Investor Expectations and the Role of Venture Capitalists in Acquisitions: Bargaining and the Winner's Curse

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Abstract:

The objective of this paper is to demonstrate and explain a striking relationship between returns to acquirers of privately held enterprises and the presence of venture capital finance. A previous paper (Gompers and Xuan, 2012) finds that the presence of venture capital tends to reduce short run returns to acquirers. We obtain a similar finding, using a larger and more up-to-date data set, although the effect is of modest size and significance. However, this aggregate finding masks a remarkable dichotomy in the data between information technology (IT) acquisitions and other acquisitions. We find a clear negative effect of venture capital in IT acquisitions and a clear positive effect in other acquisitions. We also report evidence that informational asymmetries are more significant in IT than elsewhere. Therefore we suggest that the pattern of venture capital effects on acquisitions is consistent with a role for venture capitalists involving bargaining under conditions of asymmetric information, leading a winner's curse phenomenon in IT, where informational asymmetries are most significant. We focus on short run stock market returns to acquirers. Such returns reflect investor expectations regarding acquisitions. We therefore suggest that investors anticipate a winner's curse aspect to IT acquisitions.

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1. Introduction

The primary objective of this paper is to investigate the effect of venture capitalists (VCs) on returns to acquisitions. One motivation for such analysis is that understanding the influences on returns is important in itself. More importantly, however, examining the effect of venture capital on acquisitions sheds light on the basic theory of venture capital finance.

It has been previously established (in Gompers and Yuan, 2012) - that the presence of venture capital in the financing of a privately held enterprise tends to reduce the short run stock market return to the acquirer. We obtain a similar finding using a larger and more up-to-date data set - and this finding forms the starting point of our analysis. We seek to explain why and under what circumstances the presence of venture capital should tend to reduce acquirer returns, focusing particularly on the role of informational asymmetries.

Venture capitalists do several things for emerging privately held enterprises in addition to providing financing. Normally they sit on the board of directors and often contribute directly to management activities in these enterprises. One such managerial function would be advising on or carrying out acquisition negotiations with potential acquirers. VCs might even play a role in finding potential acquirers and bringing them "to the table". Thus one task of the VC is to help the target enterprise get the highest possible price from an acquirer.

We suggest that venture capitalists would have a negative effect on stock market returns to acquirers if investors (potential buyers and sellers of the acquirers' stock) anticipate that venture capitalists raise the acquisition price through effective bargaining. However, the ability of venture capitalists to influence acquisition prices would depend on circumstances. If valuation of the target enterprise is relatively straightforward we might expect that venture capitalists could have little impact on the acquisition price. On the other hand, if the acquirer is uncertain of the target's value -- either because

of informational asymmetries or because of general uncertainty -- there is much more scope for bargaining by a venture capitalist to have an impact.

Specifically, if there is significant asymmetric information it is possible that a winner's curse phenomenon might be present. Potential acquirers most susceptible to high price-demands would be the ones most likely to end up "winning" a bidding contest and overpaying for the target. There is a significant literature on the winner's curse phenomenon in acquisitions, including McNichol and Stubben (2012), which shows that the extent of the winner's curse problem depends on the quality of available information.

One striking fact about venture capital is its concentration by industry. Venture capital is closely associated with the information technology[1] (IT) sector. In recent years close to 50 percent of all venture capital investment in the U.S. has gone into IT, despite the fact that this sector accounts for less than 10 percent of GDP[2]. Furthermore, many of the most influential corporations in the IT sector were financed in part by venture capital, including Microsoft, Intel, and Yahoo, among others. Other sectors such as finance, general manufacturing, retailing and distribution have correspondingly low levels of venture capital relative to GDP. Aside from IT, the other sector often given emphasis in discussions of venture capital is biotechnology, which has accounted for about 20% of U.S. venture capital investment in recent years.

