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ON THE IMPORTANCE OF TIME IN IT-RELATED EVENT STUDIES

Abstract

Until now, time has been mainly used as a variable in IT-related event studies to explain the delayed impact of IT investments on firm value and productivity. Yet, the timing of the event announcement itself, due to investor sentiment, may have an effect on its valuation by the capital market. Using the example of product source code releases as open source, I find that market valuation takes a curvilinear shape over time due to investor sentiment caused by the rise and fall of the dot.com bubble. Future IT-related event studies will need to take this potentially interfering effect into account.

Keywords: event study; investor sentiment; dot.com bubble; open source software;

1 INTRODUCTION

One factor influencing the valuation of IT investments that seems to have been neglected in event studies on the impact of IT investments on the value of firms—and one that is particularly relevant to this area—is the assumption of rational investor underlying event studies, that is, that investors treat similar investments equally. However, with the dot.com bubble and its burst at the beginning of this decade, the IT industry is probably the most prominent example of irrational investor behavior of our time. In IT-related event studies, time, so far, has mainly been included to explain the delayed effect of IT investments (see, e.g., Im, Dow, & Grover, 2001). Yet, to the knowledge of the author, very few event studies have explicitly addressed the effect on market valuation that is inherent in the timing of the announcement, that is, the day on which it happened, in relation to investor sentiment in general, and, with respect to the IT industry, in particular to the dot.com bubble. In this paper, I thus tackle the question whether the timing of a strategic IT investment has an impact on its valuation by the capital market. Using the example of firms announcing the release of proprietary product source code as OSS, during the time span from January 1, 1999, to April 30, 2007, I find a curvilinear (u-shaped) trend in the market reaction to firms announcing the release of source code as OSS which can be ascribed to negative investor sentiment after the burst of the dot.com bubble, rendering time a variable that must not be ignored it IT-related event studies when the sample, or parts of it, might have been impacted by investor sentiment.

The rest of this paper is organized as follows. I will first review the literature on event studies in general and IT-related ones in particular. Next, I introduce the concept of investor sentiment and deduce my hypothesis. Afterwards, I explain data and methods used, and, thereafter, present the results. Finally, I discuss the implications of my findings and limitations of the study and give recommendations for future research.

2 THEORY AND HYPOTHESES

2.1 Literature Review

Event studies have been widely used in the IT and IS literature (see, e.g., Dehning & Richardson, 2002; Dehning, Richardson, & Zmud, 2003; Dos Santos, Peffers, & Mauer, 1993; Im et al., 2001; Oh, Gallivan, & Kim, 2006). In an event study, the stock market reactions on the public announcement of specific information affecting a firm are investigated. According to the efficient market hypothesis (Fama, Fisher, Jensen, & Roll, 1969), the semi-strong form of which is underlying an event study, the market reacts to the announcement of new information. Basically all publicly available information goes into the stock price of firms. An event is anything that results in new relevant information which may have an impact on the future cash flows of a firm (McWilliams and Siegel 1997). Thus, when firms announce IT-investments to the public the information can be expected to be included in the stock price shortly after the announcement (Dann, Mayers, Rafts, & Jr, 1977; Mitchell & Netter, 1989).

Past studies have shown that different kinds of IT investments are valuated differently, for example that innovative IT investments are valuated more positively than non-innovative ones (Dos Santos et al., 1993) and that the strategic importance of IT is related positively to the valuation of transformational IT investments (Dehning et al., 2003). They have also shown that firm size or time horizon of the investment matter: Im, Dow, and Grover (2001) find a negative reaction of stock price and trading volume with respect to firm size, which, however, becomes more positive as time passes. The latter is in accordance with findings from related studies that the positive effects of IT investments only become visible over time (Brynjolfsson, 1993).

