The Performance of IPO Investment Strategies and Pseudo Market Timing – Evidence from Germany

Andreas Trauten[a], Roland C. Schulz[b] and Maik Dierkes[c]

June 2007

Abstract

We analyse the performance of simple investment strategies in IPOs based on a large sample of IPOs in Germany between 1985 and 2002. We find that investing in each IPO and disinvesting after a certain holding period yields significantly negative abnormal performance compared to a broad market index on average. In contrast, investing in a portfolio that comprises recent IPOs does not result in statistically significant underperformance. Since the only difference between these strategies is that the first weights each IPO equally and the latter weights each calendar month equally, this finding implies that firms going public in hot IPO markets perform worse than those going public in cold markets. Schultz (2003) offers a rational explanation for the clustering of IPOs at market peaks and subsequent underperformance which he calls pseudo market timing. It arises if firms' propensity to go public increases with market price levels. Indeed, we find that the IPO activity in Germany can largely be explained by price levels. We apply simulations in order to test the extent to which pseudo market timing can account for economically significant underperformance of IPOs in Germany. We find that pseudo market timing can partly explain the performance of IPO investment strategies between 1985 and 2002. Our results indicate that investing in a portfolio of recent IPOs is preferable to investing in each firm going public separately.

Keywords: Initial Public Offerings, long-run stock performance, market efficiency, German stock market, market timing

JEL-classification: G10, G11, G14

---

[a] Finance Center Münster, Lehrstuhl für BWL, insbesondere Finanzierung, Universität Münster, Universitätsstr. 14-16, 48143 Münster. E-Mail: Andreas.Trauten@wiwi.uni-muenster.de.

[b] Forschungsteam Baetge, Universität Münster, Universitätsstr. 14-16, 48143 Münster. E-Mail: Roland.Schulz@wiwi.uni-muenster.de.

[c] Finance Center Münster, Lehrstuhl für BWL, insbesondere Finanzierung, Universität Münster, Universitätsstr. 14-16, 48143 Münster. E-Mail: Maik.Dierkes@wiwi.uni-muenster.de.

We would like to thank Thomas Langer and participants in the Finance Center Muenster doctoral seminar for valuable comments and insights. Financial support from the Bundesministerium für Bildung und Forschung (BMBF) through its project "Internetökonomie und Hybridität" is gratefully acknowledged.

1 Introduction

Initial Public Offerings (IPOs) frequently attract a lot of public attention due to extensive marketing and broad media coverage. In particular, IPOs often serve as a "gateway drug" to the stock market for private investors. For example, large IPOs like those of Deutsche Telekom AG and Deutsche Post AG initiated individual investors' stock investments in Germany in many cases. Consequently, it is worth asking how investments in German IPOs performed on average. Indeed, subsequent to the seminal study by Ritter (1991), numerous studies investigated the long-run performance of IPOs in different countries including Germany. Many of them found significant underperformance of IPOs, an observation that prompted Loughran and Ritter (1995) to claim: „Investing in firms issuing stock is hazardous to your wealth" (p. 46). However, most of the literature focuses on the implications of underperformance for market efficiency (e.g., see Fama 1998). Little research is done explicitly on the performance of different investment strategies in IPOs. In this paper, we discuss the performance of four intuitive IPO investment strategies. In addition, we analyse the extent to which the pseudo market timing theory proposed by Schultz (2003) is able to explain the performance of those IPO investment strategies.

An obvious way to invest in IPOs is to purchase shares of each firm that goes public and to sell those shares after a certain holding period. The length of the holding period may be chosen arbitrarily subject to the individual perception of when an IPO firm turns to be an established publicly listed company. In this study, we focus on holding periods of three and five years. Depending on the capital invested in each IPO, we can distinguish two sub strategies: On the one hand, an investor might want to invest the same amount of capital in each IPO (strategy 1 hereafter). On the other hand, an investor might want to acquire the same proportion of each IPO's market value (strategy 2 hereafter). Throughout this study, we refer to this family of investment strategies as "each-IPO investment strategies". With an each-IPO investment strategy, the capital invested varies with IPO activity. Thus, these strategies implicitly assume that investors do not face a budget constraint. The uncertainty about the capital needs is amplified in case of value weighting each IPO. Here, capital needs fluctuate not only with IPO activity but also with variance in the market value of firms going public. We analyse the performance of these investment strategies in comparison to simultaneous investments in an equally weighted and a market value weighted broad market portfolio in Germany between 1985 and 2002. In order to realise excess returns, investors would have to sell the benchmark portfolio when investing in an IPO and to repurchase the benchmark portfolio from the proceeds of the IPO sale at the end of the holding period. For simplicity, we assume that investors make their investment decisions at the end of each calendar month.

An alternative to investing in each IPO is to invest in a portfolio that comprises firms that recently went public. Throughout this study, we refer to this family of investment strategies as “IPO-portfolio investment strategies”. Again, the definition of recently is arbitrary subject to the individual perception of when an IPO firm turns to be an established publicly listed company. We refer to the period of time in which newly listed companies are considered in the IPO portfolio as formation period. To be consistent with the holding periods of each-IPO investment strategies, we focus on formation periods of three and five years. As with strategies 1 and 2, we can distinguish in this class of IPO portfolio investment strategies between two sub strategies with respect to the weighting of each firm in the portfolio: On the one hand the investor can invest in a portfolio that weights each IPO equally (strategy 3). On the other hand, an investor might want to invest in a portfolio that weights each IPO according to its market value (strategy 4). In contrast to each-IPO investment strategies, there is no uncertainty about the capital invested as investors decide about the investment amount only once at the beginning of the investment period. Afterwards, purchases of new IPOs and sales of former IPOs are considered by rebalancing the IPO portfolio. Consistent with the former strategies, we assume that investors revise their IPO portfolio at the end of each calendar month. In case of strategy 3, this implies portfolio rebalancing whenever newly listed firms are included or former IPO firms are excluded. It implies mandatory monthly rebalancing in case of strategy 4. Table 1 summarizes the investigated IPO investment strategies.

Table 1: IPO investment strategies

Equally weighting of IPOs implies investing the same nominal amount of capital irrespective of the time of the going public (strategy 1) or the IPO portfolio contains each IPO firm at equal proportions (strategy 3). Market value weighting implies purchasing the same proportion of total shares of each firm going public (strategy 2) or IPO portfolio proportions are determined according to market values (strategy 4).

	Equally weighted	**Market value weighted**
Each-IPO investment strategies	Strategy 1	Strategy 2
IPO-portfolio investment strategies	Strategy 3	Strategy 4

Frequent portfolio rebalancing is associated with considerable transaction costs in practice. Such transaction costs question the feasibility of IPO-portfolio investment strategies for individual investors. However, individual investors can easily implement these investment strategies if there existed investment funds or certificates that emulate such an IPO portfolio. To our knowledge, there are two certificates available to private investors in Germany that to some extent replicate such an IPO portfolio. The „IPO-Select Basket Zertifikat“ issued by Sal. Oppenheim represents a portfolio of selected European IPOs.[1] An opportunity to invest into a selection of firms that went public in Germany within the last ten years is provided by certificates on the German Entrepreneurial Index (GEX®).[2]

1 See Sal. Oppenheim (2006). IPO firms may be included in the basket within the first year after the going public. No information is given on the time IPO firms may stay in the basket.

2 The GEX® only comprises firms whose owners are actively engaged in the management. For further information see Achleitner, Kaserer and Moldenhauer (2005).

In efficient capital markets with IPOs occurring randomly over time we expect the choice of IPO investment strategies to be irrelevant. Since we calculate the performance of all investment strategies by the very same monthly returns of the IPOs and the benchmarks, any difference in performance among strategies must be due to the different methods of aggregating monthly returns implied by the different investment strategies. We find that investments in IPOs according to each-IPO investment strategies underperform investments in the benchmark portfolios on average. According to a skewness-adjusted test statistic, this underperformance is highly significant in most cases. Likewise, IPO portfolio strategies result in underperformance. However, applying a bootstrapping methodology, we do not find this underperformance to be statistically significant. These results imply that firms going public in periods of high IPO activity perform worse than firms going public in other times.

A popular explanation for bad IPO performance in "hot" IPO markets is market timing. Market timing states that managers or owners take their firms public when the market overvalues IPOs. Underperformance emerges if the market learns about the firm's true value subsequent to the IPO. However, Schultz (2003) provides a rational explanation for worse IPO performance in hot markets which he calls pseudo market timing.[3] This explanation is based on the assumption that IPO activity rises with market prices and especially with prices of recent IPOs as managers' or owners' propensity to go public increases with potential IPO proceeds irrespective of their ability to predict future market returns. Consequently, IPO activity will peak at market peaks. As we explain in section 3.1, this results in long-run underperformance on average without requiring markets to misprice IPOs if returns of recent IPOs are positively correlated in a calendar month.

We estimate the relation between price levels and IPO activity in Germany by applying negative binomial regression models. We find that the price levels of recent IPOs significantly influences the number of IPOs which points to the pseudo market timing phenomenon. In order to test whether the relation between price levels and IPO activity results in economically significant underperformance, we simulate the IPO activity and calculate the performance of IPO investment strategies in the simulations. Using simulations of ex ante efficient capital markets allows us to focus solely on pseudo market timing and to control for other explanations of underperformance, such as market timing or simply inappropriate benchmark portfolios. Each-IPO investment strategies highly significantly underperform the benchmark by 8.3% points on average in the simulations when considering the entire sample period, while IPO-portfolio investment strategies yield no abnormal performance. These results show that pseudo market timing can partly, albeit not fully explain the performance of IPO investment strategies in Germany between 1985 and 2002.

---

[3] Miller (1977) provides an alternative rational explanation based on heterogeneous expectations. Pastor and Veronesi (2005) provide a rational explanation for the emergence of IPO waves. Here, we focus on the pseudo market timing explanation.

This paper adds to the literature on German IPOs in several ways. Firstly, we focus on the performance of investment strategies involving IPOs. While the each-IPO investment strategies resemble the methodology of various event studies measuring the long-run performance of IPOs in event time, the IPO-portfolio strategies resemble the calendar-time approach in event study methodology which has not been studied systematically on German IPOs yet. Secondly, our sample including all German IPOs between 1985 and 2002 is larger than the samples of previous studies and comprises both the hot IPO market of 1999/2000 and the subsequent cooling-down phase. Thirdly, we find that pseudo market timing and calendar time effects can explain the variation of IPO activity in Germany. Further, we provide evidence that pseudo market timing explains a considerable part of the underperformance of each-IPO investment strategies. The pseudo market timing phenomenon has not been studied previously for German IPOs. Thereby, we complement the literature on rationales for long-run underperformance of IPOs in Germany that is dominated by behavioural explanations so far.

The paper is organised as follows. Section 2 describes the data and methodology, briefly reviews the literature on long-run performance of IPOs in Germany and analyses the performance of the IPO investment strategies described above. Section 3 introduces pseudo market timing as a rationale for the performance of IPO investment strategies and discusses the explanatory power of pseudo market timing for the performance of different IPO investment strategies in Germany. Section 4 summarises and concludes.