A concentration of venture capital in areas characterized by informational asymmetry is consistent with a widely held view of venture capitalists described, for example, by Amit, Brander, and Zott (1998), that venture capitalists exist as specialized financial intermediaries because they have particular expertise in dealing with high levels of informational asymmetry. The informational asymmetry perspective suggests that venture capitalists will tend to specialize in areas where such asymmetries are

[1] Sometimes this sector is referred to as the “information and communication technology” (ICT) sector. We intend no distinction between IT and ICT.

[2] The Price Waterhouse Coopers Moneytree website at www.pwcmoneytree.com provides a 17 industry breakdown of U.S. venture capital investment from 1995 to the present. The IT sector as we define it comprises 6 of the 17 industries: computers, IT services, networking, semiconductors, software, and telecommunications. Relevant GDP numbers can be obtained from the Bureau of Economic Analysis website at www.bea.gov.

particularly important. These are the areas where venture capitalists have a comparative advantage relative to other financial intermediaries.

Our approach is to compare the stock market returns of firms that acquire venture-backed targets to the returns obtained by acquirers of comparable target firms that were not financed with venture capital. We carry out this exercise for IT acquisitions and for other acquisitions. (We also consider biotech acquisitions for some purposes.) We use an event study methodology, focusing on the effect of an acquisition announcement on the acquirer's stock price. We then consider and correct for other factors that might affect acquisition returns such as when the acquisition took place, the acquirer's industrial classification, the acquirer's acquisition experience, acquirer size, acquisition size, and the method of payment for the acquisition (stock or cash).

We consider standard event windows of one to seven days to measure abnormal returns to acquirers surrounding an acquisition announcement. We are therefore looking at investor expectations of the acquirers' performance and - in effect - at investor expectations of the role of venture capitalists. Our primary hypothesis is that investors anticipate that venture capitalists have the effect of creating or enhancing a winner's curse phenomenon in IT acquisitions.

Section 2 sets out the conceptual foundations of our primary hypotheses and, in the process, provides an overview of the relevant literature. Sections 3 is devoted to a discussion of the event study methodology we use and Section 4 describes our data. Section 5 reports our estimation results. Section 6 contains discussion and concluding remarks. An appendix contains definitions of the IT and biotechnology sectors using NAIC codes.

2. Hypothesis Development and Literature Review

One important conceptual foundation for the theory of venture capital is the theory of asymmetric information, as pioneered by Akerlof (1970) and Arrow (1973), among others. Early work on venture capital, including Sahlman (1990) and Amit, Glosten, and Muller (1990) emphasize that informational asymmetries are particularly important in the venture capital industry. As noted in Amit, Brander, and Zott (1998) and elsewhere, VCs focus on developing skills in monitoring and mentoring client enterprises

in the presence of informational asymmetries. They devote considerable effort to getting information about particular firms, technologies, and industries, and often have a technical background in the relevant industry.

Informational asymmetries related to entrepreneurial enterprises are particularly important when the enterprise reaches the stage at which venture capitalists and other early stage investors seek to "exit" (sell all or part of their investments). The most extensively studied exit vehicle is the initial public offering (IPO), which occurs when the entrepreneurial firm first offers its shares to the general investing public on an organized public exchange. However, third party acquisitions (in which another firm buys the venture outright) are also very important as exit vehicles, but have attracted much less attention than IPOs from academic researchers working on venture capital. If we combine full (100 percent) acquisitions and partial acquisitions together, they are far more important than IPOs as an exit vehicle.[3]

With IPOs, one potentially important effect of venture capitalists is to certify the value of an enterprise under conditions of asymmetric information. Investors might therefore be willing to pay more than they otherwise would for enterprises going public. This certification hypothesis is posed and tested for IPOs by Megginson and Weiss (1991), who find that firms financed with venture capital have higher IPO stock prices (and therefore less short run “under-pricing”) than other IPOs. Thus, venture capitalists seem to provide certification for the quality of their ventures.