2.2 Investor Sentiment

Time does not only play a role with respect to the effects, that is, the *time horizon*, of the decision to go OSS, the *timing* of the announcement, too, might be of vital importance. The importance of this observation lies in the fact that, sometimes, capital markets may be inefficient with respect to investors not behaving rationally. Instead, they, too, are subject to sentiment (De Long, Shleifer, Summers, & Waldmann, 1990; Lee, Shleifer, & Thaler, 1991): investors will value stocks more positively in a time of positive investor sentiment and more negatively in a time of negative investor sentiment. Following the definition of Baker and Wurgler (2007), investor sentiment "is a belief about future cash flows and investment risks that is not justified by the facts at hand." Furthermore, Shleifer and Vishny (Shleifer & Vishny, 1997) have shown that it is both costly and risky for investors to buy and sell against investor sentiment, leading to an inefficient market that may well result in a crash. Furthermore, managers seem to be able to react to investor sentiment, so that they for example time IPOs to happen during phases of positive investor sentiment (Baker & Wurgler, 2000; Lee et al., 1991), which, with arbitrage unlikely to happen as argued before, will even further increase the risk of a crash. The rise and fall of Internet-related stocks in the dot.com boom and the eventual burst of the bubble is a prime example of this phenomenon. In the following, I will give the results of several studies that help illustrate the effect of the dot.com bubble and the market valuation of IT investments.

As an example for investor sentiment with respect to the IT market around the dot.com bubble burst, Lee (2001) and Cooper, Dimitrov and Rau (2001) show that IT markets react favorably to firms changing their name to include '.com' before mid-2000, whereas Cooper et al. (2005) show a positive effect of the removal of '.com' from the firm name after mid-2000. Similarly, Dehning et al. (2004) report positive effects on stock price caused by the announcement of e-commerce initiatives in 1998 and—depending on the method they use—negative effects or indications for those for the forth quarter of 2001.

2.3 Hypothesis

I will analyze to potential effect of investor sentiment due to the burst of the dot.com bubble using the example of firms announcing the release of product source code as open source software (OSS). OSS is strongly related with the dot.com bubble as (1) the term "open source" was first publicly announced on April 8, 1998, right during the dot.com hype and in the course of the source code release of the Internet browser Netscape Navigator (Tiemann, 2006), (2) the spread of OSS and OSS development methodologies solely depended on the availability of cheap mass communication as provided by the Internet, and (3) the release of product source code is an IT-enabled strategic decision as it has a long-term impact on the firm, its ability to generate and appropriate value, and the software development process. Following the above argumentation on investor sentiment, companies announcing a release of product source code under OSS should first have received a premium on their stock price during the rise of the dot.com bubble. Other companies should be able to observe this effect and follow suit. With the burst of the dot.com bubble in the second half of 2000, market valuation should turn negative. The number of release announcements will become smaller, too.

With a normalization of investor sentiment with respect to IT investments in general and to the announcement of the release of (potential) commercial products under an OSS license in particular over time, I expect this trend to stabilize, and, eventually, to turn positive, that is, both the number of such announcement and their valuation by investors. In the following, I will give several reasons why this may be the case, that is, which factors might lead to a normalization of investor sentiment with respect to product source code releases following the burst of the dot.com bubble.´While customers did not expect to get access to source code to products at all at the beginning of this decade, for some segments of the IT industry, this has developed so far as that openness has even become a competitive factor, thereby making offering one's source code as OSS the rule rather than the exception in these areas (Henkel, 2006). Moreover, at the time of the burst of the dot.com-bubble, the market only had a

rather small number of objects of comparisons showing the positive effects of OSS—especially with respects to their long-term sustainability of such a strategy. In the time of skepticism thereafter, consequently, investors most likely evaluated the potential of the idea of releasing valuable intellectual property into the open skeptically. When positive effects of IT investments and in particular of going OSS were becoming visible over time (Brynjolfsson, 1993; Dehning et al., 2003), however, the market began to understand the rational behind and the positive effects of the initial decision, and consequently reacted more positively to similar future decisions. Again, it is important to note that "market reaction" not only includes the behavior of investors observing the market, but also other firms observing the success of their competitors' OSS efforts, that is, the number of firms announcing a release of product source code under an OSS license (Baker et al., 2000; Cooper et al., 2005; Lee et al., 1991).