2 Performance of IPO investment strategies in Germany

2.1 Data and Methodology

We study the long-run performance of IPOs in Germany from 1985 to 2002. In addition to the analysis of the entire sample period, we take a separate look on the sub-periods 1985 to 1995 and 1996 to 2002, respectively. The rationales for this split-up are changes in the institutional environment for IPOs and changes in the German equity culture from the mid-1990s onwards. The institutional framework for IPOs changed with both the shift from fixed-price offerings to book-building in 1996 and the establishment of the "Neuer Markt" in Frankfurt in 1997. In June 1996, Eurobike AG was the first German firm to go public via the book-building procedure. This mechanism allows IPO pricing closer to the market as the offer price is based on market demand. 443 companies went public via bookbuilding following the IPO of Eurobike AG till the end of 2002, compared to only 25 firms using a fixed-price offering in the same time period.[4] The Neuer Markt provided a platform for small and medium size firms with high growth potential desiring to be listed at the stock exchange. It soon

[4] "Trius AG" and "Hydrotec AG" went public via uniform price auctions in May 2000 and in August 2001, respectively.

attracted the attention of both these firms and the public. 292 companies went public on the Neuer Markt between its establishment and its closure in June 2003. In the same period, only 165 companies went public on other segments of the German stock exchange. Thus, the Neuer Markt remarkably accelerated the establishment of an equity culture in Germany. Apart from the Neuer Markt, the German equity culture evolved from the IPO of Deutsche Telekom AG in November 1996.[5] With an issue volume of 19.7 billion Deutsche Mark (10.1 billion €), this IPO outnumbered all previous IPOs in Germany by far. Deutsche Telekom shares were promoted intensively in the media which caused a strong interest of private investors in this IPO. The finance minister at the time, Theo Waigel, characterised the impact of the Deutsche Telekom IPO as follows: „The privatisation of Deutsche Telekom AG is associated with crucial impulses to the stimulation of the financial market and the popularisation of shares […].“[6] The favourable performance of the „T-Aktie“ until 2000 nourished a continuing interest of private investors and the media in IPOs.

From the new issue database of Deutsches Aktieninstitut e. V. and the website of Deutsche Börse AG we identified 667 IPOs in Germany between 1985 and 2002. Closing prices and market values on the last trading days of the 61 months following each IPO, the benchmark performance in the respective months as well as information on dividends and other payments are provided by Thomson Financial Datastream and the financial database Karlsruher Kapitalmarktdatenbank. Information not provided by these databases is collected from the financial sections of the daily newspapers Frankfurter Allgemeine Zeitung and Handelsblatt. As we ceased collecting market prices in August 2005, we do not have 61 months time series for each IPO in the sample. Based on monthly data, we calculate the total return per calendar month for each firm assuming that dividend payments and other cash distributions are reinvested in the firm's shares. Due to the calculation of returns based on end of calendar month prices, the first monthly total return for each IPO is available for the month following the IPO month. This procedure implies that investors take their investment decisions at the end of each month in case of each-IPO investment strategies. Accordingly, investors rebalance their IPO portfolios at the end of each month in case of IPO-portfolio investment strategy 3 and in case of 4 if necessary. Summarising, at the end of each month investors put money in those companies which went public in this very month.[7]

---

5 Anecdotal evidence for the evolution of equity culture is provided by the IPO's media coverage, e.g.: Borggreve (1995), Borggreve and Dobrikat (1995) or Kutzer (1997). For a detailed illustration of the Deutsche Telekom IPO see Reuschenbach (2000).

6 This quote was taken from Kutzer (1995). The original quote was in German: “Die Privatisierung der Deutschen Telekom AG ist mit entscheidenden Impulsen für die Belebung des Finanzmarkts und die Popularisierung der Aktie verbunden […].”

7 Alternatively, if investors would receive allocations in each IPO, the success of the investment strategies could be analysed on the basis of issue prices, thereby including underpricing. However, as investors may not receive an allocation in case of oversubscription, such an investment strategy would involve allocation risk.

Table 2 presents some descriptive statistics on the IPOs in our sample and in the two sub samples. Between 1985 and 2002, an average of 3.09 companies went public per month. Comparing the first and the second sub-period reveals that the average issuance activity has tripled since 1996. The mean market capitalisation of firms going public in the second sub period was more than twice as high as in the first sub period. In all sample periods, market capitalisation considerably varies among IPOs, and the median size is about a quarter of mean size. The latter observation indicates that mean IPO size is driven by few very large issues. The largest IPO in the sample is that of T-Online AG in April 2000. After five years, quotes of 38 new issues had been ceased, out of which 16 had filed for bankruptcy, 19 had been acquired and 3 had been merged with other companies. Insolvencies as well as mergers and acquisitions are predominantly a phenomenon of the IPOs between 1996 and 2002.[8]

The firms which had filed for bankruptcy remain in the sample for five years to avoid distortions owing to survivorship bias (e.g., see Brown, Goetzmann, Ibbotson and Ross 1992). In case of mergers, we complement the IPO firm's time series by the returns of the new entity subsequent to the merger.[9] In case of acquisitions, however, the cash compensation or the cash payment in return for selling shares is invested in the benchmark portfolio.[10]

Choosing an appropriate benchmark portfolio is a delicate task as it might significantly alter results. Generally, the benchmark portfolio's risk profile should correspond to the risk profile of the IPO sample in order to detect abnormal returns. At best, IPO firms should be compared to benchmark portfolios that exhibit the same characteristics with respect to the relevant risk factors identified in the present asset pricing literature. For example, Brav and Gompers (1997), Ritter and Welch (2002) and others suggest to use benchmark portfolios of firms with similar market values and market-to-book ratios.[11] Yet, comparing IPO firms to benchmark portfolios adjusted for size, market-to-book ratios and/or other risk factors causes practical problems for the German market due to data limitations. Further, in comparison to the

---

8 In fact, 30 of the 38 firms subject to insolvency, mergers or acquisitions went public in 1999 or 2000. The subsequent downturn of stock prices prompted these firms to engage in takeover activities which is reflected by a mean time between the IPO and such activities of slightly above three years. The fact that the time between IPO and insolvency is about three and a half years indicates that firms that did not engage in takeover activities successfully failed subsequently.

9 Mergers have to be approved by investors in the shareholders' meeting. Thus, if an IPO firm merges with a second firm to a new entity, we assume that investors convert their shares into those of the new entity.

10 If the IPO firm is acquired by purchasing its shares in the market, investors selling shares receive cash payments. If the acquiring company suggests an exchange of shares, the IPO firm's investors can either agree or obtain an cash compensation at the time of the delisting. For reasons of simplicity, we assume that investors prefer cash compensations in any case. By investing the cash compensation in the benchmark portfolio, the relative abnormal performance at the time of the acquisition is preserved in the time series.

11 For instance, Ritter and Welch (2002) provide evidence for negative excess returns of US IPOs between 1980 and 2001 amounting to -23.4% compared to a market index but only to -5.1% compared to a portfolio of matching firms with similar market values and similar market-to-book ratios.

US market the lower overall number of listed firms hampers the construction of matching portfolios and adds subjectivity to the analysis.

Thus, we simply compare the performance of IPOs to broad market indices. Even though this methodology yields potentially less accurate measures of abnormal performance, it does not affect our main results as the focus of our analysis is on differences in performance among IPO investment strategies rather than on absolute levels of abnormal performance and hence, on the detection of market inefficiencies. We prefer broad market indices to sector specific indices or other sub-indices in order to mitigate the problem of benchmark contamination. That is, if the IPO firms are also constituents of the benchmark portfolio, the estimate for abnormal performance will be biased downwards (Loughran and Ritter 2000). The indices chosen are the value weighted Composite DAX® (CDAX hereafter) and the equally weighted version of the "Deutscher Aktien-Forschungsindex" (DAFOX). The CDAX contains all firms listed on the market segments "Amtlicher Handel" or "Geregelter Markt" which are regulated by public law. The equally weighted DAFOX (ewDAFOX) comprises all stocks listed on the Amtlicher Handel (see Göppl and Schütz 1995 for details).

Table 2: Descriptive statistics on the IPO sample

Market capitalisation is calculated on the basis of the closing price of the last trading day of the IPO month. The number of mergers, acquisitions and insolvencies within 60 months after the IPO and the mean number of months after IPOs are calculated on the basis of the delisting dates.

	85-02	**85-95**	**96-02**
Total number of IPOs	667	196	471
Number of IPOs per month			
Mean	3.09	1.48	5.61
Median	1.00	1.00	2.50
Market capitalisation [€ million]			
Mean	538.86	245.75	660.84
Median	136.21	76.49	162.66
Min	1.96	2.70	1.96
Max	45429.96	8037.50	45429.96
Mergers (up to 60 months after IPO)			
Number	3	0	3
Mean number of months after IPO	39	N/A	39
Acquisitions (up to 60 months after IPO)			
Number	19	2	17
Mean number of months after IPO	38.2	38.4	37
Insolvencies (up to 60 months after IPO)			
Number	16	2	14
Mean number of months after IPO	43.2	50.5	42.3

2.2 Empirical results of previous studies

Table 3 presents results of selected studies concerning the long-run performance of IPOs in Germany.[12] In all studies, abnormal returns are calculated in event time methodology which implies that each IPO is weighted equally. This resembles the each-IPO investment strategy 1 proposed in this study. Regarding methodology, a majority of studies applies the Buy-and-Hold Abnormal Return (BHAR) method to measure long-run abnormal performance. We discuss the calculation methods in the following sections. The results of the literature are mixed. Until the early 1990s, the majority of studies do not provide evidence for significant positive or negative abnormal returns of German IPOs after holding periods of three years. Only Ljungqvist (1997) detects long-run underperformance of IPOs to the broad market index DAFOX which is significant on a 10%-level.[13] Rehkugler and Schenek (2001) as well as Mager (2001) examine the performance of German IPOs in the 1980s and 1990s. While Rehkugler and Schenek find negative, but non-significant abnormal returns, Mager (2001) observes significant negative abnormal returns in comparison to the ewDAFOX after five years.

Some more recent studies analyse the long-run performance of IPOs on the Neuer Markt in Frankfurt. Gerke and Fleischer (2001) find that for one-year holding periods the IPOs significantly outperformed the Nemax All-Share Index. For two-year holding periods the Neuer Markt-IPOs still outperformed the index, albeit to a weaker extent and statistically insignificant (Lubig 2004). Note however, that these results suffer from benchmark contamination as the Nemax All-Share comprised all firms listed at the Neuer Markt. In effect, these studies test the performance of later IPOs to early IPOs on the Neuer Markt. For holding periods of three years the Neuer Markt-IPOs significantly underperformed the CDAX (Neuhaus and Schremper 2003; Rath, Tebroke and Tietze 2004).

In general, the empirical results of previous studies underline the sensitivity of IPO abnormal performance to variations in the sample period, the choice of the benchmark portfolio and the length of the holding period. As regards the sample periods, significant underperformance is predominantly found for IPOs in the 1990s and for IPOs on Neuer Markt in particular. Regarding the holding period, underperformance rises with an increasing holding period. Overall, we cannot unambiguously conclude that IPOs in Germany underperform in event time. In other words, the each-IPO investment strategy 1 did not consistently yield abnormal returns.

---

12 For more detailed literature overviews see e.g. Stehle and Ehrhardt (1999), p. 1412 or Stehle, Ehrhardt and Przyborowsky (2000).

13 Stehle and Ehrhardt (1999) partly attribute the negative abnormal returns in comparison to the DAFOX to the methodology chosen by Ljungqvist (1997). See Stehle and Ehrhardt (1999), p. 1408 for details.

There are few studies resembling the each-IPO investment strategy 2 in Germany. For instance, Kiss and Stehle (2002) study the performance of Neuer Markt IPOs in case of equally and value weighting each IPO. They find that strategy 2 performs similar to strategy 1 if each IPO is held for one year. To our knowledge, the IPO portfolio investment strategies 3 and 4 have not been analysed in Germany yet. Such IPO portfolios did not perform significantly different from their benchmark portfolios in the US (Gompers and Lerner 2003; Schultz 2003). Thus, in the literature there is no clear evidence for out- or underperformance of any of the investment strategies considered here.

Table 3: Studies on the long-run performance of IPOs in Germany

*/**/***: statistically significant on a 10%-/5%-/1%-level; AH: Amtlicher Handel; NM: Neuer Markt; ew: equally weighted; mvw: market value weighted; [a] Benchmark firm's market value slightly above IPO firm's market value; [b] Benchmark firm's market value slightly below IPO firm's market value; BHAR: Buy-and-Hold Abnormal Return; WR: Wealth Relative; CAR: Cumulative Abnormal Return.

