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THE RISE AND FALL OF EUROPE'S NEW STOCK MARKETS

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8. THE EXPIRATION OF MANDATORY AND VOLUNTARY IPO LOCK-UP PROVISIONS – EMPIRICAL EVIDENCE FROM GERMANY'S NEUER MARKT

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ABSTRACT

This chapter explores the stock price impact of expirations of lock-up provisions that prevent insiders from selling their shares after the Initial Public Offering (IPO). We examine 172 lock-up expirations of 142 IPOs floated on Germany's Neuer Markt. We detect significant negative abnormal returns and a 25% increase in trading volume surrounding lock-up expiration. The negative abnormal returns are larger for firms with high volatility; superior performance after the IPO, low free float, and venture capital financed firms. The negative price reaction is significantly stronger for the expiration of voluntary lock-up agreements than for mandatory prohibitions of disposal.

1. INTRODUCTION

On January 11, 2001, the German *Schutzgemeinschaft der Kleinaktionäre* – an association for the protection of the interests of small shareholders – announced

1 a warning that the lock-up provision of Letsbuyit.com, an E-commerce firm,
2 would expire on January 21. This warning was published in all major newspapers,
3 expressing concern about the fact that most of the incumbent shareholders of
4 the trouble-shaken firm would probably sell their shares upon expiration at the
5 prevailing market price of €0.30, given that some of them had an initial investment
6 per share of only €0.01.[1] Although this information was public ex ante, the share
7 price of Letsbuyit.com declined by almost 50% on the first trading day after the
8 lock-up expiration, and the trading volume was the highest for all shares on the
9 German XETRA stock exchange system on that day.
10   This chapter explores the stock price impact of expirations of lock-up provisions
11 that prevent insiders from selling their shares after the initial public offering
12 (IPO). We examine 172 lock-up expirations of 142 IPOs floated on Germany's
13 Neuer Markt. This chapter provides two contributions to the literature on IPOs
14 and lock-up provisions. First, it documents further evidence on downward-sloping
15 demand curves and costly arbitrage for a capital market outside the United States.
16 We find statistically significant negative abnormal returns and a 25% increase in
17 trading volume surrounding lock-up expiration. The negative abnormal returns
18 are larger for firms with high volatility, superior performance between the IPO
19 date and the lock-up expiration date, and low free float.
20   Second, and more important, we can differentiate between the effects of manda-
21 tory lock-up provisions and the U.S.-type private lock-up agreements between
22 issuers and underwriters. The latter we refer to as "voluntary" lock-up agreements
23 that serve as a commitment device to reduce information asymmetry at the IPO.
24 We show that the average negative price reaction is significantly stronger for
25 the expiration of voluntary lock-up agreements than for mandatory prohibitions
26 of disposal. Furthermore, we find that venture-capital financed firms experience
27 more negative abnormal returns than non-venture backed firms, on average.
28   The remainder of this chapter is organized as follows: Section 2 reviews other
29 studies that have investigated lock-up agreements. Section 3 describes the nature
30 of mandatory and voluntary lock-up provisions in Germany. Section 4 presents
31 the data description and the sample selection. Section 5 presents the event study
32 methodology. Results on abnormal returns surrounding the time of the lock-up
33 expiration for both types of provisions and on abnormal volume are analyzed in
34 Section 6. Section 7 investigates the relation between certain firm characteristics
35 and the price reaction. Section 8 concludes.

2. LITERATURE REVIEW

40 Field and Hanka (2001) examine the expiration of IPO share lockups in the United
    States. They find a significantly negative three-day abnormal return of minus 1.5%

and a permanent 40% increase in trading volume upon expiration of the lock-up period for 1,948 firms in the period 1988–1997. In another study, Keasler (2001) finds negative abnormal returns prior to the lock-up releases and shows that unrestricted investors liquidate positions prior to the scheduled lock-up release. He finds that negative abnormal returns are more robust for firms that are not influenced by SEC Rule 144 than for firms that are.

Cao et al. (2004) test the hypothesis that insider trading impairs market liquidity by analyzing intraday trades and quotes around 1,497 IPO lock-up expirations in the period 1995–1999. They find that, while lock-up expirations are associated with considerable insider trading activity for some IPO firms, they have little effect on effective spreads. Thus, they argue that blockholding insider traders can enter a market from which they had previously been absent, and substantially change trading volume and share price without impairing market liquidity.

Aggarwal et al. (2002) develop a model in which managers strategically underprice IPOs to maximize personal wealth from selling shares at lock-up expiration. They test the model on a sample of IPOs in the 1990s and find – consistent with their model – that higher ownership by managers is positively correlated with first-day underpricing and underpricing is positively correlated with research coverage. Finally, research coverage is positively correlated with stock returns and insider selling at the lock-up expiration.

Brav and Gompers (2003) focus on the role of lock-ups as a commitment device to alleviate moral hazard problems in IPOs. They find that investment banks impose longer lock-ups on their IPO firms, when moral hazard in the aftermarket is higher. On the other hand, they show that venture-backed firms and firms going public with high-quality underwriters are more likely to have early releases of insider lock-up restrictions.

Ofek and Richardson (2000) investigate volume and price patterns when the lock-up period ends, and document that there is a 3% drop in the stock price, and a 40% increase in volume. They argue that the evidence is consistent with a downward sloping demand curve for shares.

Harper et al. (2004) look at follow-on offerings and how these alter firm value above and beyond the typical lock-up effects, and whether the effects are conditioned by firm-specific variables. They find that follow-on offerings elicit an average market response of minus 3.21% over a three-day period surrounding the filling date. In their sample, the offerings experience adverse effects as of lock-up expiration that are about 3.75% worse than other IPOs, after considering other factors. Overall, their research suggests that follow-on offerings benefit some insiders who can circumvent the lock-up expiration date, at the expense of other investors.