An important role of venture capitalists in the acquisition process is the provision of superior bargaining ability. This view is consistent with the findings of Brander, Amit, and Antweiler (2002) and Hellmann and Puri (2002) who emphasize the managerial role of venture capitalists, although neither paper explicitly addresses acquisitions. If venture capitalists are particularly good at bargaining they should obtain higher acquisition prices. If investors anticipate this effect then acquirers would obtain lower abnormal returns when venture capitalists are present. Furthermore, the bargaining role of venture

[3] The National Venture Capital Association states on its website (www.nvca.org/def.html) “While the initial public offering may be the most glamorous and heralded type of exit for the venture capitalist and owners of the company, most successful exits of venture investments occur through a merger or acquisition...”. Hellmann, Egan, and Brander (2005) report that, “Over the last ten years approximately twice as many venture capital backed firms have been acquired as have experienced an IPO”.

capitalists is likely to be most important under conditions of informational asymmetry – where potential acquirers have inferior information about the true value of a target enterprise and are therefore subject to a winners curse problem.

Hypothesis: *Venture capitalists provide value-added bargaining contributions for their client firms, resulting in higher acquisition prices in presence of informational asymmetries and correspondingly lower short run returns to acquirers.*

One way to assess this hypothesis is to consider cross-industry differences in the extent of informational asymmetry. We consider evidence on whether IT to exhibits more informational asymmetry than areas like general manufacturing, retailing, etc., where the underlying technology is better understood.

In contrast to the large literature dealing with venture capital and IPO returns, there is relatively little work dealing with the relationship between venture capital and acquisition returns. Gompers and Xuan (2012) do consider this relationship. As noted in the introduction, they find a negative venture capital effect on short run abnormal returns. We obtain a similar result, which serves as the starting point for our primary analysis on the striking differential effects of venture capital by sector.

Our paper also contributes to the substantial literature on the gains (or losses) arising from mergers and acquisitions. Widely cited early reviews of this literature include Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988). Both papers report the well-known finding that there are net short-run gains to acquisitions, but that these gains accrue almost entirely to the targets rather than the acquirers. This finding is confirmed in more recent work as well, including the survey by Andrade, Mitchell, and Stafford (2001), who note that acquirers, if anything, provided a subsidy to the acquisition process over the 1973-1998 period, and Moeller, Schlingemann, and Stulz (2005), who report large losses to shareholders of acquiring firms in the most recent acquisition wave.

The consistent finding of zero or negative abnormal returns to acquirers is based on acquisitions of publicly traded firms. As reported by Chang (1998), the results for acquisitions of privately held firms are different. Acquirers of privately held firms have earned positive abnormal returns. Our analysis in this paper is based entirely on acquisitions of privately held firms and, consistent with Chang, we find that acquirers earn small but significant positive abnormal returns on average. This finding is also consistent with Fuller, Netter, and Stegemoller (2002) and Officer, Poulsen, and Stegemoller (2006).

An important theme in our analysis is the relatively high level of informational asymmetry associated with IT. This is consistent with, for example, Cumming and MacIntosh (2001) and the references cited there. There is a small but significant literature on the measurement of informational asymmetries. We draw in particular on Dierkens (1991), Officer, Paulsen, and Stegemoller (2006), and Moeller, Schlingemann, and Stulz (2006).

Table 1 provides a list of papers that do not study venture capital but that do investigate the effects of other variables on returns to acquisitions. These variables include the size of the acquirer, the size of the acquisition (transaction value or TV), the method of payment (usually cash or stock), the effect of the boom of the 1990s, and the total size and leverage of the acquirer. We consider all of these variables as control variables in our analysis.