Author(s) (year)	Sample period	Number of IPOs	Benchmark	Holding period (mths)	Excess return (%)		Calculation method
Ehrhardt (1997)	1960-1990	159	Size portfolio (ew)	36	-0.6		BHAR
		159	Size portfolio (mvw.)	36	-3.8		BHAR
Ljungqvist (1997)	1970-1990	189	mvwDAFOX	36	-12.1	*	WR
Stehle/Ehrhardt (1999)	1960-1992	187	Size portfolio (ew)	36	-5.0		BHAR
			Size portfolio (mvw)	36	1.5		BHAR
Sapusek (2000)	1983-1993	142	Benchmark firms (by size)	60	-34.7		CAR
			DAX	60	1.8		CAR
Stehle/Ehrhardt/ Przyborowsky (2000)	1960-1992	187	Market portfolio (ew)	36	-5.0		BHAR
			Market portfolio (mvw)	36	1.54		BHAR
			Benchmark firms [a]	36	-11.6		BHAR
			Benchmark firms [b]	36	-3.4		BHAR
Gerke/Fleischer (2001)	1997-2000	263 (NM)	Nemax All-Share	12	96.6	***	BHAR
Rehkugler/Schenek (2001)	1983-1996	450	CDAX	36	-8.5		CAR
Mager (2001)	1987-1997	152	ewDAFOX	36	-13.5		CAR
				60	-41.3	**	CAR
Neuhaus/Schremper (2003)	1995-2000	27 (AH)	CDAX	36	-31.8	**	BHAR
		25 (NM)	CDAX	36	-72.9	***	BHAR
Rath/Tebroke/Tietze (2004)	1997-2001	301 (NM)	CDAX	36	-87.8	***	BHAR
Lubig (2004)	1997-2002	326 (NM)	Nemax All-Share	24	5.0		BHAR

2.3 Each-IPO investment strategies

We study the performance of an investment in each IPO by comparing the buy-and-hold return of each IPO to the buy-and-hold return of the benchmark irrespective of the IPO point in calendar time. As calendar time is ignored, this analysis resembles an event study methodology. We calculate the abnormal performance of each-IPO investment strategies applying the well-known Buy-and-Hold Abnormal Return (BHAR) approach firstly mentioned by Cusatis, Miles and Woolridge (1993).[14] The $BHAR_{H,i}$ of firm i exhibiting a total return $R_{i,h}$ in holding period month h following the IPO versus the total return of a benchmark portfolio $R_{B,h}$ in holding period month h for a maximum holding period H is calculated as

$$BHAR_{H,i} = \left(\prod_{h=1}^{H} \left(R_{i,h} + 1 \right) \right) - \left(\prod_{h=1}^{H} \left(R_{B,h} + 1 \right) \right) \quad . \tag{1}$$

The mean of the buy-and-hold abnormal returns $BHAR_{H,i}$ of $i = 1 \ldots N$ IPOs in the sample is calculated in case of investment strategies S=1 or S=2 as

$$\overline{BHAR}_H^S = \sum_{i=1}^{N} w_i^{(S)} \left[\left(\prod_{h=1}^{H} \left(R_{i,h} + 1 \right) \right) - \left(\prod_{h=1}^{H} \left(R_{B,h} + 1 \right) \right) \right] \tag{2}$$

where

$w_i^{(1)}$ = 1/N (strategy 1) and
$w_i^{(2)}$ = market value of firm i at the end of the IPO month / sum of market values of all firms at the end of the respective IPO months (strategy 2).

In order to draw statistical inference on abnormal performance of IPOs in investment strategies 1 and 2, we test the null hypothesis $\mathrm{H}_0 : \overline{BHAR}_H^S = 0$ to the alternative hypothesis $\mathrm{H}_A : \overline{BHAR}_H^S \neq 0$. As monthly IPO and benchmark returns are combined multiplicatively, the distributions of buy-and-hold returns of the IPOs and of the benchmarks are right-skewed. We obtain a right-skewed distribution of the buy-and-hold abnormal returns $BHAR_{H,i}$, too. In addition, we can reasonably assume that the buy-and-hold abnormal returns are correlated across IPOs. Cross-correlation arises as the holding periods overlap in calendar time and as the

---

[14] Alternative measures for long-run abnormal performance are Cumulative Abnormal Returns introduced by Fama et al. (1969) and Wealth Relatives introduced by Ritter (1991). The former measure does not fit here as it implies monthly rebalancing which is not intended for each-IPO investment strategies. Jakobsen and Sørensen (2001) argue that Wealth Relatives expressing the relative performance of IPOs to their benchmarks are most appropriate as they facilitate significance tests. We prefer the BHAR-method as the success of the investment strategies cannot easily be interpreted economically if measured by WRs. Though the WR-method answers the question of the mean relative performance of IPOs to their benchmarks and thereby indicates out- or underperformance, by its nature the method does not allow drawing conclusions on average monetary wealth gains or losses. In contrast, mean BHARs can easily be interpreted as mean wealth gains or losses in percentage points of the capital invested. Stehle and Ehrhardt (1999) provide a discussion of different measures for the long-run performance of IPOs.

IPO activity exhibits clustering in time and across industries. As a consequence, standard t-statistics for hypotheses tests are inefficient (see, e.g. Kothari and Warner 2006). We apply the transformed t-statistic proposed by Hall (1992). This statistic allows efficient hypotheses tests even in case of severely skewed distributions.[15]

Table 4 exhibits the $\overline{BHAR}_H^S$ of the each-IPO investment strategies S=1 and S=2 for holding periods of three and five years compared to the CDAX and the ewDAFOX in the sample and sub sample periods. At the end of the sample periods, all IPO investments are liquidated irrespective of the time elapsed since the going public.[16] We observe non-significant outperformance in case of an equally weighted investment in IPO firms between 1985 and 1995 with holding periods of 36 months. All other variations of the each-IPO investment strategies underperform the benchmark. The magnitude of the underperformance varies between and within the two strategies depending on the sample period, the holding period and the benchmark portfolio. Firstly, we take a closer look at the performance of the equally weighted strategy 1. It is remarkable that strategy 1 performs considerably worse with 60 months holding periods than with 36 months holding periods irrespective of the sample period and the benchmark. According to the p-values of the skewness adjusted t-statistic, the underperformance for three year holding periods is not significant, whereas the underperformance for five year holding periods is highly significant except for the first sub sample period in comparison to the CDAX. The separation of the sample period into the sub samples 1985 to 1995 and 1996 to 2002 reveals that investment strategy 1 performs substantially worse in the second sub sample. In the first sub sample, statistically significant underperformance can only be found compared to the ewDAFOX with a holding period of 60 months.[17] Irrespective of holding period and sample period, mean BHARs are lower compared to the value weighted CDAX than compared to the equally weighted ewDAFOX. This points to a relative out-performance of the ewDAFOX compared to the CDAX in the average

---

15 Lyon, Barber and Tsai (1999) suggest a bootstrapped version of Johnson's (1978) transformed t-statistic. However, Hall (1992) applies simulations to demonstrate that his transformed t-statistic is more efficient than the one suggested by Johnson (1978) as the latter does not fully adjust for skewness.

16 Consequently, the average holding period of IPOs in the sample periods is lower than 36 months and 60 months, respectively. In case of the entire sample period, the average holding period amount to 33.7 and to 45.6 months, respectively. The average holding periods in the sub sample period 1985 to 1995 amount to 30.9 and 48.0 months, respectively, while in the sub sample period 1996 to 2002 they amount to 32.8 and 39.7 months, respectively. In an analysis not presented in this paper, we analyse the performance of strategies 1 and 2 if the IPO investments may be held up to December 2004. This raises the averages holding period close to 36 and 60 months. In this analysis we observe even worse underperformance in any case. However, the significance levels as well as the patterns of abnormal returns with respect to the benchmark, the holding period and the sample period do not differ from the results reported here.

17 A critical reader might be surprised by the fact that mean BHARs to the CDAX in the entire sample period are higher than the sum of mean BHARs in the sub samples even though the whole sample period consists of both sub samples. The rationale is that in the first sub period, the return series of IPOs are cut after December 1995. In the entire sample period the return series of firms that went public till December 1995 are considered completely.

calendar time holding period. In turn, this implies that firms predominantly went public prior to periods in which small firms outperformed large firms.

Table 4: Mean BHARs of each-IPO investment strategies for holding periods of 36 and 60 months

Holding periods of 36 and 60 months indicate maximum holding periods as each IPO investment is liquidated at the end of the sample periods (1995 and 2002, respectively). $\overline{BHAR}_H^S$ is calculated according to expression (2). Italic figures below $\overline{BHAR}_H^S$ are p-values of skewness-adjusted t-statistics according to Hall (1992). P-values of strategy 2 $\overline{BHAR}_H^{S=2}$ are calculated by duplicating $\overline{BHAR}_H^{S=2}$ based on the market value at the end of the IPO month. The number of duplications is determined by the number of 10 million € pieces of market value exceeding a market value of 10 million €.

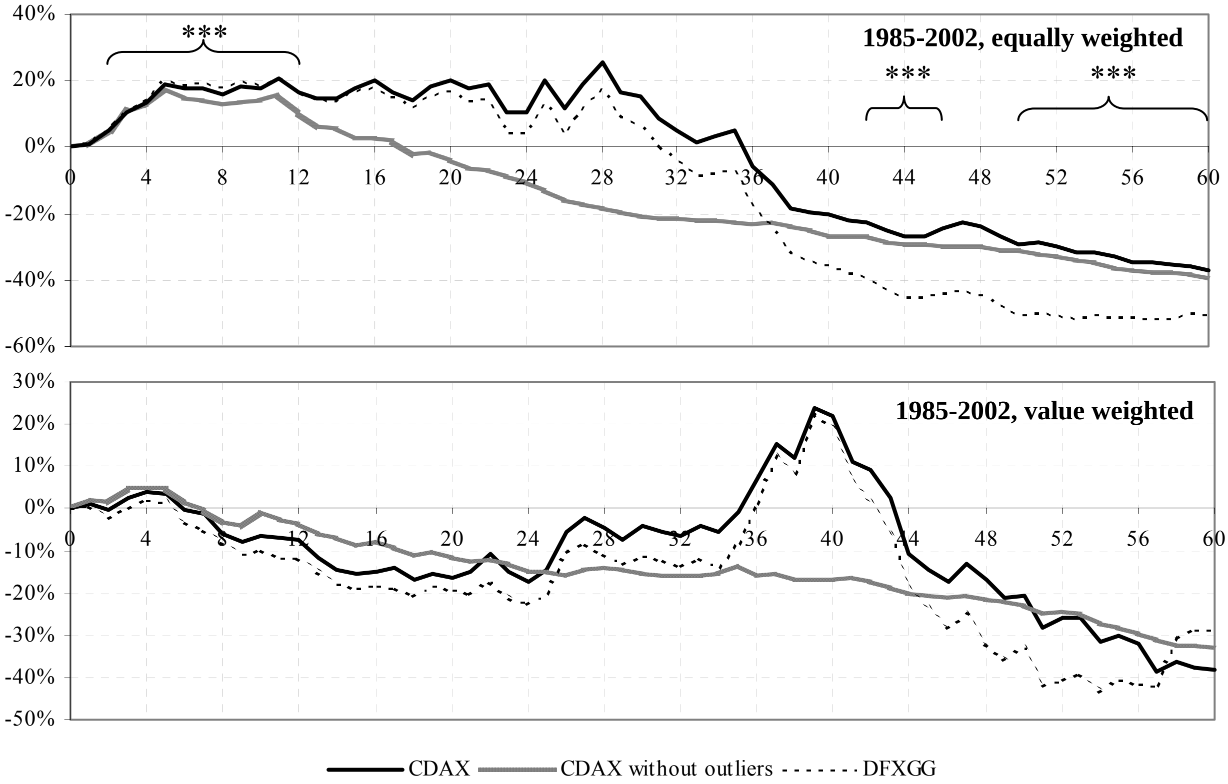
		Equally weighted (Strategy S=1)				Value weighted (Strategy S=2)			
Benchmark portfolio		**CDAX**		**ewDAFOX**		**CDAX**		**ewDAFOX**	
Holding period		**H=36**	**H=60**	**H=36**	**H=60**	**H=36**	**H=60**	**H=36**	**H=60**
85-02	$\overline{BHAR}_H^S$	-4.87%	-30.29%	-15.59%	-44.05%	-6.07%	-29.98%	-18.98%	-48.74%
N = 667	*p-value*	*0.8798*	*0.0000*	*0.5384*	*0.0004*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
85-95	$\overline{BHAR}_H^S$	2.80%	-6.91%	-5.93%	-14.79%	-13.28%	-20.74%	-17.33%	-24.68%
N = 196	*p-value*	*0.5144*	*0.2094*	*0.1973*	*0.0068*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
96-02	$\overline{BHAR}_H^S$	-3.51%	-28.86%	-18.61%	-53.63%	-3.89%	-26.11%	-3.95%	-26.19%
N = 471	*p-value*	*0.9895*	*0.0000*	*0.5992*	*0.0000*	*0.0012*	*0.0000*	*0.0005*	*0.0000*

The value weighted investment strategy 2 results in similar underperformance when investing over the whole sample period. Again, holding each IPO for 60 months considerably increases underperformance. In contrast to strategy 1, however, IPOs significantly underperform the benchmark for the 36-months holding period, too. A comparison of the first and the second sample period reveals investing equally weighted in IPOs was preferable to investing value weighted between 1985 and 1995, while value weighted IPO investments performed better than equally weighted investments between 1996 und 2002. This allows further insights into the relation between size and long-run performance. Weighting each IPO equally results in lower underperformance in the first sub-period. In turn, this implies that the average underperformance of investment strategy 1 is mainly caused by large IPOs. In the second sub period, however, small IPOs are the main drivers of the average underperformance.