There are only a few studies that examine capital markets other than the United States. Surprisingly, to the opposite of studies on U.S. data, Espenlaub et al. (2001) do not find significant abnormal returns around the expiry for a sample of

IPO lock-up agreements in the United Kingdom. Goergen et al. (2004) compare the characteristics of lock-up agreements in German and French firms that went public on the Neuer Markt and the Nouveau Marché during the years 1996/1997 to 2000. They find that the level of uncertainty about the firm's prospects and venture backing have a major influence on the characteristics of the lock-up contracts. In addition, shareholder characteristics explain the diversity of contracts that exist within the same firm. However, their paper does not look at price reactions upon the lock-up expiration day. This chapter aims to fill this gap.

3. MANDATORY AND VOLUNTARY LOCK-UP PROVISIONS IN GERMANY

In March 1997, Deutsche Börse established the Neuer Markt, a trading segment for innovative growth stocks, who had to meet international standards of transparency and publicity.[2] Trading on the Neuer Markt took place in the Regulated Unofficial Market (Freiverkehr) under private law, but all companies admitted to the Neuer Markt also had to be admitted to the Regulated Market (Geregelter Markt). Organized under private law, Deutsche Börse formally imposed strict admission and disclosure requirements for the Neuer Markt.

In theory, the legal framework of the Neuer Market was comparable to and, in some respects, even stricter than the admission requirements and post-listing duties under the SEC regime in the United States. In practice, however, the system has been hampered by inconsistent enforcement by Deutsche Börse. The Neuer Markt rules were purely private agreements between Deutsche Börse and issuers (who were also its customers). The German stock market regulator – the BAWe now BAFin – did not have a mandate to supervise these.

A total of 342 companies had listed on the Neuer Markt by July 2001. Although a number of other European growth markets opened,[3] these had been significantly less popular with issuers. The Neuer Markt quickly became Europe's biggest exchange for securities of innovative growth companies. In the end, the Neuer Markt was severely hit by the collapse of share prices following the bursting of the bubble and was finally shut down, because of the irreparable loss in investor confidence.

Deutsche Börse required all issuers to sign and comply with the so-called "Undertaking Concerning the Prohibition on Disposal," as stated in the Neuer Markt Rules and Regulations:

Prohibition on Disposal
(1) The issuer shall be obligated, subject to the applicable provisions of the national corporate law, to refrain, within a period of six months from the date of admission of the shares to the Neuer Markt, from offering or selling shares directly or indirectly, or announcing such action,

or taking other measures economically equivalent to a sale. Further, the issuer shall inform Deutsche Börse without delay should it become aware of any factors indicating a breach of the prohibition on disposal on the part of an existing shareholder (Part 2, 2.2).

The prohibition of disposal, although legally only a private contract between the issuer and Deutsche Börse, was effectively a mandatory lock-up rule, since it was a listing requirement applying to all firms on the Neuer Markt and (at least in theory but less so in practice) enforceable by law.

Furthermore, a number of issuers stated in the offering prospectus that their shareholders had agreed not to sell shares for a longer period without the consent of the underwriter under a voluntary lock-up agreement. These voluntary lock-up agreements were not mandated by the stock exchange; hence they could only be enforced if the underwriter undertook legal actions in case of deviation (which basically never happened). Typically, while the mandatory prohibition applied to all existing shareholders holding stock before the offering, only the management and the largest incumbent shareholders were locked by a voluntary non-selling agreement. For example, while usually small incumbent shareholders and venture capitalists were allowed to sell six months after the IPO, the founding members and/or the top management of the firm often agreed to lock their shares for an additional period of six-to-30-months.

Table 1 gives an overview on the insider trading regulation rules that applied to German firms at the time of the Neuer Markt, as compared to those for U.S. IPO firms. Mandatory lock-up rules exist only in Germany, whereas there are more general disclosure rules and restrictions concerning insider sales in the United States.

Table 1.   Insider Trading Regulation for IPOs on Germany's Neuer Markt versus the United States.

	German Rules	U.S. Rules
Lock-up provisions		
Mandatory rules	*Prohibition on disposal* (Paragraph 7.2.9 Rules and Regulations Neuer Markt)	Non-existent
Voluntary agreements	Complementary lock-up contracts between underwriter and issuer Pool contracts among incumbent shareholders of the firm	Private lock-up contracts between underwriter and issuer
Legal insider selling restrictions and disclosure rules	Section 21 WpHG (German Securities Law) Section 13 WpHG	Rule 144 Section 16 Securities Exchange Act (SEA)

In this paper we are interested in mandatory and voluntary lock-up provisions. Technically, the two types of lock-up provisions are different in nature. However, given the severe adverse selection problem in the going public process, both serve as a commitment device to induce the public to buy shares at the offering (Brav & Gompers, 2003). The mandatory prohibition of disposal was to signal to the public that the Deutsche Börse would be committed to enforce this device. The (second) voluntary lock-up agreement signals not only the commitment of the issuing firm, but may also reflect the quality of the underwriter.

Venture capitalists typically do not lock their investments for more than the mandatory six-month period in Germany. Their business model forces them to unwind their equity stakes in portfolio investments that successfully go public. On the one hand, one would therefore expect that venture backed firms have a larger number of shares coming to market at lock-up expiration (Brav & Gompers, 2003). On the other hand, venture capitalists may want to maintain a reputation of financing high-quality IPOs. Thus, they could force the management of their portfolio firms to agree upon a further voluntary lock-up provision, and they may want to retain their own shares for signaling reasons. Or, as Barry et al. (1990, p. 461) put it: "By retaining their share ownership, the venture capitalists can provide assurance of continued monitoring and can credibly signal their belief in the firms' prospects." Both arguments have conflicting implications for abnormal price reactions and the contractual structure of lock-up provisions.

4. DATA DESCRIPTION AND SAMPLE SELECTION

We investigate all IPOs on the Neuer Markt segment from its inception in 1997 until October 1999. For these 194 firms, we identify all lock-up events and hand-collect the dates from the offering prospectuses. In some cases we have to contact the issuers to clarify the exact date. One firm drops out of the sample, because it has a short lock-up of only three months. Another 26 firms

Table 2. Sample Selection.

