	Assets
N	588	588	588	588
R2	0.91%	0.38%	0.00%	0.00%
Prob > F	1.38%	58.87%	83.20%	69.72%
Constant	48.99%	-3.86%	139.77%	92.05%
	*0.000****	*0.000****	*0.000****	*0.001****
Crisis	-17.88%	-9.29%	11.73%	14.98%
	*0.014****	*0.589*	*0.832*	*0.697*

Table VI
Firm Characteristics, Crisis vs Non-Crisis

The table shows the arithmetic average of the firm characteristics Market Capitalization (Mkt Cap), Return on Assets (ROA), Book Value of Assets (Assets), and the Ratio of venture capital backed IPOs (VC Backed) over the years 2003-2007, and 2010 as non-crisis period and over the years 2008, and 2009 for the crisis period

Firm Characteristic	Mkt Cap	ROA	Assets	VC Backed
Crisis Period	$1514m	-13.15%	$1070m	31%
Non-Crisis Period	$1397m	-3.86%	$921m	49%

Table VII
Initial IPO Long-Term Performance
3-year Buy-and-Hold-Abnormal-Return (BHAR)

This table reports the inferential statistics where t-Stat and the significance test are based on a Student's t-Distribution. The p-value of each coefficient is reported in *italic*. ***, **, and * denote statistical significance from zero at a level of 1%, 5%, and 10% respectively. The 'Buy-and-Hold Abnormal Return' is based on firm characteristic matched portfolios and single firms respectively for IPO firm *i*. All other variables are defined in Table III.

	Buy-and-Hold Abnormal Return The Effect of the Crisis					
	Overall		**Crisis**		**Non-Crisis**	
Period	2003-2010		2008/2009		2003-2007/2010	
Matching Procedure	(1) Portfolio	(2) Single Firm	(3) Portfolio	(4) Single Firm	(5) Portfolio	(6) Single Firm
N	570	570	42	42	528	528
R2	5.20%	4.48%	32.83%	22.65%	4.00%	3.51%
Prob > F	0.26%	7.19%	0.00%	0.66%	5.75%	18.81%
Constant	-5.99%	-32.59%	-11.87%	-29.14%	-3.57%	-14.79%
	0.590	*0.063**	*0.471*	*0.244*	*0.727*	*0.336*
Crisis	38.19%	63.95%				
	*0.019***	*0.005****				
Post	0.85%	39.79%			0.83%	26.17%
	0.961	*0.059**			*0.961*	*0.157*
VC	-8.18%	-2.07%	59.48%	81.17%	-13.23%	-7.13%
	0.614	*0.919*	*0.126*	*0.081*	*0.436*	*0.736*
ROA	66.44%	4.86%	179.00%	123.02%	61.77%	3.99%
	*0.067**	*0.927*	*0.001****	*0.054**	*0.099**	*0.942*
MktCap	4.08%	7.59%	1.73%	4.23%	5.41%	10.07%
	0.272	*0.155*	*0.524*	*0.305*	*0.275*	*0.151*
Assets	1.85%	1.47%	17.86%	18.79%	-0.48%	-2.63%
	0.546	*0.693*	*0.000****	*0.003****	*0.888*	*0.525*
HotPeriod	-1.00%	47.61%				
	0.944	*0.015***				
ColdPeriod	3.80%	6.41%				
	0.837	*0.773*				
Under-pricing	-116.75%	-200.01%	-164.17%	-143.49%	-116.20%	-214.87%
	0.113	*0.019***	*0.000****	*0.008****	*0.181*	*0.03***

Figure V
Initial IPO Long-Term Performance
3-year Raw Returns over 1 to 36 months

This figure shows the development of the raw buy-and-hold returns over the periods of 1 to 36 months when applying the single firm matching procedure.