Further, we analyse the relation between $\overline{BHAR}_H^S$ and the length of the holding period. Figure 1 shows the long-run performance of all IPOs compared to the CDAX and the ewDAFOX for holding periods between 1 and 60 months. The upper graph plots the long-run abnormal performance of equally weighted IPOs, while the lower graph plots the long-run abnormal performance if IPOs are weighted according to their market value at the end of the IPO month. Bold black lines illustrate the IPO performance compared to the CDAX, dashed black lines the performance compared to the ewDAFOX and hatched grey lines the performance to the CDAX if outliers are excluded. Note that these graphs resemble, but do not exactly mirror investment strategies 1 and 2. Here, a data point for a certain holding period *H* only comprises IPOs whose return series is long enough to compute a $BHAR_{H,i}$. For example, the $\overline{BHAR}^{S}_{H=60}$ comprises 601 IPOs.

Figure 1: Average BHAR in relation to the holding period

The upper graph plots $\overline{BHAR}^{S=1}_{H}$ for different holding periods H=1,…,60 if IPOs are weighted equally. The lower graph plots $\overline{BHAR}^{S=2}_{H}$ for different holding periods H=1,…,60 if IPOs are weighted according to their market value at the end of the IPO month. Bold black lines illustrate the performance of IPOs compared to the CDAX. Dashed black lines illustrate the performance of IPOs to the ewDAFOX. Hatched grey lines illustrate the performance of IPOs compared to the CDAX if the following three outliers are excluded: Ballmaier & Schultz Wertpapier AG, Frankfurt, Mobilcom AG, Büdelsdorf and EM.TV & Merchandising AG, Unterföhring. Curly braces indicate holding periods associated with a significant out- or underperformance compared to the CDAX on a 1% significance level.



The upper graph reveals that IPOs outperform their benchmarks by roughly 20% for short holding periods. The outperformance to the CDAX illustrated by the bold black line is highly significant for holding periods between 2 and 12 months. Only after three years IPOs perform worse than the CDAX. We observe highly significant underperformance to the CDAX for holding periods between 42 and 46 months as well as for holding periods greater than 50 months. The IPO performance to the ewDAFOX is similar for holding periods up to 20 months. Thereafter, the IPOs perform worse on average than compared to the CDAX. The hatched grey line provides further insights into the drivers of the IPO performance as it represents the IPO performance to the CDAX if three extreme outliers are excluded. These outliers are Ballmaier & Schulz Wertpapier AG (B&S), a securities broker, Mobilcom AG, a mobile telecommunication provider and EM.TV & Merchandising AG, a multimedia firm. B&S went public in July 1994 and experienced an extreme stock price jump in spring 1998 resulting in a *BHAR* of 3,746% after 47 months. The lack of significance of the underperformance between 45 and 47 months reflects the B&S stock price jump. Mobilcom went public in March 1997 and peaked at a BHAR of 2,474% after 22 months. The EM.TV stocks that were taken public in October 1997 reached the highest relative price levels in the IPO sample culminating in a BHAR of 27,820% after 28 months. The deviation of the hatched grey line from the bold black line between 10 and 44 months reflects the extreme performance of Mobilcom and EM.TV. Without these two outliers, IPOs would have performed worse than the CDAX after a holding period of 18 months yet. Excluding all outliers, the IPO underperformance almost monotonically increases in the holding period.

As the lower graph shows, weighting each IPO according to its market value generates a very different picture. Here, IPOs only slightly outperform the CDAX or the ewDAFOX for holding periods up to six months. Holding each IPO longer than six months results in an average performance that is worse than investing in the benchmarks except for holding periods between 35 and 43 months in case of the CDAX and between 36 and 42 months in case of the ewDAFOX, respectively. Here, results are driven by an extreme outlier Deutsche Telekom AG. This firm reached the highest overall market value in our sample by far. Deutsche Telekom's value culminated in 186.2 billion € 39 months after the IPO in February 2000 which is reflected in the peak of the IPO performance relative to the CDAX after 39 months. Excluding this outlier, the value weighted performance of IPOs is similar to the equally weighted performance in the sense that the value weighted performance increases in the holding period, too. The level of underperformance is higher in case of equally weighted IPOs for holding periods greater than 27 months.

2.4 IPO-portfolio investment strategies

Investors pursuing the IPO portfolio investment strategies 3 and 4 do not invest in each IPO, but in a portfolio that comprises firms that went public recently. The IPO portfolio may either be equally weighted (strategy 3) or value weighted (strategy 4). The meaning of "recently" may be arbitrarily concretised by choosing a certain formation period. We concentrate on formation periods of 36 and 60 months which is in line with the holding periods in the each-IPO investment strategies. With IPO portfolio investment strategies, investors put money into the IPO portfolio only once at the beginning of the investment period. At the end of each month the investors rebalance the IPO portfolio by including firms that went public this month and by taking out firms for which the time since IPO exceeds the formation period. In addition, strategy 3 requires monthly rebalancing in order to keep the portfolio equally weighted. Transaction costs associated with portfolio rebalancing are not incorporated in our analysis. As discussed in the introduction, we assume individual investors implement IPO portfolio investment strategies through the purchase of investment funds or certificates that duplicate the IPO portfolio at low transaction costs. We calculate the excess return $BHAR^{S}_{F,\mathrm{T}}$ of investment strategies S=3 or S=4 for a formation period of F=36 or F=60 months and a sample period of T calendar months as

$$BHAR_{F,T}^{S} = \prod_{t=1}^{T}\left[\sum_{i=1}^{N_{F,t}} w_{i,t,F}^{(S)}\left(1+R_{i,t}\right)\right] - \prod_{t=1}^{T}\left[1+R_{B,t}\right] \qquad (3)$$

where

$R_{i,t}$ = return of firm i in calendar month t,
$R_{B,t}$ = return of the benchmark portfolio B in calendar month t,
$N_{F,t}$ = number of firms that went public in the F months prior to calendar month t,
$w_{i,t,F}^{(3)}$ = $1/N_{F,t}$ in case of each IPO is weighted equally (strategy 3) and
$w_{i,t,F}^{(4)}$ = market value of firm i in calendar month t divided by the sum of the market values of all $N_{F,t}$ firms that went public in the F months prior to calendar month t (strategy 4).

We test the null hypothesis $BHAR_{F,T}^{S} = 0$ against the alternative hypothesis $BHAR_{F,T}^{S} \neq 0$. In contrast to the each-IPO investment strategies, we do not have a distribution of abnormal returns that could serve as a basis for statistical tests. When calculating the performance of IPO-portfolio investment strategies according to expression (3), we obtain a single data point instead. We apply a bootstrapping procedure in order to generate an empirical distribution of $BHAR_{F,T}^{S}$. We proceed as follows: From our entire sample period of 215 calendar months we randomly draw (with replacement) a new sample of 215 months. Since tests for serial correlation reveal that the returns of the ewDAFOX and the IPO portfolios are positively autocorrelated at lag one, we apply an overlapping block resampling procedure as described in detail by Davison and Hinkley (1997).[18] We calculate the $BHAR_{F,T}^{S*}$ of the newly generated sample period from the empirical IPO portfolio and benchmark returns associated with the calendar months in the randomly drawn sample. This procedure is repeated X = 10,000 times. We can now use the empirical distribution of 10,000 $BHAR_{F,T}^{S*}$ to calculate an empirical p-value to test the null hypothesis.[19]

---

18 We use blocks of six consecutive months. In general, the goodness of the resampling approximations in case of autocorrelation in the original data increases with the block length. In our sample, however, the approximations for block length of 3, 12 and 24 months only slightly differ from the six-months blocks reported here. To ensure that each return observation can be drawn with equal chance, the data is wrapped around a circle by adding the first five returns to the end.

19 In order to determine the critical values of the empirical distribution, we sort the $BHAR_{F,T}^{S*}$ in ascending order yielding the order statistics $BHAR_{F,T,[1]}^{S*} \leq ... \leq BHAR_{F,T,[X=10000]}^{S*}$. For a significance level α the critical values are equal to $BHAR_{F,T,[1-\alpha/2)X]}^{S*}$ and $BHAR_{F,T,[\alpha/2\cdot X]}^{S*}$, respectively. As the empirical distribution of $BHAR_{F,T}^{S*}$ is asymmetric due to the multiplicative combination of monthly returns, we mirror the critical values on the mean of the distribution of $BHAR_{F,T}^{S*}$ according to the percentile bootstrapping method (e.g., see Trede 2002). Let $\overline{BHAR}_{F,T}^{S*}$ denote the mean and define $c_{low} = 2\overline{BHAR}_{F,T}^{S*} - BHAR_{F,T,[(1-\alpha/2)X]}^{S*}$ and $c_{high} = 2\overline{BHAR}_{F,T}^{S*} - BHAR_{F,T,[\alpha/2\cdot X]}^{S*}$. The null hypothesis is rejected if 0 lies outside of the interval [c_{low},c_{high}]. P-values indicate the smallest α and hence widest range [c_{low}, c_{high}] for which the null hypothesis is rejected. We proceed in the same way in case of the sub sample periods.

Table 5 shows buy-and-hold abnormal returns of IPO-portfolio investment strategies for formation periods of 36 and 60 months. We analyse the performance of the equal weighting strategy 3 in comparison to the equally weighted ewDAFOX and the performance of the value weighting strategy 4 to the value weighted CDAX. Note that the number of calendar months T does not equal the number of years in the sample period times twelve as we observe the first calendar month IPO return in February 1985. In the sub sample 1996-2002 we observe the first calendar month IPO return in July 1996. In case of the entire sample period, the buy-and-hold return of the IPO portfolio is considerably lower than the buy-and-hold return of the benchmark portfolio. For example, pursuing strategy 3 yields a difference of IPO return and benchmark return of more than -265% for 60 months formation periods.

Consistent with our findings for the each-IPO investment strategies, the equally weighted IPO-portfolio investment strategy performs worse than the value weighted strategy. The underperformance of the 60 months formation period differs only slightly from the 36 months formation period. This contrasts to the impact of holding periods on the performance of each-IPO strategies. In spite of the large underperformance, the p-values obtained by bootstrapping indicate no statistical significance. The BHARs for the sub sample periods are negative, too, even though the absolute level of underperformance is substantially lower. In the first sub period strategy 4 performs worse than strategy 3, while in the second sub period strategy 4 outperforms. This indicates that small IPOs perform disproportionately well in the first sub period and disproportionately poorly in the second sub period which is consistent with our findings for each-IPO investment strategies. Again, the sub sample BHARs are not statistically significant.