Pl. check Table 2 for its correctness.

|	
Initial public offerings and first trading of shares on the Neuer Markt from 03/97 to 12/99	194 firms
− Firm with lock-up less 6 months	1 firm
− Data restrictions	26 firms
− Confounding news one week before and after the event	25 firms
= Final sample of firms	142 firms
+ Of which have complementary lock-up agreement	30 firms
= Final sample of events	172 events

Table 3. Descriptive Statistics.

	Min	25th Percentile	Median	75th Percentile	Max	Mean	Standard Deviation
Volatility	1.62	3.33	4.00	4.80	10.09	4.37	1.65
Post-IPO performance (log)	−339.14	−83.16	−30.28	48.65	240.73	−24.46	100.76
Free float in percent	18.60	25.03	30.50	40.00	100.00	36.39	16.72
Trading volume	0.10	0.48	0.83	1.44	6.18	1.16	1.07
Underpricing (%)	−14.11	4.24	23.47	57.01	140.65	34.70	37.70
Market value of equity (DM millions)	5.62	32.76	56.50	110.68	876.00	97.39	129.66

Note: Volatility is the standard deviation in the estimation period (between IPO and unlock day). Post-IPO performance is the log of the total return from the IPO until the unlock day. Free float is taken as reported by Deutsche Börse and checked against the offering prospectuses. Trading volume is order book turnover as reported by Deutsche Börse (excluding OTC trades). Underpricing is the first day return against the offering price. Market value of equity is number of shares issued multiplied by the issue price, as reported by Deutsche Börse.

are excluded from the sample because we could not retrieve price data. We control for confounding news one week before and after the event day of the lock-up expiration. In order to identify an information-clean event, 25 firms with confounding news (e.g. earnings announcements) one week before and after the
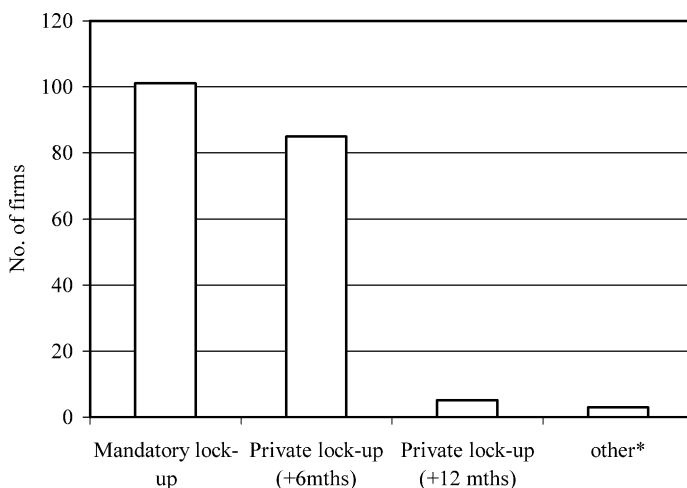
Fig. 1. Length of Lock-Up Agreements. *Note:* (*) Other Lock-up-agreements involve three firms, of which two have a 6 plus 3 month lock-up, and one company that shortened the length to three months.

1   event day of the lock-up expiration are eliminated from the sample. The remaining
2   sample consists of 142 IPO firms floated on the Neuer Markt. Of those 142
3   firms 30 have an additional voluntary lock-up agreement as stated in the offering
4   prospectus. The final full sample therefore consists of 172 lock-up expiration
5   events. Tables 2 and 3 provide descriptive statistics for 142 sample IPO firms.
6   For the empirical analysis, we could take into account stock market data
7   until June 30, 2000. The event window ends 30 trading days subsequent to the
8   IPO. Daily stock price and trading volume data are directly provided by the
9   Deutsche Börse, and are adjusted for dividend payments and capital changes.
10 Information on free float and venture capital financing are obtained directly from
11 prospectuses.
12   Figure 1 shows the distribution of lock-up length for the sample of lock-up
13 provisions. Most of the IPO firms do not have a voluntary lock-up agreement
14 complementing the prohibition of disposal. The majority is only locked for
15 six months.
16
17
18   **5. EVENT STUDY METHODOLOGY**
19
20 We calculate abnormal returns for each IPO over the event window $(t_{-10}; t_{30})$ as
21 the difference between the actual return and the expected return. We benchmark
22 the expected return by market returns as well as by estimating a market model,
23 using a simple OLS regression. The estimation window for the market model is the
24 90-day period $(t_{-100}; t_{-11})$. We employ the value-weighted NEMAX All-Share
25 Performance Index as proxy for the market return. Thus the abnormal return (AR_{it})
26 is calculated as:
27
28 $$AR_{it} = R_{it} - [\alpha_i + \beta_i E(R_{mt})] \tag{1}$$
29 with R_{it} actual return of stock i at time t, $E(R_{mt})$ expected return of the (NEMAX)
30 market at time t, α_i constant return component, β_i sensitivity of firm i's stock
31 returns to the market index return, ε_{it} uncorrelated random error term.
32   For testing the statistical significance of the abnormal returns we employ a set
33 of parametric as well as non-parametric tests. We have chosen the simple t-test and
34 the modified t-test proposed by Brown and Warner (1985). In order to check for the
35 influence of non-normal distribution of residuals in small samples, we apply the
36 non-parametric rank test of Corrado (1989). We also compute a potentially more
37 powerful test proposed by Böhmer et al. (1991) that takes heteroskedasticity into
38 account, but explicitly employs information from the estimation period.
39   Calculation of abnormal trading volume is done using a simple constant mean
40 methodology. First, we calculate the average trading volume for each sample firm

in the estimation period. We then compute an abnormal volume index (AVI) as follows:

$$\text{AVI}_{it} = \frac{V_{it}}{V_i} \quad \text{with} \quad V_i = \frac{1}{90} \sum_{t-100}^{t-10} U_{it}, \tag{2}$$

where V_{it} is shares traded in firm i at time t, and V_i is the average trading volume in the estimation period. Finally, the abnormal volume index is averaged across firms in the sample:

$$\text{AV}_{it} = \frac{1}{N} \sum_{i=1}^{N} (1 + \text{AV}_{it}) \tag{3}$$

6. EVENT STUDY RESULTS

This section presents the event study results. Since the date of the lock-up expiration is common knowledge at the time of the IPO, we do not expect to find abnormal returns surrounding the event day, assuming that markets are informationally efficient.