H1: Over time, there will be a curvilinear (u-shaped) development of the effect on stock price of firms announcing the release of proprietary software as OSS.

3 DATA AND METHOD

3.1 Event Study Method and Dependent Variable

The research design used in this study is mainly based on the papers of McWilliams and Siegel (1997), MacKinlay (1997), McWilliams and McWilliams (2000) and Campbell, Lo, and MacKinlay (1997). In an event study, the stock market reactions on the public announcement of specific information affecting a firm are investigated. According to the efficient market hypothesis, the semi-strong form of which is underlying an event study, the market reacts to the announcement of new information. Basically all publicly available information goes into the stock price of firms. An event is anything that results in new relevant information which may have an impact on the future cash flows of a firm (McWilliams and Siegel 1997). Thus, when software or technology companies announce the release of source code to the public the information of releasing code can be expected to be included in the stock price shortly after the announcement.

In this paper, I define an event as follows: *an event is the announcement of the release of proprietary source code—that could have been sold (or has been)—under an OSI compliant license either to an existing public open source project or by setting up a new public OSS project.* Using Lexis Nexis, I searched the PR-Newswire, Business Wire, and Market Wire database using the search term "open source AND (contribute OR release OR reveal) AND code" from January 1999 to April 2007. After checking whether the company that released code was listed on the AMEX, NYSE, or NASDAQ and whether the event fit to the event definition, 111 events by 58 firms were identified. As expected, descriptive statistics of the events show a curvilinear trend in the number of events over time. After creating a sample of events the time windows had to be specified.

The length of the windows was strongly orientated on the window length found in the related literature (Brown & Warner, 1985; Campbell et al., 1997; MacKinlay, 1997; McWilliams et al., 1997). The estimation window was defined as 125 trading days and the event window as two days including the event day and the day prior to the event. The inclusion of the day prior to the event was to take anticipation effects into account. I then checked for confounding events within this period of time. A confounding event was defined as an announcement within the event window that might overshadow the effect of the actual event on the stock price of the company. Confounding events were for example the announcement of new products, information about pending lawsuits, or the release of quarterly or annual reports.

The check for confounding events eliminated 69 of the 111 events. A possible reason for the mass of confounding events may be that many software companies tend to publish information on new

products, strategic partnerships, etc. in bundles on conferences and other mass events.[1] In addition, four more events had to be removed from the sample; three events because the IPO of the respective firms had only happened recently, so that the available stock price data would not have sufficed for the 125-day estimation window. Another event was removed because the respective firm was considered for delisting at the time of the event. A list of all remaining 38 events by 30 firms with no confounding events is given in Table 1.