Table 5: IPO-portfolio investment strategies BHARs for formation periods of 36 and 60 months

$BHAR_{F,T}^{S}$ are calculated according to expression (3). P-values are based on empirical distributions of $BHAR_{F,T}^{S}$ generated by 10,000 bootstrapped resamples of the original sample of calendar months. P-values indicate the smallest significance level α and hence widest range [c_{low},c_{high}] for which the null hypothesis is rejected. T indicates the number of calendar months in the (sub) sample.

		Equally weighted (Strategy S=3)		**Value weighted (Strategy S=4)**	
Benchmark		**ewDAFOX**		**CDAX**	
Formation period		**F=36**	**F=60**	**F=36**	**F=60**
85-02	$BHAR_{F,T}^{S}$	-251.23%	-265.73%	-179.33%	-194.60%
T = 215	*p-value*	*0.4096*	*0.2716*	*0.4666*	*0.2916*
85-95	$BHAR_{F,T}^{S}$	-67.56%	-79.88%	-109.39%	-105.37%
T = 131	*p-value*	*0.2654*	*0.2368*	*0.2786*	*0.2773*
96-02	$BHAR_{F,T}^{S}$	-71.76%	-68.16%	-42.28%	-45.38%
T = 78	*p-value*	*0.6687*	*0.6718*	*0.3578*	*0.6490*

In the light of the large underperformance observed, it appears that IPO-portfolio investment strategies are very unattractive to investors. However, we can infer from the non-significant p-values that IPO-portfolio strategies are not unattractive in general. In addition, we can conclude that those strategies are more attractive than each-IPO investment strategies since the latter strategies performed significantly worse than their benchmark in many cases. This surprising result is confirmed by the calculations presented in Table 6. Here, we compare the monthly mean abnormal performance of the equal weighting strategies 1 and 3. We obtain monthly means for strategy 1 as follows: For each IPO we calculate the monthly mean abnormal return by subtracting the monthly geometric mean return of the benchmark portfolio from the monthly geometric mean of IPO returns. The monthly mean abnormal returns are the arithmetic averages of the IPO mean abnormal returns in the different settings. For strategy 3, we calculate monthly mean abnormal returns as geometric averages of the monthly abnormal returns in the sample periods. We find negative monthly mean abnormal returns with strategy 1 as well as with strategy 3. Yet, the magnitude of monthly underperformance with strategy 1 is a multiple of the strategy 3 underperformance for the entire sample period and the later sub sample period. In sub period 1985 to 1995 strategy 1 monthly underperformance is still greater than that of strategy 3. Strategy 1 monthly mean abnormal returns are highly significant in any case, while strategy 3 monthly mean abnormal returns are significant in no case. These results strongly support our findings for the performance of investment strategies.

Table 6: Monthly mean abnormal returns of strategies 1 and 3

Months specifies the length of the holding period in case of strategy 1 and the length of the formation period in case of strategy 3. In case of strategy 1, mean refers to the arithmetic mean of the monthly mean abnormal returns of the IPOs in the sample where the monthly mean abnormal return of each IPO is calculated by subtracting the monthly geometric mean return of the benchmark portfolio from the monthly geometric mean of IPO returns. In case of strategy 3, mean refers to the geometric mean of the monthly abnormal returns in each sample period. P-values are based on t-statistics in case of strategy 1. P-values are based on t-statistics of the log-transformed distribution of the monthly returns in case of strategy 3. N specifies the number of IPOs in the sample period of strategy 1. T specifies the number of calendar months in the sample period of strategy 3.

		Each-IPO investment strategy (S=1)				**IPO-portfolio investment strategy (S=3)**			
Benchmark		**CDAX**		**ewDAFOX**		**CDAX**		**ewDAFOX**	
		H=36	**H=60**	**H=36**	**H=60**	**F=36**	**F=60**	**F=36**	**F=60**
85-02	Mean	-3.43%	-3.60%	-4.08%	-4.40%	-0.57%	-0.65%	-0.57%	-0.64%
	p-value	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.1506*	*0.0704*	*0.1247*	*0.0541*
	N / T	667	667	667	667	215	215	215	215
85-95	Mean	-0.38%	-0.58%	-0.26%	-0.42%	-0.25%	-0.29%	-0.22%	-0.27%
	p-value	*0.0035*	*0.0000*	*0.0492*	*0.0023*	*0.5984*	*0.4817*	*0.1924*	*0.1037*
	N / T	196	196	196	196	131	131	131	131
96-02	Mean	-4.62%	-4.75%	-5.52%	-5.90%	-0.99%	-0.91%	-1.09%	-1.00%
	p-value	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.2536*	*0.2756*	*0.2670*	*0.2830*
	N / T	471	471	471	471	78	78	78	78

Recall that the performance of all investment strategies is calculated by the very same monthly returns of the IPOs and the benchmarks, respectively. Thus, any difference in performance among strategies must be due to the different methods of aggregating monthly returns defined by expressions (2) and (3). Each-IPO investment strategies imply an equal (respectively market value) weighting of each IPO irrespective of calendar month, while IPO-portfolio investment strategies imply an equal weighting of each calendar month irrespective of the number of IPOs in a calendar month. In the latter strategies, each IPO's weight in a calendar month return depends on the number of IPOs in the formation period of that calendar month. It follows that the more firms go public within a certain formation period, the less weight is attributed to each IPO.

As we observe significant underperformance with each-IPO investment strategies but not with IPO-portfolio investment strategies, we can infer that IPOs performed disproportionately poorly in periods of high issuance activity. This pattern is consistent with international evidence that IPOs in hot markets perform worse than IPOs in cold markets (e.g., see Helwege and Liang 2004). This leads to section III which discusses Pseudo Market Timing as an explanation for the differences in underperformance among investment strategies.

3 Pseudo Market Timing

3.1 Market Timing vs. Pseudo Market Timing

Market timing describes a manager's ability to explicitly time an IPO into a period of irrational overvaluation of his firm, the firm's industry or the entire stock market. As a matter of fact, two out of three CFOs responding to a survey by Graham and Harvey (2001) confirm the considerable influence of over- or undervaluation on the decision to go public.

Two phenomena are frequently considered to be empirical indicators for IPO market timing in the literature. Firstly, IPOs cluster at market peaks or in times of high market-to-book ratios of comparable firms. Secondly, firms going public at market peaks or in times of high IPO activity perform considerably worse than firms going public in other times.[20] Our comparison of each-IPO investment strategies to IPO-portfolio investment strategies suggests the same phenomena for German IPOs. Regarding these phenomena, Ritter (1991) was the first to suppose that managers identify periods of overvaluation of IPOs („windows of opportunity") and choose such periods to go public.[21] However, neither a concentration of IPOs at market

[20] Loughran and Ritter (1995, 2000), Webb (1999) and Helwege and Liang (2004) find evidence for the US market, Keloharju (1993) for the Finnish market and Page and Reyneke (1997) for the South-African capital market. Lerner (1994) shows that venture capitalists predominantly take their firms public at market peaks.

[21] An overvaluation of IPOs on the secondary market could be the consequence of an irrational investors' behaviour on the primary market. In a survey by Shiller (1990), only 43% of US investors stated to subscribe for IPOs on the basis of fundamentals. 57% subscribe because of attractive products or promising strategic concepts of the firms. Loughran and Ritter (2004) suppose that investors were subject to herding behaviour during the internet bubble. An IPO oversubscription due to irrational investors on the primary market could signal an inflated firm value to the secondary market.

peaks nor long-term negative abnormal returns of IPOs around market peaks necessitate that the managers have indeed identified a peak and knowingly time the market. If managers were able to identify overvaluations, IPO activity could predict future returns. Indeed, Baker and Wurgler (2000) provide evidence that the proportion of equity issuance in total securities issuance predicts future equity returns in the US.[22] Yet, there are also studies that find phenomena and behaviour patterns on US capital markets that contradict the market timing hypothesis. For instance, on the basis of data about insider-trading, Lee (1997) shows that managers buy shares prior to price declines. This is contradictory if managers have market timing abilities. Spiess and Affleck-Graves (1999) find stock underperformance following to debt issuance, although market timing predicts that firms issue debt in times of undervaluation which should result in outperformance after debt issues. Hence, there is no clear evidence for managers' ability to time the market in the US.

There is even less evidence for market timing in Germany. For instance, Rehkugler and Schenek (2001) have to reject the market timing hypothesis as they find larger underperformance for firms that went public in periods of low IPO activity. Similarly at odds with market timing, Loughran, Ritter and Rydqvist (1994) detect a positive correlation between the number of IPOs and future returns. The finding of Rath, Tebroke and Tietze (2004) that market sentiment at the date of the IPOs on Neuer Markt is negatively correlated to their long-run performance is no reliable indicator for market timing on Neuer Markt given the short sample period.

Schultz (2003) shows that a concentration of IPOs around market peaks and long-run negative abnormal returns of IPOs are not necessarily a consequence of managers timing the market und hence, a consequence of market inefficiencies. Instead, in efficient capital markets negative abnormal returns of IPOs can be observed if the following conditions hold: The probability of a going public increases with the price level of the market and of recent IPOs in particular. Furthermore, excess returns of recent IPOs in a calendar month need to be positively correlated. In this case, IPO clustering at market peaks occurs which might be misleadingly perceived as market timing. Schultz (2003) finds that this pseudo market timing can explain the level of long-run underperformance observed in the US in event time. Butler, Grullon and Weston (2005) attribute the predictive power of the proportion of equity issuance found by Baker and Wurgler (2000) to pseudo market timing.

---

[22] Apart from using IPO clustering and performance as an indicator for market timing, market timing could be tested based on a measure of investor sentiment that indicates market overvaluations. Lee, Shleifer and Thaler (1991) use the closed-end fund discount as an indicator of investor sentiment where low discounts point to overvaluations. Indeed, they find that more firms go public at times of a low closed-end fund discount. Their result is confirmed by Lowry (2003). Rajan and Servaes (1997) find that IPO activity is positively correlated with analysts' optimism about the growth prospects of recent IPOs.

The first condition states that managers or owners take the price level of a benchmark portfolio into account when deciding about an IPO. The entire stock market, a benchmark firm or a portfolio of recent IPOs could serve as appropriate benchmark portfolios. The assumption that managers consider absolute price levels instead of relative performance prior to an IPO can be rationalised as follows:[23] An increasing market price level or increasing price levels of particular industries imply new investment opportunities. These investments have to be funded at least partly by equity. Thus, IPO activity should be positively correlated with price levels. Regardless of the underlying investment opportunities, an IPO's attractiveness rises with increasing expected proceeds. Loughran, Ritter and Rydqvist (1994) provide empirical evidence for a positive correlation between IPO activity and stock market price levels in several countries. Pagano, Panetta and Zingales (1998) detect a positive correlation between the probability of Italian firms to go public and the market value of firms in the same industry. Pastor and Veronesi (2005) find a positive correlation between the valuation of IPOs relative to the entire market valuation and IPO activity. Secondly, pseudo market timing requires a positive correlation among the abnormal returns of recent IPOs in a calendar month in order to observe fluctuations of the aggregate price level of IPOs in excess of fluctuations of market price levels. As IPOs of firms within a certain industry cluster in certain time periods, a positive correlation of abnormal returns is plausible.