Figure 2 presents a time series plot of the average cumulative abnormal return and shows that the share price declines sharply around the lock-up expiration day. For the period from ten days before the unlock day through 30 days after, the cumulative abnormal return is significantly negative at −7.95%. Cumulative
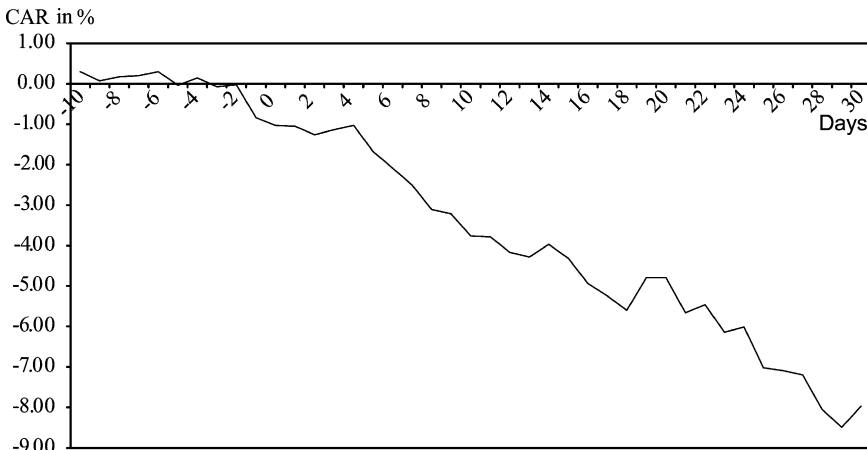
Fig. 2. Cumulative Abnormal Returns Around Unlock Day.

Table 4.   Event Study Results: Full Sample.

	All Events ($N = 172$)		
Event Window	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	−0.84	51.10	−0.41
t_{-2}	0.05	54.65	−0.51
t_{-1}	−0.82**	59.88	−0.92
t_0	−0.19	59.30	−0.61
t_1	−0.03	55.81	−0.59
t_2	−0.21	56.98	−0.72
t_{-2} to t_2	−1.18^{rr}	57.33	−0.61
t_{-1} to t_0	−1.01*	59.59	−0.61
t_{-10} to t_{10}	−3.76**	56.20	−0.46
t_1 to t_{15}	−3.30*	55.47	−0.45
t_{-1} to t_{30}	−7.95***	56.78	−0.48

Note: $^{TTT, TT, T}$ Denote significance of the simple *t*-test; $^{ttt, tt, t}$ denote significance of the Brown and Warner *t*-test; and $^{rrr, rr, r}$ denote significance of the non-parametric rank test according to Corrado (1989).

*Significance of all test metrics at the 10% level.
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

abnormal returns over various event windows are tabulated in Table 4. Sixty percent of the daily abnormal returns on the unlock day are negative. The results are robust to different specifications of event window, benchmark, calculation of abnormal returns, and the test statistic employed.

Figure 3 and Table 5 and show the results for mandatory versus voluntary lock-up provisions. Both experience significantly negative abnormal returns on the unlock day. However, those stocks with a complementary lock-up expiration underperform the benchmark by more than 20%.

Thus, there is a significantly negative abnormal return upon lock-up expiration, which is stronger for voluntary lock-up agreements. An explanation of this finding is that founding entrepreneurs, managers, and other corporate insiders are more likely to be subject to the longer voluntary lock-up period. These insiders are assumed to have higher equity stakes. When these insiders sell, more shares will therefore enter the market, on average, than at the first mandatory lock-up expiration that restricts other investors and friends and family from selling. However, since we have 30 complementary lock-up agreements versus 142 mandatory prohibitions of disposal, one should be careful when interpreting this result.

Finally, since the cumulative abnormal return is still negative after 30 trading days following the unlock day, we can reject a price pressure
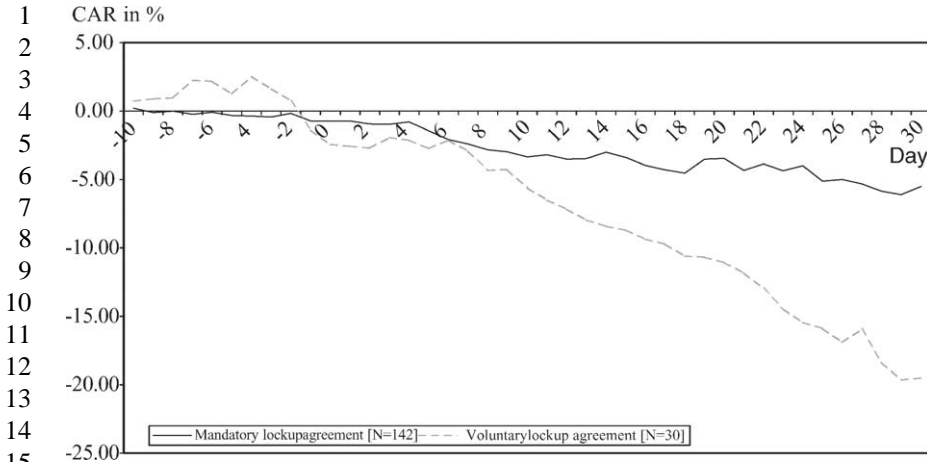
Fig. 3.   Cumulative Abnormal Returns Based on the Length of the Lock-Up Period.