ID	Firm	Date	CAR_i	Main OSS business model as stated
1	3DFX INTERACTIVE	1999-03-01	0.86%	Complementary goods or services
2	APPLIX	1999-03-02	10.86%	Complementary goods or services
3	SILICON GRAPHICS	1999-04-26	4.18%	Complementary goods or services
4	VISIO	1999-07-27	5.32%	Dual licensing
5	SILICON GRAPHICS	2000-02-14	-0.57%	Complementary goods or services
6	BINDVIEW DEV	2000-02-15	-0.84%	Business transformation
7	SUN MICROSYSTEMS	2000-03-13	-3.92%	Complementary goods or services
8	INTEL	2000-06-15	-3.27%	Complementary goods or services
9	SYBASE	2000-08-22	-1.80%	Cost or risk reduction
10	CADENCE DESIGN SYS.	2000-09-11	12.39%	Complementary goods or services
11	SAP	2000-10-04	-3.79%	Complementary goods or services
12	SANCHEZ COMPUTER ASSOCS.	2000-11-06	4.97%	Complementary goods or services
13	PROGRESS SOFTWARE	2000-12-11	0.02%	Complementary goods or services
14	ADAPTEC	2001-01-30	1.05%	Complementary goods or services
15	SUN MICROSYSTEMS	2001-04-25	-8.38%	Business transformation
16	ON2 TECHS.	2001-08-07	1.08%	Business transformation
17	IBM	2001-11-05	-1.36%	Business transformation
18	OPENWAVE SYS.	2002-05-30	-3.01%	Complementary goods or services
19	ORACLE	2002-08-14	1.12%	Complementary goods or services
20	APPLE	2002-09-25	-2.25%	Business transformation
21	COMMERCE ONE	2003-04-29	-7.57%	Business transformation
22	REALNETWORKS	2003-07-07	-0.48%	Dual licensing
23	BEA SYSTEMS	2004-05-19	1.26%	Complementary goods or services
24	TIPPINGPOINT TECHS.	2004-11-01	11.50%	Complementary goods or services
25	IONA TECHNOLOGIES	2005-06-20	-1.09%	Business transformation
26	EBAY	2005-06-21	-2.51%	Complementary goods or services
27	QUOVADX	2005-07-19	-2.97%	Business transformation
28	ORACLE	2005-08-09	0.88%	Complementary goods or services
29	IBM	2005-08-09	0.61%	Complementary goods or services
30	IBM	2005-08-15	0.42%	Business transformation
31	AUTODESK	2006-03-07	-1.04%	Complementary goods or services
32	WIND RIVER SYSTEMS	2006-07-31	1.46%	Complementary goods or services
33	SUN MICROSYSTEMS	2006-08-23	3.21%	Business transformation
34	TIBCO SOFTWARE	2006-10-02	0.67%	Dual licensing
35	QUALCOMM	2006-10-11	4.92%	Cost or risk reduction
36	ADOBE SYSTEMS	2006-11-07	2.75%	Business transformation
37	SUN MICROSYSTEMS	2006-11-13	-2.09%	Business transformation
38	ADOBE SYSTEMS	2007-04-26	0.07%	Dual licensing

Table 1. List of all events

As is shown in Figure 1, as expected, we find a curvilinear trend in the number of event announcement over time in the sample when both including and excluding confounding events.

[1] An example of such a conference is the JavaOne conference organized by Sun Microsystems Inc. (SUN, 2007).