If managers behave as described above, IPOs concentrate around market peaks even if managers do not possess timing abilities. In other words: Even though managers are ex ante not able to predict a market peak and hence a trend reversal in share prices, ex post it seems as if managers time the market as IPOs cluster around market peaks. However, this clustering does not reflect any superior abilities of managers, owners or investment bankers to identify periods of overvaluations. Market timing is simply a statistical illusion. Hence, Schultz calls this phenomenon pseudo market timing. If managers behave as predicted by pseudo market timing, and the second condition concerning the correlation of IPO returns holds, negative long-run performance of IPOs will be observed when averaging over all IPOs irrespective of the market's efficiency. The extent of negative abnormal returns induced by pseudo market timing in the each-IPO investment strategies depends on the variance of IPO returns to the benchmark returns. The expected return of a perfect benchmark portfolio should equal the expected IPO return. Yet, IPO returns and benchmark returns do not have to be perfectly positively correlated. The greater the variance of IPO returns compared to benchmark returns, the greater the abnormal performance. It follows from this property that if the benchmark portfolio yields positive returns, the IPOs are likely to yield even greater positive abnormal returns. On the other hand, if the benchmark portfolio's price drops, the IPO prices are likely to drop even further, resulting in a negative abnormal performance. As market drops are preceded

---

[23] Pastor and Veronesi (2005) provide evidence for a positive correlation between IPO activity and the market returns rather than market price levels.

by higher prices and thus, by greater IPO activity, the IPO underperformance in bear markets weights heavier than the outperformance in bull markets if pursuing an each-IPO investment strategy.[24]

Thus, pseudo market timing predicts that each-IPO investment strategies underperform in the long-run which is in line with our empirical findings. If each calendar month is weighted equally, however, IPOs do not underperform their benchmarks in efficient capital markets as a clustering of IPOs is irrelevant in an analysis based on calendar time. Thus, pseudo market timing predicts that IPO portfolio investment strategies do not underperform their benchmarks. Indeed, we observe underperformance of IPO portfolio investment strategies, but not on a statistically significant level.

3.2 Price levels and IPO activity

In order to analyse the ability of pseudo market timing to explain the performance of each-IPO investment strategies in Germany, we first estimate the extent to which managers or owners take price levels into account when deciding to go public. In order to control for the discrete and non-negative nature of the dependent variable (*NoIPOs*), we apply a count data regression model.[25] A natural starting point is the poisson regression model, where the dependent variable follows a poisson distribution with mean μ_t in each time point t. μ_t is linked to the independent variables $x_{1,t},\ldots,x_{n,t}$ as follows:

$$\mu_t = \exp(\beta_0 + \beta_1 x_{1,t} + \ldots + \beta_n x_{n,t}) \qquad (4).$$

Unfortunately, the poisson distribution with density $f(y \mid \mu_t) = \exp(-\mu_t)\mu_t^y / y!$ has only one free parameter μ_t which at the same time corresponds to the mean and the variance of the distribution. As in our sample, count data usually shows more variability than can be accounted for by the poisson distribution. Hence, we introduce a stochastic parameter ε to allow for unobserved heterogeneity:

$$\begin{aligned}\mu_t &= \exp(\beta_0 + \beta_1 x_{1,t} + \ldots + \beta_n x_{n,t} + \varepsilon) \\ &= \exp(\beta_0 + \beta_1 x_{1,t} + \ldots + \beta_n x_{n,t})\exp(\varepsilon)\end{aligned} \qquad (5).$$

Let the unobservable random variable $z = \exp(\varepsilon)$ follow a gamma distribution with density $g(z \mid \alpha, \beta) = 1/(\Gamma(\beta)\alpha^{\beta}) z^{\beta-1} \exp(-z/\alpha)$ and with parameters $\alpha > 0, \beta > 0$. Setting $\beta = 1/\alpha$, this gamma distribution has mean 1 and variance α and therefore does not bias the model, but introduces unobserved heterogeneity. Especially, for $\alpha \to 0$ we yield the simple

---

[24] Schultz (2003), pp. 485, provides further discussions and examples for the pseudo market timing phenomenon and its impact on the performance of IPOs.

[25] See Green (2003), p. 740 or Cameron and Trivedi (1998), pp. 100. Dahlquist and De Jong (2004) apply similar count data regression models in order to analyse pseudo market timing in the US. Schultz (2003), however, ignores the count data characteristics of the number of IPOs and applies linear regression models.

poisson regression model since then z equals 1 deterministically. The distribution of the dependent variable now results from the marginal distribution with density

$$\begin{aligned} h(y \mid \mu_t, \alpha) &= \int_0^{\infty} f(y \mid \mu_t, z) g(z \mid \mu_t, \alpha) dz \\ &= \frac{\Gamma(\alpha^{-1} + y)}{\Gamma(\alpha^{-1})\Gamma(y+1)} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu_t} \right)^{\alpha^{-1}} \left(\frac{\mu_t}{\alpha^{-1} + \mu_t} \right)^{y} \end{aligned} \quad (6).$$

This is a negative binomial distribution with mean μ_t and variance $\mu_t(1+\alpha\mu_t)$. Thereby we come up with the negative binomial regression model which nests the poisson regression model, as noted earlier. Standard statistic packages implicitly test the explanatory power of the poisson regression model against the more general negative binomial model ($\alpha = 0$ vs. $\alpha \neq 0$). It turns out that negative binomial models fit our data better than the poisson model at a 1% significance level.

If possible, the natural logarithms of the independent variables enter the regression models to avoid a fixed exponential link, but to allow for different functional links between the independent variables and the dependent variable.[26] We apply the log levels of the CDAX (ln_CDAX) and of an index of recent IPOs (ln_IPOidx) as proxies for price levels.[27] The CDAX is set to 100 in January 1985. Starting with a level equal to 100 in January 1985, the IPO index is calculated as a monthly equally weighted performance index consisting of companies whose IPOs date back a maximum of three years. The price level proxies enter the regression model with a one-month lag, as the price level at the end of the previous month should be a predictor of the number of IPOs in the current month. Regarding the complex process of going public, the actual decision to go public is taken approximately six months prior to the first listing on the stock exchange. Thus, we also include the CDAX and the IPO index with lags of three and six months in the regression models.

In addition, we consider several control variables in our regression models. To control for autocorrelation in the number of IPOs, we include the log number of IPOs (ln_NoIPOs) with lags of one, three and six months. Further, we observe calendar time effects in IPO activity. In particular, a significantly smaller number of firms went public in January (cold_month), possibly owing to the vacation period between Christmas and New Year's eve which hampers the registration process and the promotion of new issues (see Lowry 2003). In June, July, October and November (hot_months), the IPO activity is significantly higher than

---

26 To see this make a change of variables in equation (4) from $x_{j,t}$ to $\ln(x_{j,t})$, presuming $x_{i,t} > 0$. Then we yield $\mu_t = \exp(\beta_0) \cdot x_{1,t}^{\beta_1} \cdot \ldots \cdot x_{n,t}^{\beta_n}$. Thus, we allow for polynomial ($1 \leq \beta_j$), root ($0 < \beta_j < 1$), reciprocal polynomial ($\beta_j \leq -1$) and reciprocal root ($-1 < \beta_j < 0$) influences of the independent variables. β_0 determines the scaling factor.

27 As an alternative to the CDAX, the regression models are also estimated applying the ewDAFOX as proxy for market price levels. The results are not reported here since they differ marginally only.

in the remaining months. This phenomenon can be attributed to the release of updated corporate planning figures which facilitate the valuation of the IPO firm (Bösl 2004, pp. 57). These calendar month effects are allowed for by the dummy variables cold_month and hot_months, respectively. The dummy variable hot_market captures the change in going public behaviour associated with the hot IPO market between 1998 and 2000.

Table 7 presents the coefficient estimates for eight negative binomial regression models with the number of IPOs as the dependent variable based on the historic IPO activity and price levels in Germany between 1985 and 2002. Note that the interpretation of a coefficient is not straightforward as its impact on the number of IPOs at a certain point of time depends on the realisations of the other independent variables at that point of time.[28] However, the sign of the regression coefficients is unambiguous. A negative sign indicates a negative correlation between the independent and the dependent variable and vice versa. The Pseudo R^2 is calculated according to Cameron and Trivedi (1998), p. 154. The Pseudo R^2 of a negative binomial regression estimation is generally lower than in poisson regressions and in OLS regressions. To give a rough impression of the explanatory power of our regression models, we calculate squared correlation coefficient between the realisations and the predicted values of the dependent variable, denoted by correlation-based R^2 in table 7. The only theoretically correct measure for the models' explanatory power is, however, the Pseudo R^2.

Model I comprises the calendar time control variables only. All coefficients are highly significant and exhibit the signs expected regarding the dummy definitions. As the model highly significantly fits the data, we keep the calendar time control variables in the following regression models. Models II to IV provide insights into the separate explanatory power of IPO price levels, market price levels and the previous number of IPOs at one-month, three-months and six-months lags. The coefficients at lag t-1 and at t-6 are significant in each case, though the signs of IPO price levels and market price levels at lag t-6 are counterintuitive. The coefficients of the dependent variables at lag t-3 are significant in no case.

[28] Since the mean in each time point t is given by equation (4), a one-unit change in the j-th independent variable $x_{j,t}$ increases the expectation μ_t by $\partial\mu_t / \partial x_{j,t} = \beta_j \exp(\beta_0 + \beta_1 x_{1,t} + \ldots + \beta_n x_{n,t})$. This change depends on the current values of the other independent variables in each point of time. See Cameron and Trivedi (1998), p. 80.

Table 7: Negative binomial regression estimations of the number of IPOs

The dependent variable in all negative binomial regression models is the number of IPOs at time t. Independent variables are the natural logarithm of the price level of an index comprising the IPOs of the last 36 months (ln_IPOidx), the natural logarithm of the CDAX level (ln_CDAX), the natural logarithm of the number of IPOs (ln_NoIPOs) and dummy variables for June, July, October and November (hot_months), for January (cold_month) and for the hot IPO market phase in Germany from January 1998 to December 2000 (hot_market). The IPO index and the CDAX are set 100 in January 1985. Time lags of 1/3/6 month(s) are indicated by t-1/3/6. In each model, the α is significantly different from 0, indicating that the negative binomial regression model fits the data better than the poisson regression model. N denotes the number of observations. Since we apply explanatory variables with lag t-6, we have 210 observations from July 1985 to December 2002. Prob > χ^2 indicates the probability that a constant-only model fits the data better than the given model. Pseudo R^2 denotes the explanatory power of the negative binomial regression models. Corr.-based R^2 indicates the models' explanatory power calculated as the squared correlation coefficient between the realisations and the predicted values.