Table 5.   Cumulative Abnormal Returns Around Mandatory vs. Complementary Lock-Up Expirations.

Event Window	Mandatory Prohibition of Disposal ($N = 142$)			Complementary Lock-Up Agreements ($N = 30$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	−0.73	56.83	−0.45	−1.38	52.67	−0.29
t_{-2}	0.25	53.52	−0.48	−0.88	60.00	−0.92
t_{-1}	−0.54	59.15	−0.82	−2.14***	63.33	−1.88
t_0	0.00	57.76	−0.27	−1.06	66.67	−0.81
t_1	0.00	57.04	−0.55	−0.14	62.31	−0.06
t_2	−0.22	55.63	−0.53	−0.12	63.33	−1.04
t_{-2} to t_2	−0.52	56.36	−0.51	−4.34**	60.67	−0.99
t_{-1} to t_0	−0.54	58.45	−0.53	−3.20**	65.00	−1.14
t_{-10} to t_{10}	−3.36**	59.36	−0.47	−5.62^{t}	54.60	−0.40
t_1 to t_{15}	−2.67^{T}	55.45	−0.44	−6.25**	55.56	−0.49
t_{-1} to t_{30}	−5.35***	56.16	−0.44	−20.24***	59.69	−0.74

Note: $^{TTT,\ TT,\ T}$ Denote significance of the simple *t*-test; $^{ttt,\ tt,\ t}$ denote significance of the Brown and Warner *t*-test; and $^{rrr,\ rr,\ r}$ denote significance of the non-parametric rank test according to Corrado (1989).

**Significance of all test metrics at the 5% level.

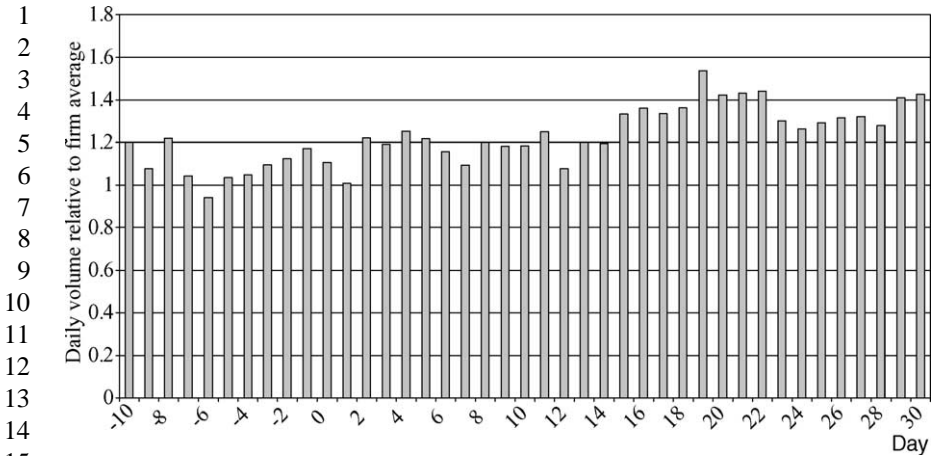***Significance of all test metrics at the 1% level.

Fig. 4. Abnormal Trading Volume Around Unlock Day.

hypothesis. This price pressure hypothesis would predict only a temporary effect (Scholes, 1972).

Figure 4 plots the sample mean of the daily abnormal volume as defined in Eq. (2). Figure 4 shows that, for the full sample, volume increases temporarily to 25% above average on the day after the unlock day, and remains at that level throughout the event window. Thus, unlocking the shares of the incumbent shareholders seems to result in a permanent increase in trading volume.

7. CROSS-SECTIONAL DETERMINANTS OF ABNORMAL RETURNS

Tables 6–11 present the mean and median abnormal returns for various subsamples, and Table 12 presents pooled OLS regressions of the cumulative abnormal return on several control variables. Table 6 shows that firms with a high standard deviation in the estimation period (between IPO and unlock day) experience significantly negative abnormal returns of −20.41% in the thirty-day event window. On the other hand, firms with volatility below the median experience significantly positive abnormal returns of +9.72% during the same time interval. Although the causality is not clear-cut, this supports the risk-diversification hypothesis proposed by Meulbroek (2001) that states that insiders of risky high-growth firms have to reduce their stakes in order to decrease the suboptimal risk inherent in their portfolios. The significantly negative slope of volatility

Table 6. Cumulative Abnormal Returns Partitioned by Residual Standard Deviation.

Event Window	Firms with Volatility < Median ($N = 71$)			Firms with Volatility > Median ($N = 71$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	0.80	58.03	−0.41	−2.25	55.27	−0.56
t_{-2}	−0.30	60.56	−0.57	0.80	46.48	−0.76
t_{-1}	−0.23	59.15	−0.50	−0.85	59.15	−1.53
t_0	−0.26	63.38	−0.24	0.25	52.11	−0.59
t_1	0.73**	50.70	−0.15	−0.74^{t}	63.38	−0.87
t_2	0.25	52.65	−0.03	−0.70	60.56	−1.39
t_{-2} to t_2	0.20	56.90	−0.34	−1.24	56.34	−0.94
t_{-1} to t_0	−0.48	61.27	−0.27	−0.60	55.63	−1.06
t_{-10} to t_{10}	3.54**	54.93	−0.40	−10.26***	58.15	−0.56
t_1 to t_{15}	4.79***	51.17	−0.08	−10.13***	59.72	−0.86
t_{-1} to t_{30}	9.72***	52.99	−0.22	−20.41***	59.33	−0.81

Note: $^{TTT, TT, T}$ Denote significance of the simple *t*-test; $^{ttt, tt, t}$ denote significance of the Brown and Warner *t*-test; and $^{rrr, rr, r}$ denote significance of the non-parametric rank test according to Corrado (1989).
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

Table 7. Cumulative Abnormal Returns Partitioned by Post-IPO Performance.