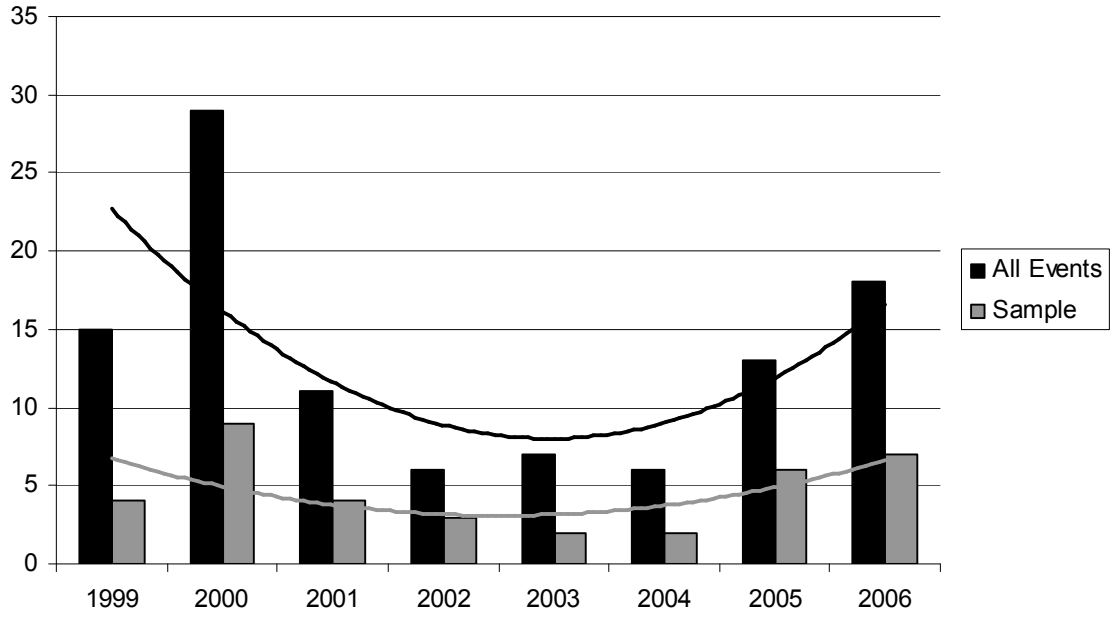

Figure 1. Distribution of events over time

Using the market model and the NASDAQ Composite Index as comparable market index, I then calculated the cumulated abnormal return (CAR) for each event, which was the dependent variable in the multivariate analysis.

3.2 Independent and Control Variables

In order to measure the effect of time, I calculated the number of days that had passed since the press conference on April 8, 1998 (Tiemann, 2006) in which "open source" was coined and the day of the event. For ease of interpretation, I divided this figure by 365.25 to arrive at the number of years. To account for the assumed curvilinear relationship, I included a variable "time-squared."[2]

With respect to control variables, Henkel (2006) found that small firms tend to release more code since they lack development resources and benefit from external development support. In addition, I included the firm's R&D-to-sales and sales-per-employee ratio to account for research intensity of the firm and employee productivity. Sales per employee were transformed to sales per 1000 employees to ease interpretability of the results. To account for the type of IT investment inherent in the decision to go OSS, the business model the company chose to do so was included. In the press releases, I looked for information which business models the firm was primarily intending to follow. I distinguished between (solely) long-term strategic investments that targeted at transforming the industry the company was active in on the one hand and on business models with a short to mid-term impact on bottom-line profits of the corporation as inherent in the business models cost or risk reduction, dual licensing, and sale of complementary goods and assets. This was coded as a dummy variable with respect to whether the business transformation model was employed or not. In order to ensure

[2] Similarly, one may include dummy variables for the separate years (see, e.g., Aggarwal, Dai, & Walden, 2006) which would also allow to more accurately analyze for different effects in the individual years. I refrained from doing so in this study and instead used the time and time-squared measures to reduce the number of variables in the regression because of the sample size. I have also conducted a regression using only time-dummy variables, dropping the singular event from 2007, arriving at similar results as those depicted herein.

reliability of this variable, multiple coders completed such a categorization independently of one another. Differences were resolved in discussions afterwards, and the final categorization was unanimously accepted. Descriptive statistics are available in Table 2, correlations are given in Table 3.

	Median	Mean	Std. dev.	Min	Max
CAR_i	0.00	0.01	0.04	-0.08	0.12
Time	4.41	4.86	2.74	0.90	9.05
$Time^2$	19.43	30.96	27.78	0.80	81.88
ln(Total Assets)	14.40	14.37	2.58	8.28	18.46
$ln(Total\ Assets)^2$	207.26	212.91	72.38	68.49	340.74
R&D-to-sales	0.16	0.22	0.28	0.06	1.74
Sales per 1000 employees	0.28	2.30	12.48	0.00	77.21
Business transformation	0.00	0.32		0	1
Cost/Risk reduction	0.00	0.05		0	1
Dual licensing	0.00	0.11		0	1
Compl. goods or services	1.00	0.53		0	1

Table 2. Descriptive statistics (N=38)

	CAR_i	Time	$Time^2$	ln(Total assets)	R&D-to-sales	Sales per 1000 employees	Business transformation
CAR_i	1						
Time	-0.05	1					
$Time^2$	0.01	0.98**	1				
ln (Total assets)	-0.12	0.20	0.18	1			
R&D-to-sales	-0.04	-0.07	-0.10	-0.56**	1		
Sales per 1000 employees	0.41*	0.10	0.07	0.22	0.02	1	
Business transformation	-0.34*	0.22	0.18	-0.04	0.28†	-0.11	1

*Table 3. Correlation table (N=38; † p < .10, * p < .05, ** p < .01; p-values are two-sided)*