Model	I	II	III	IV	V	VI	VII	VIII
Indep. variables								
ln_IPOidx_{t-1}		2.2208			1.3751		1.8542	2.0588
		0.0000			*0.0000*		*0.0070*	*0.0000*
ln_IPOidx_{t-3}		-0.2843					-0.3192	
		0.6430					*0.7000*	
ln_IPOidx_{t-6}		-0.8194				0.4898	-0.8738	-1.1049
		0.0230				*0.1360*	*0.1430*	*0.0000*
ln_CDAX_{t-1}			2.6050		-0.3126		0.9338	
			0.0010		*0.1980*		*0.3570*	
ln_CDAX_{t-3}			-0.3388				-0.3261	
			0.7330				*0.7840*	
ln_CDAX_{t-6}			-1.7704			-0.3186	-0.5223	
			0.0030			*0.2650*	*0.5540*	
ln_NoIPOs_{t-1}				0.1613	0.0801		0.1110	
				0.0120	*0.2020*		*0.0900*	
ln_NoIPOs_{t-3}				0.0596			0.0858	
				0.3300			*0.1650*	
ln_NoIPOs_{t-6}				0.1392		0.1280	0.1347	0.1295
				0.0240		*0.0600*	*0.0260*	*0.0290*
hot_months	0.7213	0.8062	0.7960	0.7119	0.7231	0.7801	0.8191	0.8490
	0.0000	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
cold_month	-1.2396	-1.0897	-1.1686	-1.4073	-1.1737	-1.3551	-1.2580	-1.1817
	0.0020	*0.0030*	*0.0020*	*0.0000*	*0.0010*	*0.0000*	*0.0010*	*0.0010*
hot_market	1.9823	0.7867	1.4790	1.3192	0.7923	1.6487	0.4972	0.6836
	0.0000	*0.0010*	*0.0000*	*0.0000*	*0.0010*	*0.0000*	*0.0630*	*0.0030*
Constant	0.1806	-5.7484	-2.6267	0.1433	-5.3843	-0.7157	-3.8761	-4.9146
	0.0840	*0.0000*	*0.0100*	*0.1720*	*0.0000*	*0.5230*	*0.0030*	*0.0000*
α	0.4019	0.2199	0.2987	0.3611	0.2566	0.3744	0.1961	0.2062
N	210	210	210	210	210	210	210	210
Prob > χ^2	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
Pseudo R^2	0.1572	0.2019	0.1812	0.1717	0.1925	0.1666	0.2128	0.2066
Corr.-based R^2	0.5951	0.6717	0.629	0.5955	0.6408	0.5706	0.6911	0.6724

In order to shed light on the influence of lagged variables on the number of IPOs, we separately estimate regressions with one-month and six-months lagged variables in models V and VI. In case of one-month lagged variables, only the coefficient of the IPO index is significant. With six-months lagged variables, neither the IPO index coefficient nor the CDAX coefficient is significant, but the number of IPOs coefficient is weakly significant. This might indicate that the decision to go public is more strongly driven by the number of IPOs at the decision point of time, while the actual time of the first listing is more strongly driven by the performance of recent IPOs. Model VII incorporates all variables considered here. The signs and p-values of the coefficients reflect the results from the partial models. Only the (positive) coefficient of the IPO price level at lag t-1 is highly significant. Not surprisingly, model VII exhibits the highest explanatory power of all models with a Pseudo R^2 of 21.3% (correlation-based R^2: 69.1%). Model VIII is derived from the coefficient estimates in models I to VII and includes the combination from our set of independent variables that seems to best explain the IPO activity in Germany. Apart from the calendar time control variables, it includes the IPO price levels at lag t-1 and t-6 as well as the number of IPOs at lag t-6. Although we omit six independent variables compared to model VII, model VIII has only slightly less explanatory power as reflected in a Pseudo R^2 of 20.6% (correlation-based R^2: 67.2%).

We can conclude from the regression estimations that IPO activity is significantly related to the IPO price level of the previous month. This is in line with the pseudo market timing hypothesis. However, we can hardly infer any economic significance from this result. In particular, it is not obvious whether the statistically significant impact of the explanatory variables on IPO activity results in long-run underperformance of each-IPO investment strategies. In order to test the extent to which the estimated relations can account for economically significant underperformance of each-IPO investment strategies, we simulate IPO activity in Germany and then, calculate the performance of each-IPO and IPO-portfolio investment strategies in the simulated capital markets.

3.3 Simulating the IPO activity

In order to simulate the IPO activity in Germany, we proceed as follows: First, a market index and an IPO index for each simulation is generated. In order to simulate capital markets that closely resemble the historic market in Germany between 1985 and 2002, we draw market index returns from a normal distribution with mean and standard deviation equivalent to the historic parameters of the CDAX. The IPO index return is modelled as a linear function of the CDAX returns and adding an adjustment term as well as an normally distributed error term. The reason for adding an adjustment term is as follows: After simulating IPO activity, our goal is to analyse the performance of each-IPO and IPO-portfolio investment strategies in each simulated capital market. This is done by comparing the buy-and-hold returns of investments into the IPO index to such investments in the market index. In order to eliminate any bias due to an imperfect benchmark portfolio in the first place, the IPO index is constructed as such that the CDAX index fits as a perfect benchmark portfolio. This is achieved by adjusting each IPO index return by a fixed term that sets the expected IPO index equal to the expected CDAX return.

In line with the regression estimations, we assume that the behaviour of CDAX returns as well as of IPO index returns in the hot IPO market phase from January 1998 to December

2000 structurally differ from those in the remaining months of the sample period. Hence, we separately estimate the CDAX and IPO index parameters for the hot market and the cold market phase. The IPO index parameters are obtained from an OLS regression of the historic IPO index returns on the historic CDAX returns. Table 8 exhibits the CDAX and IPO index parameters in both market phases.

Table 8: Parameters for simulating IPO activity

StDev denotes standard deviation. IPO index parameters are derived from an OLS regression where the IPO index return is the dependent variable and the CDAX return is the independent variable. Adj. R2 denotes the adjusted explanatory power of the regression model and Root MSE denotes the root mean square error of the model. The adjustment term is calculated as CDAX mean - CDAX mean * Slope.

	CDAX parameters		OLS regression of IPO index on CDAX				Adjustment
	Mean	**StDev**	**Constant**	**Slope**	**adj. R2**	**Root MSE**	**term**
Cold market	0.61%	6.14%	-0.0056	0.7900	57.05%	4.20%	0.13%
			0.0770	*0.0000*			
Hot market	1.07%	6.18%	0.0048	1.3850	50.08%	8.42%	-0.41%
			0.7400	*0.0000*			

By drawing 180 cold market and 36 hot market CDAX returns from the distributions presented in Table 8, we generate a market index that starts with 100 in January 1985, incorporates a hot market phase from 1998 to 2000 and ends in December 2002. For each month, the IPO index return is calculated as the CDAX return times 0.79 and 1.38, respectively, and adding an error term according to respective root mean square error. By adjusting each IPO index return by +0.13% in cold markets and –0.41% in hot markets, the expected IPO index returns become equal to the expected CDAX return of 0.61% and 1.07%, respectively. Consistent with the CDAX construction, the IPO index is set to 100 in January 1985. Having generated a CDAX index and an IPO index, we estimate the number of IPOs per month using regression model VIII. We simulate the IPO activity in 100,000 capital markets. Table 9 exhibits statistics on the simulated IPO activity.

Table 9: IPO activity in simulated capital markets

Mean, median and standard deviation for the number of IPOs in 100,000 simulated capital markets. Simulations are based on the negative binomial regression model VIII. Historic denotes the actual number of IPOs in Germany in the respective sample period.

	Simulations			
Sample Period	**Mean**	**Median**	**StDev**	**Historic**
1985 - 2002	582.2	397	641.9	667
1985 - 1995	178.2	151	109.2	196
1996 - 2002	403.9	233	570.9	471

As regards the entire sample period, the mean IPO activity in the simulations fits the historic IPO activity relatively closely with a deviation of less than 15%. In the second sub sample period, the mean simulated IPO activity deviates stronger from the historic number of IPOs which might indicate that our regression model does not fully capture the issuance behaviour during the hot IPO market between 1998 and 2000.

3.4 Investment strategy performance in simulated markets

Knowing the number of IPOs in each month of a simulated sample period we calculate the buy-and-hold abnormal return of each IPO in the simulated market according to expression (1). We assume that all IPOs realise the same return in each calendar month, which is the return of the IPO portfolio. This implies a perfectly positive correlation among IPO returns in each calendar month. Based on the individual IPO's buy-and-hold abnormal performance, we compute the mean buy-and-hold abnormal return of IPOs according to expression (2). This yields the performance of an each-IPO investment strategy in the simulated capital markets. The performance of an IPO-portfolio investment strategy in each simulated capital market is calculated according to expression (3). From the assumption that each IPO earns the return of the simulated IPO index in a particular calendar month follows that the length of the formation period does not affect results. Since the formation period only alters the number of IPOs considered in the portfolio in a calendar month, it is irrelevant in an analysis of portfolio performance if each IPO earns exactly the same return per calendar month.

As our simulations yield the number of IPOs per month but not the market value of each IPO, we assume equal market values of all IPOs. Incorporating market values in the simulations properly requires an analysis as to whether the market values of IPOs are endogenous to price levels, IPO activity or other variables. These questions are left to future research. Table 10 presents the mean performance of the equally weighted each-IPO and of the equally weighted IPO-portfolio investment strategies in 100,000 simulated capital markets.

Table 10: Average performance of IPO investment strategies against the CDAX in simulated capital markets

Mean BHAR is calculated as the arithmetic average of the mean BHARs of 100,000 simulated capital markets. In case of the each-IPO investment strategy, the mean BHAR in each simulation is calculated as the average of the BHARs of the individual IPOs in this simulated market according to expression (2). In case of the IPO-portfolio investment strategy the BHAR in each simulated market is calculated according to expression (3). Std. deviation denotes the standard deviation of mean BHARs of the simulations. P-values are based on skewness adjusted t-statistics.

		Each-IPO investment strategy		IPO-portfolio
		36 months hold. per.	**60 months hold. per.**	**investment strategy**
1985-2002	Mean BHAR	-5.09%	-8.21%	-1.90%
	Std. deviation	17.90%	27.70%	544.91%
	p-value	*0.0000*	*0.0000*	*0.2747*
1985-1995	Mean BHAR	-1.94%	-2.94%	0.00%
	Std. deviation	-1.80%	-2.33%	-2.57%
	p-value	*0.0000*	*0.0000*	*0.9959*
1996-2002	Mean BHAR	-9.99%	-12.12%	-0.46%
	Std. deviation	-11.26%	-13.11%	-25.01%
	p-value	*0.0000*	*0.0000*	*0.3400*

The each-IPO investment strategy yields highly significantly negative abnormal returns for holding periods of 36 and 60 months irrespective of the sample period. Recall that by construction, the expected value of the IPO index equals the expected value of the market index irrespective of the length of the sample period. Thus, any abnormal performance of the each-IPO investment strategy cannot be traced back to a misspecification of the benchmark portfolio, but to pseudo market timing.[29] The pattern of abnormal performance in the simulations resembles that of the empirical data: For 60 months holding periods the IPO investments perform worse than for 36 months holding periods. Further, IPOs perform considerably worse in the second sub sample. The absolute level of underperformance in the simulations, however, is substantially lower than the underperformance observed in the historic data. Although this finding can partly be attributed to imperfect models of IPO activity and of IPO returns, it most notably indicates that the pseudo market timing phenomenon cannot fully explain the underperformance of German IPOs between 1985 and 2002.With the IPO-portfolio investment strategy, the mean BHAR should equal zero by construction. Indeed, we find non-significant average BHARs close to zero in each sample period. The slight deviations from zero are caused by chance as the multiplicative combination of the return series causes very high standard deviations. Extreme outliers are not even fully averaged out after 100,000 simulations.

4 Conclusion

Based on a large sample of IPOs in Germany between 1985 and 2002, we compare the performance of each-IPO investment strategies and of IPO-portfolio investment strategies. Weighting each IPO equally in an each-IPO investment strategy yields a non-significant underperformance if each IPO is held for three years. However, for a holding period of five years this strategy highly significantly underperforms the CDAX and the equally weighted DAFOX. Weighting each IPO according to its market value yields a highly significant underperformance even if each IPO is held for three years. In general, IPO underperformance increases with the length of the holding period. In order to control for institutional changes in the German primary markets and the evolution of a German equity culture since the mid-1990 that might affect the long-run performance of IPOs, we separately analyse the two sub sample periods 1985 to 1995 and 1996 to 2002. Investing equally in each IPO yields considerably worse performance in the second sub sample than in the first. However, this result changes in case of value weighted investments. This allows interesting insights into the cross-section of IPO performance. Between 1985 and 1995 small IPOs performed disproportionately well, while those IPOs performed disproportionately poorly between 1996 and 2002. IPO-portfolio

[29] The reader might wonder whether the underperformance is possibly driven to a larger extent by the control variables in the regression model VIII than by the pseudo market timing variables, i.e. the IPO index at lag t-1 and at lag t-6. Indeed, simulations based on an estimation of regression model VIII without the pseudo market timing variables yield statistically significant underperformance of the each-IPO investment strategy, too. However, the highest underperformance observed is -1.52% in case of 60 months holding period in sub period two. This shows that the magnitude of the underperformance and thus, the economic significance is mostly driven by pseudo market timing.

investment strategies underperform their benchmarks, too. However, based on a bootstrapping methodology we do not find significant underperformance.