Table 1: Influences on Returns to Mergers and Acquisitions

Variable	References	Public or Private	Effect
Transaction value (TV)	Asquith, Bruner, & Mullins (1983)	Mergers of public firms	Larger TV increases returns
Payment method (Cash or Stock)	Huang & Walkling (1987), Fuller et. al. (2002), Chang (1998), Gompers & Xuan (2005)	Mergers of public firms, and acquisitions of public and private firms	Payment in cash produces lower returns.
Boom effect	Moeller, Schlingemann, & Stulz (2005)	Mergers and acquisitions of public firms	Increased returns in boom period.
Total assets (acquirer)	Loderer & Martin (1990)	Acquisitions of public firms	Large firms overpay
Leverage (acquirer)	Maloney, McCormick, & Mitchell (1993)	Acquisitions of public firms	High leverage reduces returns
Informational asymmetry	Officer et. al. (2006)	Acquisitions of private firms	Positive returns to acquisitions

3. Methods

This paper uses an event study methodology in which an acquisition is viewed as an event that might cause a shock to the returns of the acquiring company. Thus each acquisition is an observation. We focus on the returns to the acquirer when the acquisition is announced. While there is often some discussion of possible acquisitions before they occur, there is normally significant uncertainty until the acquisition is formally announced. We therefore anticipate that the acquisition announcement transmits significant new information to the market, especially for acquisitions of the small entrepreneurial firms that dominate our sample. Primary attention is focused on the 3-day "event window" incorporating the announcement day, the previous day and the subsequent day. We also look at larger windows in an effort to see if there is apparent leakage of information before the announcement or if there is a delayed effect.

There is a large literature on event study methodology. A useful overview is provided by McKinlay (1997). Despite this large literature, and the hundreds of applications in the academic literature, there are significant differences of opinion regarding the appropriate methodology and each particular context requires thoughtful judgments to be made. In our case the results are sufficiently robust that such differences would not appear to affect the substantive conclusions. We treat the set of acquisitions as a sample generated by some underlying data-generating process, implying that sampling theory can be used to provide statements about the statistical significance of our findings. We generate an abnormal return measure for each acquisition, and then treat this return as an observation that might be explained by the "treatment" variable – the presence of venture capital, along with various control variables.

When we try to assess the effect of some event, like an acquisition, on returns we seek to isolate effects due to the event. This requires adjusting for any changes in returns that would have occurred even without the event. The first step in this process to estimate a "market model" that estimates the relationship between each acquiring firm's stock return and a market index. Specifically, for each firm i we estimate the following market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (1)$$

where R_{it} is the return on the stock of firm i at time t, α_i and β_i are the firm specific parameters of the market model, ε is the error, and R_{mt} is the return on the "market" portfolio. The market index used here to determine the market return is the (commonly used) value-weighted composite AMEX, NASDAQ, NYSE index provided by the Center for Research on Security Prices (CRSP) as available through Wharton Research Data Services (WRDS). We use a 250 trading-day estimation window (approximately one calendar year) prior to the event to estimate the parameters of the market model.

This estimated relationship between an acquiring firm's returns and market returns is used to predict normal returns to the acquirer during the event window containing the acquisition announcement. Specifically, using asterisks to denote estimates, the estimated normal return in the event window is given by $\alpha_i^* + \beta_i^* R_m$. The abnormal return in the event window, AR_i, is the difference between the actual return in the event window and the estimated normal return:

$$AR_i = R_i - (\alpha_i^* + \beta_i^* R_m) \qquad (2)$$

There has been much documentation of problems in estimating abnormal returns. See, for example, Conrad and Kaul (1993) and Coutts, Mills, and Roberts (1994). One way of interpreting much of the criticism is that whatever model is used to construct predicted returns is an auxiliary hypothesis. If this auxiliary hypothesis is inaccurate, then tests of the primary hypothesis are unreliable. However, for short event windows surrounding an announcement date there is very little bias from this source as long as any reasonable method is used[4]. An alternative to the market model is to subtract a daily market index return from the daily return to the acquirer and use the difference as the abnormal return. We obtain very similar results (not reported) if we use this index subtraction method instead of the market model.