4 RESULTS

Independent Variable	Coefficient value
Time	-0.030*
$Time^2$	0.003*
ln(Total assets)	-0.040
$ln(Total\ assets)^2$	0.001
R&D-to-sales	-0.029
Sales per 1000 employees	0.002**
Business model: business transformation (dummy)	-0.025†
Constant	0.379†

Table 4. Results of OLS regression on CAR using business model "business transformation" as reference group (†p < .10, p < .05, **; p < .01; p-values are two-sided)*

As expected, descriptive statistics show a curvilinear trend in the number of announcements over time (see Figure 1). Turning to the abnormal returns, I take a look at factors influencing the CAR for individual events. Conducting a regression analysis with CAR_i as dependent variable using the independent and control variables introduced before, I arrive at a model with an R^2 of 44% (see Table 4). With respect to my hypothesis, I find that both measures for time—years since the inception and

OSS and years squared—carry the expected sign and are highly significant ($p_{one\text{-}sided} < 0.01$ for both) resulting in the predicted curvilinear trend.

To control for possible autocorrelation effects between, that is, events originating from the same firm, in the regression, I reduced the sample to include only one event by one firm (N = 30) by using only the first or only the last event by the respective firms in two separate regression. In both analyses, the effect of time remains significant (all p-values = 0.02). Similar tests where conducted for events having happened shortly after one another only to find identical results.

5 DISCUSSION AND IMPLICATIONS

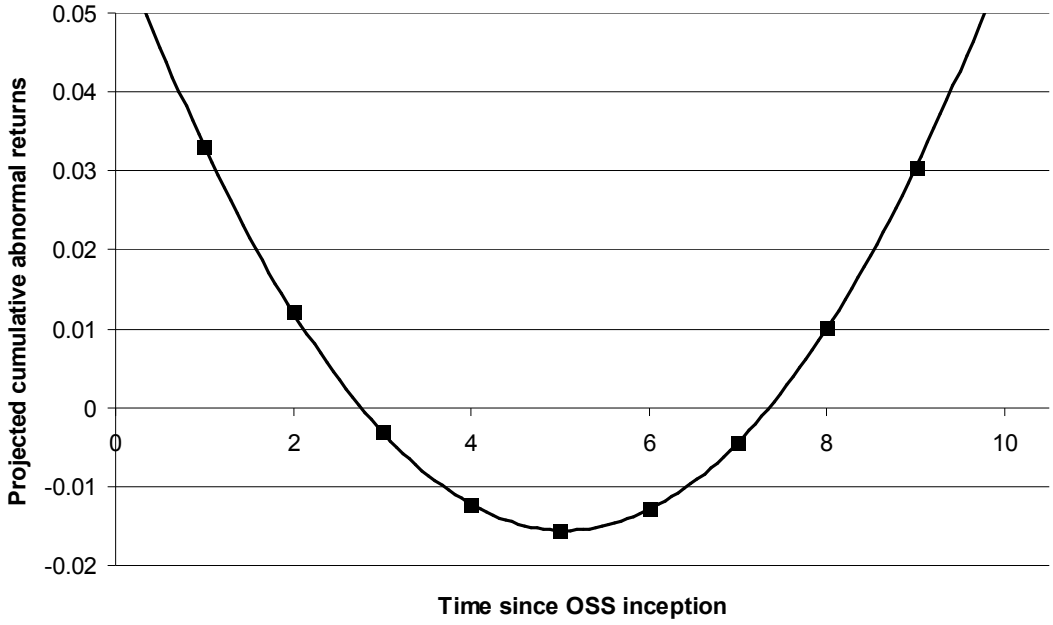

Figure 2. Projected CARs using only time and time squared

In this study, I have shown that the timing of a strategic IT investment drives its valuation by the capital market. I find that there is a curvilinear trend that is most likely explained by investor sentiment. Initially, that is, during the dot.com hype, I see a positive valuation of OSS by the capital market that, however, turns negative with the burst of the bubble. In fact, if I use the regression coefficients from Table 4 and insert mean values for all other variables but time (see Figure 2), the date value of the first root of the resulting quadratic equation turns out to be January 10, 2001, which is right after the dot.com crash. The second root is August 13, 2005, coming shortly before the NASDAQ price increased to and then stabilized around 2,300 points—the highest value since 2001—and during a series of source code releases in 2005. Furthermore, when I assign the events to two groups based on whether they lie within or outside this time interval, I see that they significantly differ in their market valuation (see Table 5). Moreover, I see a nearly identically shaped trend for the number of announcements per years, which indicates deliberate management action in response to investor sentiment.