The finding that only each-IPO investment strategies significantly underperform benchmark investments points to the phenomenon that firms going public in hot IPO markets perform worse than those going public in cold markets. We test pseudo market timing as an explanation for this phenomenon. Indeed, we find that IPO activity in Germany can largely be explained by the price level of recent IPOs, by the number of IPOs at a lag of six months, by calendar time control variables and a control variable for the hot market phase from 1998 to 2000. Simulations of IPO activity and investment strategy performance based on these explanatory variables show that pseudo market timing accounts for a considerable part of the each-IPO investment strategy underperformance observed empirically. In case of 60-months holding periods, we find an underperformance of -8.2% points on average in the simulated capital markets. Regarding the sub sample periods reveals that underperformance induced by pseudo market timing is predominantly a phenomenon of the IPOs after 1995 (-12.1%). The remaining part of the empirically observed underperformance that is not explained by pseudo market timing might be attributed to heterogeneous expectations (Miller 1977), to rational responses to changes in other market conditions (Pastor and Veronesi 2005), to "real" market timing or simply to measurement biases such as inappropriate benchmark portfolios. In line with the theoretical prediction, the IPO-portfolio investment strategies do not yield significant underperformance in the simulations. Overall, our results provide little evidence for market inefficiencies that managers can exploit by timing their going public.

With respect to the attractiveness of IPO investment strategies, we can conclude that investing in IPOs is not generally hazardous to one's. Instead of investing in each firm going public separately, investors should allocate their money to portfolios of recent IPOs where the portfolio weights are adjusted according to the number of recent new issues. This result holds even if investors believe German capital markets are efficient, i.e. no real market timing is possible. Firms simply need to continue to behave according to the pseudo market timing hypothesis.

References

Achleitner, Ann-Kristin/Kaserer, Christoph/Moldenhauer, Benjamin, 2005, German Entrepreneurial Index (GEX®), *Finanz Betrieb 2*, 118-126.

Baker, Malcolm/Wurgler, Jeffrey, 2000, The Equity Share in New Issues and Aggregate Stock Returns, *Journal of Finance. 55*, 2219-2257.

Bösl, Konrad, 2004, Praxis des Börsengangs. Ein Leitfaden für mittelständische Unternehmen, Wiesbaden.

Borggreve, Hendrik/Dobrikat, Joachim, 1996, Telekom-Börsengang beeinflusst Markt – Pläne anderer Unternehmen. Aktienemissionen werden weiter eine wichtige Rolle spielen. *Handelsblatt 1996/90 published on May, 9th, 1996,* B6.

Brav, Alon/Gompers, Paul A., 1997, Myth or Reality? The Long-Run Underperformance of Initial Public Offerings: Evidence from Venture and Nonventure Capital-backed Companies, *Journal of Finance 52*, 1791-1821.

Brown, Stephen J./Goetzmann, William/Ibbotson, Roger G./Ross, Stephen A., 1992, Survivorship Bias in Performance Studies, *The Review of Financial Studies 5*, 553-580.

Butler, Alexander W./Grullon, Gustavo/Weston, James P., 2005, Can Managers Forecast Aggregate Market Returns?, *Journal of Finance 60*, 963-986.

Cameron, Colin A./Trivedi, Pravin K., 2003, Regression Analysis of Count Data, Cambridge., United Kingdom.

Cusatis, Patrick J./Miles, James A./Woolridge, J. Randall, 1993, Restructuring through spinoffs: The stock market evidence, *Journal of Financial Economics 33*, 293-311.

Dahlquist, Magnus/De Jong, Frank, 2004, Pseudo Market Timing: Fact or Fiction?, Working Paper.

Davison, Anthony/Hinkley, David, 1997, Bootstrap Methods and Their Application, Cambridge.

Ehrhardt, Olaf, 1997, Börseneinführungen von Aktien am deutschen Kapitalmarkt, Wiesbaden.

Fama, Eugene F./Fisher, Lawrence/Jensen, Michael C./Roll, Richard, 1969, The adjustment of stock prices to new information, *International Economic Review 10*, 1-21.

Fama, Eugene F., 1998, Market efficiency, long-term returns, and behavioral finance, *Journal of Financial Economics 49*, 283-306.

Gerke, Wolfgang/Fleischer, Jörg, 2001, Die Performance der Börsengänge am Neuen Markt, *Zeitschrift für betriebswirtschaftliche Forschung 53*, 827-839.

Göppl, Hermann/Schütz, Heinrich, 1995, Die Konzeption eines Deutschen Aktienindexes für Forschungszwecke (DAFOX), TU Karlsruhe Working Paper.

Gompers, Paul A./Lerner, Josh, 2003, The Really Long-Run Performance of Initial Public Offerings: The Pre-Nasdaq Evidence, *Journal of Finance 63*, 1355-1392.

Graham, John R./Harvey, Campbell R., 2001, The theory and practice of corporate finance: Evidence from the field, *Journal of Financial Economics 61*, 1-28.

Green, William H. (2003): Econometric Analysis, 5th ed., Upper Saddle River.

Hall, Peter, 1992, On the Removal of Skewness by Transformation, *Journal of the Royal Statistic Society 54*, 221-228.

Helwege, Jean/Liang, Nellie, 2004, Initial Public Offerings in Hot and Cold Markets, *Journal of Financial and Quantitative Analysis, Vol 39*, 541-569.

Jakobsen, Jan B./Sørensen, Ole, 2001, Decomposing and Testing Long-term Returns: an Application on Danish IPOs, *European Financial Management 7*, 393-417.

Johnson, Norman J., 1978, Modified t Test and Confidence Intervals for Asymmetrical Populations, *Journal of American Statistical Association 73*, 536-544.

Keloharju, Matti, 1993, The winner's curse, legal liability, and the long-run performance of initial public offerings in Finland, *Journal of Financial Economics 34*, 251-277.

Kiss, Imre/Stehle, Richard, 2002, Underpricing and Long-Term Performance of Initial Public Offerings at Germany's Neuer Markt, 1997 – 2001, Working Paper, Humboldt-University, Berlin.

Kothari, S. P/Warner, Jerold B., 2006, Econometrics of Event Studies, to appear in: Eckbo, B. Espen, *Handbook of Corporate Finance: Empirical Corporate Finance*.

Kutzer, Hermann, 1997, Die Telekom ist ein Katalysator für die Wertpapierkultur in Deutschland. Mit der T-Aktie zur D-Aktie., *Handelsblatt 1997/120 published on June, 26th, 1997,* 2.

Lee, Immoo, 1997, Do Firms knowingly sell overvalued Equity?, *Journal of Finance 52*, 1439-1466.

Lee, Charles M. C./Shleifer, Andrei/Thaler, Richard H., 1991, Investor Sentiment and the Closed-End Fund Puzzle, *Journal of Finance 46,* 75-109.

Lerner, Joshua, 1994, Venture capitalists and the decision to go public, *Journal of Financial Economics 35*, 293-316.

Ljungqvist, Alexander P., 1997, Pricing initial public offerings: Further evidence from Germany, *European Economic Review 41*, 1309-1320.

Löffler, Torsten, 2000, Investorenunsicherheit bei Börsenerstemissionen, *Finanzmarkt und Portfolio Management 14,* 57-75.

Loughran, Tim/Ritter, Jay R., 1995, The New Issue Puzzle, *Journal of Finance 50*, 23-51.

Loughran, Tim/Ritter, Jay R., 2000, Uniformly Least Powerful Tests of Market Efficiency, *Journal of Financial Economics 55*, 361-389.

Loughran, Tim/Ritter, Jay R., 2004, Why Has IPO Underpricing Changed Over Time?, *Financial Management 33*, 5-37.

Loughran, Tim/Ritter, Jay R./Rydqvist, Kristian, 1994, Initial Public Offerings: International Insights, *Pacific-Basin Finance Journal 2*, 165-199.

Lowry, Michelle, 2003, Why does IPO volume fluctuate so much?, *Journal of Financial Economics 67*, 3-40.

Lubig, Dirk, 2004, Underpricing und langfristige Performance der IPOs am Neuen Markt, Frankfurt am Main.

Lyon, John D./Barber, Brad M./Tsai, Chih-Ling, 1999, Improved methods for tests of long-run abnormal stock returns, *Journal of Finance 54*, 165-201.

Mager, Ferdinand B., 2001, Die Performance von Unternehmen vor und nach dem Börsengang, *Wiesbaden.*

Miller, Edward M., 1977, Risk, Uncertainty, and Divergence of Opinion, *Journal of Finance 32*, 1151-1168.

Neuhaus, Stefan/Schremper, Ralf, 2003, Langfristige Performance von Initial Public Offerings am deutschen Kapitalmarkt, *Zeitschrift für Betriebswirtschaft 73,* 445-472.

Pagano, Marco/Panetta, Fabio/Zingales, Luigi, 1998, Why Do Companies Go Public? An Empirical Analysis, *Journal of Finance 53*, 27-64.

Page, Michael J./Reyneke, Ivan, 1997, The Timing and Subsequent Performance of Initial Public Offerings (IPOs) on the Johannesburg Stock Exchange, *Journal of Business Finance & Accounting 24,* 1401-1420.

Pastor, Lubos/Veronesi, Pietro, 2005, Rational IPO Waves, *Journal of Finance 60*, 1713- 1757.

Rajan, Raghuram/Servaes, Henri, 1997, Analyst Following of Initial Public Offerings, *Journal of Finance 52,* 507-529.

Rath, Nikolai/Tebroke, Hermann-Josef/Tietze, Christian, 2004, "Marktstimmung" zur Erklärung der langfristigen Kursentwicklung von Aktien nach dem Börsengang, *Zeitschrift für Bankrecht und Bankwirtschaft 16*, 269-352.

Rehkugler, Heinz/Schenek, André, 2001, Underpricing oder Overpricing? IPOs am deutschen Kapitalmarkt, in: Wirtz, Bernd W., Salzer, Eva, 2001, IPO-Management – Strukturen und Erfolgsfaktoren, Wiesbaden, 277-308.

Reuschenbach, Helmut, 2000, Der Börsengang der Deutschen Telekom AG, in: Volk, Gerrit, 2000, Going Public – der Gang an die Börse: Beratung, Erfahrung, Begleitung, 3rd ed., Stuttgart, 159-187.

Ritter, Jay R., 1991, The Long-Run Performance of Initial Public Offerings, *Journal of Finance 46,* 3-27.

Ritter, Jay R./Welch, Ivo, 2002, A Review of IPO Activity, Pricing, and Allocations, *Journal of Finance, Vol. 57,* 1795-1828.

Sal. Oppenheim, 2006, Brochure of IPO-Basket Certificate.

Sapusek, Annemarie, 2000, Benchmark-Sensitivity of IPO-Long-Run Performance: An Empirical Study for Germany, *Schmalenbach Business Review 52*, 374-405.

Schultz, Paul, 2003, Pseudo Market Timing and the Long-Run Underperformance of IPOs, *Journal of Finance 68*, 483-517.

Shiller, Robert J., 1990, Speculative Prices and Popular Models, *Journal of Economic Perspectives 4*, 55-65.

Spiess, Katherine/Affleck-Graves, John, 1999, The long-run performance of stock returns following debt offerings, *Journal of Financial Economics 54*, 45-73.

Stehle, Richard/Ehrhardt, Olaf, 1999, Renditen bei Börseneinführungen am deutschen Kapitalmarkt, *Zeitschrift für Betriebswirtschaft 69*, 1395-1422.

Stehle, Richard/Ehrhardt, Olaf/Przyborowsky, René, 2000, Long-run Stock Performance of German Initial Public Offerings and Seasoned Equity Issues, European Financial Management, *European Financial Management 6,* 173-196.

Trede, Mark, 2002, Bootstrapping Inequality Measures under the Null Hypothesis: Is it worth the effort?, *Journal of Economics 9*, 261-281.

Webb, Gwendolyn P., 1999, Evidence of Managerial Timing: The Case of Exchange Listings, *Journal of Financial Research 22*, 247-263.