Event Window	Firms with Performance < Median ($N = 71$)			Firms with Performance > Median ($N = 71$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	0.60	57.04	−0.37	−2.05	56.62	−0.54
t_{-2}	−0.49	56.34	−0.57	0.98^{TT}	50.70	−0.68
t_{-1}	−0.24	59.15	−0.71	−0.84^{T}	59.15	−1.07
t_0	0.82^{T}	53.52	−0.11	−0.82^{T}	61.97	−0.93
t_1	−0.14	57.75	−0.21	0.14	56.34	−0.60
t_2	−0.33	50.70	−0.33	−0.12	60.56	−0.93
t_{-2} to t_2	−0.38	55.49	−0.40	−0.66	57.75	−0.67
t_{-1} to t_0	0.58	56.34	−0.21	−1.66**	60.56	−1.00
t_{-10} to t_{10}	2.09^{t}	54.73	−0.34	−8.81***	58.35	−0.57
t_1 to t_{15}	2.02^{tt}	52.11	−0.23	−7.37***	58.78	−0.80
t_{-1} to t_{30}	4.26^{ttt}	53.83	−0.28	−14.96***	58.49	−0.71

Note: $^{TTT, TT, T}$ Denote significance of the simple *t*-test; $^{ttt, tt, t}$ denote significance of the Brown and Warner *t*-test; and $^{rrr, rr, r}$ denote significance of the non-parametric rank test according to Corrado (1989).
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

Table 8.   Cumulative Abnormal Returns Partitioned by Tradable Shares after the IPO (Free Float).

Event Window	Firms with Free Float < Median ($N = 71$)			Firms with Free Float > Median ($N = 71$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	−2.19	57.61	−0.49	0.74	56.06	−0.43
t_{-2}	−0.06	52.11	−0.58	0.56	54.93	−0.58
t_{-1}	−0.48	63.38	−1.07	−0.60	52.57	−0.18
t_0	−0.31	59.15	−0.49	0.31	56.34	−0.18
t_1	−0.64$^{\text{r}}$	70.42	−1.02	0.64	43.66	0.00
t_2	−0.48	59.15	−1.84	0.03	52.11	−0.31
t_{-2} to t_2	−1.97$^{\text{rrr}}$	60.85	−0.92	0.94	52.39	−0.16
t_{-1} to t_0	−0.79	61.27	−0.82	−0.29	55.63	−0.18
t_{-10} to t_{10}	−8.95***	59.09	−0.49	2.23$^{\text{t}}$	53.99	−0.40
t_1 to t_{15}	−7.39***	58.78	−0.79	2.05$^{\text{tt}}$	52.11	−0.15
t_{-1} to t_{30}	−13.19***	58.93	−0.72	2.49$^{\text{tt}}$	53.39	−0.24

Note: $^{\text{TTT, TT, T}}$ Denote significance of the simple *t*-test; $^{\text{ttt, tt, t}}$ denote significance of the Brown and Warner *t*-test; and $^{\text{rrr, rr, r}}$ denote significance of the non-parametric rank test according to Corrado (1989).
***Significance of all test metrics at the 1% level.

Table 9.   Cumulative Abnormal Returns Partitioned by Abnormal Trading Volume.

Event Window	Firms with Abnormal Trading Volume < Median ($N = 71$)			Firms with Abnormal Trading Volume > Median ($N = 71$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	−5.27***	59.01	−0.56***	3.82	54.65	−0.29
t_{-2}	−0.01	50.70	−0.68*	0.51	56.34	−0.54
t_{-1}	−1.04**	63.38	−1.07**	−0.03	54.93	−0.16
t_0	−0.44	57.75	−0.13	0.44	57.75	−0.34
t_1	−1.41**	61.97	−0.57	1.39	52.11	−0.27
t_2	0.04	53.52	−0.43	−0.49	57.75	−1.39**
t_{-2} to t_2	−2.87$^{\text{tt}}$	57.46	−0.56**	1.83	55.77	−0.50*
t_{-1} to t_0	−1.49**	60.56	−0.68**	0.40	56.34	−0.29
t_{-10} to t_{10}	−11.14***	57.88	−0.56***	4.41	55.20	−0.31*
t_1 to t_{15}	−6.71*	56.34	−0.46**	1.36	54.55	−0.41*
t_{-1} to t_{30}	−12.98***	56.90	−0.52***	2.29*	55.50	−0.45

Note: $^{\text{TTT, TT, T}}$ Denote significance of the simple *t*-test; $^{\text{ttt, tt, t}}$ denote significance of the Brown and Warner *t*-test; and $^{\text{rrr, rr, r}}$ denote significance of the non-parametric rank test according to Corrado (1989).
*Significance of all test metrics at the 10% level.
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

Table 10. Cumulative Abnormal Returns of Venture-Backed versus Non-Venture-Backed IPOs.

Event Window	Non-Venture-Backed IPOs ($N = 67$)			Venture-Backed IPOs ($N = 75$)		
	CAR (%)	% Negative	Median CAR	CAR (%)	% Negative	Median CAR
t_{-10} to t_{-1}	2.46	55.67	−0.41	−3.57[t]	57.87	−0.41
t_{-2}	1.53[**]	46.27	0.22	−0.89[*]	60.00	−1.04
t_{-1}	0.32	55.22	−0.56	−1.30[**]	62.67	−1.05
t_0	0.52	56.27	−0.05	−0.48	58.67	−0.59
t_1	0.83	53.73	−0.50	−0.74	61.57	−0.80
t_2	−0.15	59.70	−0.90	−0.29	56.38	−0.31
t_{-2} to t_2	3.05[**]	54.32	−0.33	−3.71[***]	58.67	−0.77
t_{-1} to t_0	0.84	55.97	−0.14	−1.78[**]	60.67	−0.62
t_{-10} to t_{10}	2.78	55.37	−0.36	−8.86[***]	57.59	−0.55
t_1 to t_{15}	−0.81	54.43	−0.37	−4.34[*]	56.36	−0.47
t_{-16} to t_{30}	0.54	55.82	−0.36	−4.52[*]	57.24	−0.50
t_{-1} to t_{30}	3.36	55.18	−0.39	−10.64[***]	57.04	−0.49

Note: [TTT, TT, T] denote significance of the simple *t*-test; [ttt, tt, t] denote significance of the Brown and Warner *t*-test; and [rrr, rr, r] denote significance of the non-parametric rank test according to Corrado (1989).
[*] Significance of all test metrics at the 10% level.
[**] Significance of all test metrics at the 5% level.
[***] Significance of all test metrics at the 1% level.

in the cross-sectional regressions supports this risk diversification argument (Fig. 5).