Date of Announcement	Obs.	Mean	Std. Err.	Std. Dev.
10/1/01 – 08/13/05	16	-0.008	0.011	0.044
Other	22	0.016	0.009	0.043
T-test	0.054†	(p-value, one-sided)		

Table 5. Effect of investor sentiment (univariate analysis)

Of course, I do not expect this evaluation to become infinitively more positive but rather to level off at zero—at which point in time the release of source code under an OSS license will have truly become mainstream firm behavior. In addition, I think that the curvilinear relationship observed in this study may well hold for more segments of the IT sector and related industries. Henkel and Käs (2007) have for example observed that the number of firms releasing source code in several areas of embedded computing such as single-board computers has been steadily increasing over the last years. I would assume market reaction to the respective announcements to follow a similar u-shape.

What is more, I think that this study has generally illustrated the effect that investor sentiment towards a certain action has on its valuation on the market and how investor sentiment and management reaction to it can change over time. First, during the time of the dot.com bubble, OSS—as probably any other Internet-related IT investment—was heartily embraced by the capital market and firms announcing an OSS strategy saw their stock price increase abnormally. Managers observing and understanding this would consequently think about if and how their firms could also release product source code as OSS. With the bubble burst and investor sentiment turning negative, both the valuation and the number of OSS strategies decreased. When the stock market, especially the NASDAQ, stabilized and began to again steadily increase in value, firms making OSS-related announcements could again achieve positive abnormal returns and, again, the number of firms doing so consequently increased. I would thus expect studies analyzing the development of stock prices or IPO performance in the IT sector and maybe also related industries such as telecommunications to find an underlying curvilinear trend over time with respect to market performance caused by investor sentiment on the one hand and, on the other hand, with respect to the number of announcements caused by managers' deliberate reaction to the perceived investor sentiment. Maybe such a curvilinear trend can also be found in the datasets that have been analyzed in previous event studies on the effect of IT investments on the market value of the firm.[3]

Like any other event study this paper faces some limitations. One limitation may be the rather small sample size. Limiting the event window to one day so that the confounding check eliminates fewer events might seem as a solution to this problem, however, as I expect rather strong anticipation effects on the day preceding the event, this does not seem to be a wise choice. Rather, one might think about expanding the search terms and applying those to more and different data sources as the ones used in the study, or recomposing the study in a couple of years: since the number of qualified events has been steadily increasing over the past view years, redoing the study in a few years time should produce a much larger sample size. In such a study, learning effects of firms over time might be analyzed, too, that is, such studies could look at whether the success or failure in previous efforts to release source code under an OSS license has an impact on the market valuation of another such announcement.

This study has shown the effect of investor sentiment on the market valuation of Internet-related IT investments using the example of product source code releases as open source. I have shown that, over time, the market values similar investments differently just because of the timing of the announcement. Similarly, managers were able to react to this and increased or reduced the number of corresponding actions depending on investor sentiment. The timing of the announcement, consequently, is an important variable influencing market valuation, and must not be ignored in IT-related event studies in which the sample, or parts of it, may come from periods of time during which strong investor sentiments are to be expected.

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[3] This curvilinear trend still holds when integration an interaction term between time and the business transformation model to capture potential long-term effects of this business model. Moreover, the new coefficient is positive and significant ($p_{one\text{-}sided} = 0.05$), indicating that the market, over time, has come to better appreciate this business model, too. Another possible explanation might be that firms have come to understand that the business transformation model alone is not sustainable—or at least not accordingly valuated by the capital market—and over time learned to combine it effectively with one of the other models.

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