A similar line of reasoning applies to the post-IPO performance (until the unlock day). Those firms that experience superior returns prior to the lock-up expiration seem to have significantly negative abnormal price decreases, while those firms whose stocks performed with below median performance do not have any abnormal price reactions at all. The coefficient on the post-IPO returns until the unlock is significantly negative in the cross-sectional regressions. Investors seem to be more eager to sell when the price of their shares has risen than when it has fallen (O'Dean, 1998) (Fig. 6).

If arbitrage were costly, proxies for the amount of shares that come to market at the expiration of the lock-up would be positively related to the price decline. Firms with a larger fraction of their shares locked up (i.e. firms with *lower* free float) would have a *greater* number of shares brought to market at the unlock day, and hence should experience *larger* price declines (Brav & Gompers, 2003). We find that firms with a free float below the median have significantly negative abnormal returns, while firms with high free float do not experience abnormal returns

Table 11. Z-Statistics of the Mann-Whitney-U-Test.

Event Window	Volatility < Median	Volatility > Median	Mann-Whitney-U-Test
t_{-10} to t_{10}	3.54**	−10.26***	−3.17***
t_1 to t_{15}	4.79***	−10.13***	−4.52***
t_{-1} to t_{30}	9.72***	−20.41***	−5.44***
	Post-IPO Performance < Median	Post-IPO Performance < Median	Mann-Whitney-U-Test
t_{-10} to t_{10}	2.09^t	−8.81***	−3.15***
t_1 to t_{15}	2.02^{tt}	−7.37***	−3.10***
t_{-1} to t_{30}	4.26^{ttt}	−14.96***	−3.19***
	Free Float < Median	Free Float > Median	Mann-Whitney-U-test
t_{-10} to t_{10}	−8.95***	2.23^t	−2.35***
t_1 to t_{15}	−7.39***	2.05^{tt}	−2.50***
t_{-1} to t_{30}	−13.19***	2.49^{tt}	−2.10**
	Abnormal Trading Volume < Median	Abnormal Trading Volume > Median	Mann-Whitney-U-Test
t_{-10} to t_{10}	−11.14***	4.41*	−2.40***
t_1 to t_{15}	−6.71*	1.36	−2.80***
t_{-1} to t_{30}	−4.79^{tt}	0.52	−1.95**
	−12.98***	2.29*	−1.18

*Significance of all test metrics at the 10% level.
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

on the unlock day. However, free float is not significant in the cross-sectional regressions. This could be due to the fact that free float is only an imperfect proxy for the amount of shares that come to market on the unlock day (Fig. 7).

Interestingly, for firms with abnormal trading volume larger than the median, we cannot find statistically significant negative abnormal returns. This is puzzling, since we would expect a positive relation between the price drop and trading volume, if the abnormal price reaction is driven by downward-sloping demand curves (Shleifer, 1986). Trading volume is not significant in the cross-sectional regressions. This finding can be attributed to either a very noisy proxy for trading volume or support for a liquidity story. For those stocks that have low liquidity, there is not sufficient demand to absorb the sell orders upon lock-up expiration. Then trading in these stocks "dries out," which leads to the abnormal price decrease. However, we have no direct evidence to support his claim. Future

Table 12. Regression Results for Cumulative Abnormal Returns Around Lock-Up Expirations.

	Dependent Variable CAR (t_{-1} to t_{30})
Constant	27.178* (1.922)
Volatility	−7.723*** (−4.125)
Return since IPO	−0.101*** (−3.015)
Free float	0.161 (0.786)
Abnormal trading volume	1.605 (0.635)
Underpricing	−0.123 (−0.010)
Venture capital-backing	−4.910 (−0.902)
Market value of equity	−0.057** (−2.045)
Number of observations	134
Adjusted R^2	0.326
F-statistic	6.495***

t-Statistics are in parentheses.
*Significance of all test metrics at the 10% level.
**Significance of all test metrics at the 5% level.
***Significance of all test metrics at the 1% level.

research would have to take examine better proxies for liquidity, such as bid-ask spreads, which are unavailable to me.

One of the most intriguing results is the empirical observation that only venture-backed IPOs experience significantly negative abnormal returns of –10.64%, while
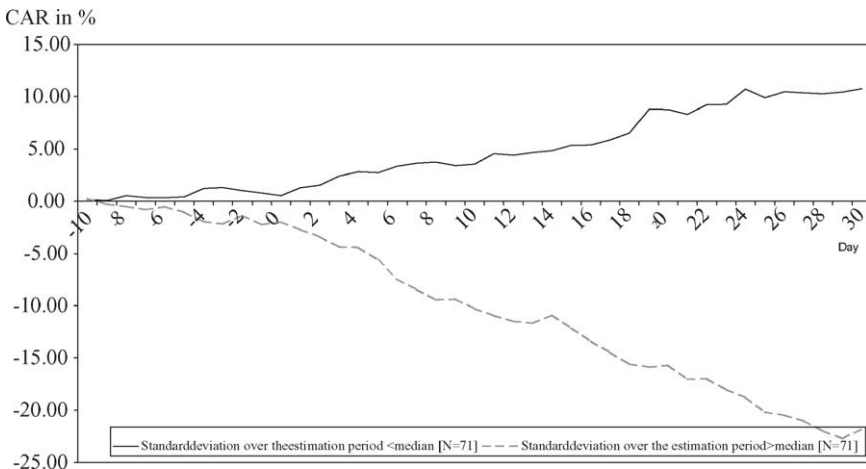
CAR in %

Fig. 5. Cumulative Abnormal Returns Based on Residual Standard Deviation.
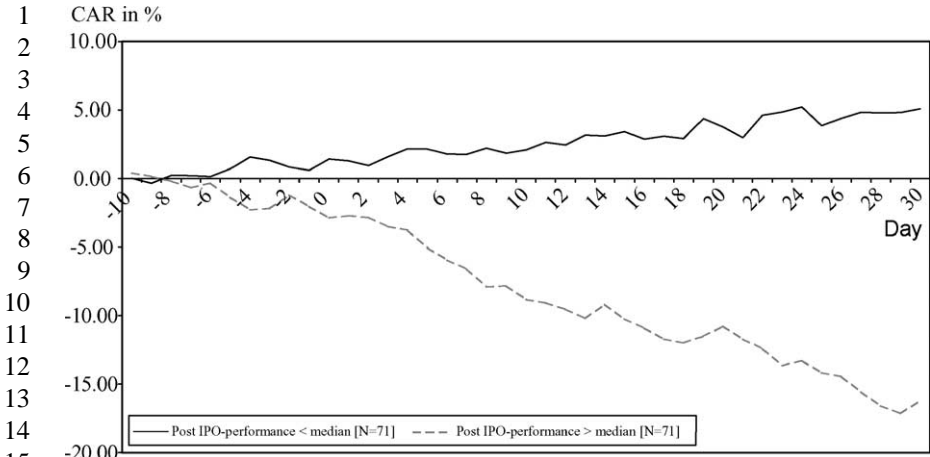
CAR in %

Fig. 6.   Cumulative Abnormal Returns Based on Post IPO-Performance.

non-venture backed firms experience positive if any abnormal returns. However, when included in the cross-sectional regressions, the venture-capital dummy is negative but not statistically different from zero. This may be due to the fact that we cannot take the exact amount of venture financing and the reputation of the venture capitalist into account. In any case, this puzzling result is similar to the finding of Brav and Gompers (2003) that the presence of venture capital investors is

CAR in%

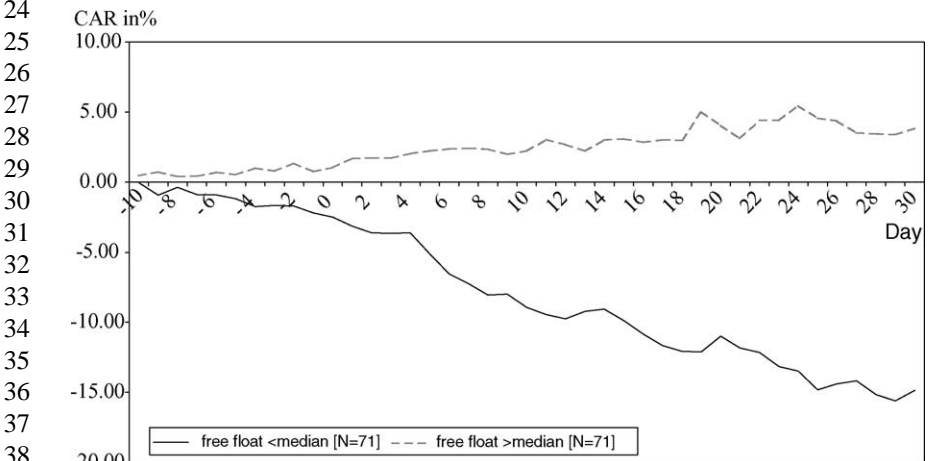*Fig. 7.*   Cumulative Abnormal Returns Based on Fraction of Tradable Shares (Free Float)
After the IPO.

associated with larger price declines in U.S. IPOs. Their explanation for this result is that VC-backing means a greater number of shares brought to the market, since venture capitalists distribute shares to their investors upon the lock-up expiration date (who then sell these shares directly to the market, if they have an automatic selling policy). Thus, on average, a larger number of shares will come to the market for VC-backed companies than for other companies. These results have been confirmed by a study of Kraus and Burghof (2003) who show that venture-backed IPOs seem to perform significantly better before than after the expiration of lock-up periods in Germany.

8. CONCLUSIONS

This chapter explores the stock price impact of expirations of lock-up provisions that prevent insiders from selling their shares after the initial public offering (IPO). We examine 172 lock-up expirations of 142 IPOs floated on Germany's Neuer Markt. Using an event-study methodology We detect statistically significant negative abnormal returns and a 25% increase in trading volume surrounding lock-up expiration. This adds further evidence to the existing U.S. studies showing downward-sloping demand curves and costly arbitrage (Scholes, 1972; Shleifer, 1986).

For the first time, we can differentiate between the effects of mandatory lock-up provisions and the U.S.-type private lock-up agreements between issuers and underwriters. We refer to the latter as "voluntary" lock-up agreements. We show that the average negative price reaction is significantly stronger for the expiration of voluntary lock-up agreements than for mandatory prohibitions of disposal.

We investigate several control variables and find that the negative abnormal returns are larger for firms with high volatility, superior performance after the IPO, and low free float. Furthermore, we find that venture-capital financed firms experience more negative abnormal returns than non-venture backed firms, on average.

A puzzling finding is the fact that abnormal trading volume seems to be negatively related to the price decline upon lock-up expiration. Unfortunately, due to data restrictions, we can not differentiate between liquidity effects and information effects, and must leave the explanation of this result for future research.

NOTES

1. www.sdk.org.
2. Neuer Markt Rules and Regulations.

3. For example the Nouveau Marché (Paris), the Nuovo Mercato (Milan), the SWX New Market (Zürich), the Alternative Investment Market (AIM) in London and NASDAQ Europe in Brussels (EASDAQ).

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