In an event study one hopes that by adjusting for movements in the overall market, over a short time horizon it is possible to isolate the effect of the particular event without the need for other control variables. In this case we expect to have a good estimate of the effect of acquisitions on returns. However,

[4] As has been pointed out by Fama (1998), among others, over a very short window (such as a few days) the normal return is close to zero under any reasonable model and most of the observed return is the abnormal return. Accordingly, the model used does not contribute much error even if not strictly correct. Model error increases in importance as the length of the event window increases and is a major problem for long-run studies.

to draw inferences about the role of venture capital it is important to correct for other factors relevant to acquisition returns. These factors include the date, the industry of the acquirer, the size of the acquirer and relative size of the acquisition, and the means of payment for the transaction (cash or stock).

4. Data

One necessary piece of data is a list of acquisitions. We use the Thomson Financial SDC Mergers and Acquisitions database, obtaining U.S. acquisitions data covering the period 1985 through 2011. As it is necessary to follow the stock market returns of the acquiring firm we restrict attention to cases in which the acquirer is publicly traded with a listing on the AMEX, the NASDAQ, or the NYSE. Furthermore, we are interested in the effect of venture capital. Accordingly we focus on the set of acquisitions for which venture capital is potentially relevant – acquisitions of privately held targets. We restrict attention to 100% acquisitions and we require that each acquisition be classified as completed.

We use the Thomson Financial VentureXpert database to identify privately held U.S. firms that received venture capital over the period 1975 through 2011. This comprises the relevant venture-backed enterprises that would be candidates for acquisition from 1985 through 2011. We match the VC-backed enterprises to the SDC target database using name-based matching software taking into account reference information such as the state of incorporation, headquarters' location, and date of incorporation of the enterprise. This method allows us to reliably identify the subset of acquired firms that were venture-backed. Financial accounting data for acquiring firms for the corresponding period is downloaded from COMPUSTAT using the WRDS interface and is linked to the SDC data using CUSIP numbers.

Stock return data is downloaded from the CRSP database, also using the WRDS interface, and is linked to COMPUSTAT and SDC data also using CUSIP numbers. The CRSP return data for each acquirer is downloaded over a long enough period to estimate, where possible, a market model using a 250 trading day estimation window (approximately one calendar year) finishing 30 trading days before the acquisition announcement. Some acquisitions were made by firms that lacked a sufficiently long and continuous estimation window. We include these observations as long as the available estimation window is at least 50 continuous trading days ending 30 days before the event.

The filters described here yield a total of 23,084 eligible acquisitions, of which 22,465 have detailed NAIC industry identification codes for the acquisition targets. We use these codes to classify the acquisitions into those where the acquired firm was operating in IT, biotech, or 'other' industries. We develop our own list of codes for each of the categories. Our classification system is very similar to other classifications used in the literature, such as Hecker (2005) and Paytas and Berglund (2004), and the results are not sensitive to small changes in the classification system.

Of the 22,465 classified acquisitions, 4,772 (about 21%) are of IT firms and 947 (about 4%) are of biotech firms. The other 16,746 (about 75%) privately-held targets operate in other sectors. The number of acquisitions where the target had venture capital finance is 2,282 (about 10%). Table 2 shows the number of acquisitions by time period, categorized by sector (IT or not) and according to whether the target is venture-backed.

Table 2: Acquisitions by Period, Sector, and VC-Backing

		1985-89	**1990-94**	**1995-99**	**2000-04**	**2005-09**	**2010-11**	**Total**
IT	Not VC-backed	109 (3.2%)	349 (10.2%)	1135 (33.5%)	823 (24.3%)	719 (21.2%)	254 (7.5%)	3389 (100%)
	VC-backed	55 (4.0%)	62 (4.5%)	232 (16.8%)	385 (27.8%)	435 (31.5%)	214 (15.5%)	1383 (100%)
Non-IT	Not VC-backed	912 (5.4%)	2517 (14.8%)	6,668 (39.3%)	2,880 (17.0%)	3060 (18.1%)	913 (5.4)	16,950 (100%)
	VC-backed	51 (6.9%)	64 (8.6%)	154 (20.7%)	208 (28.0%)	167 (22.4%)	99 (13.3%)	743 (100%)
All	Total	1127 (5.0%)	2992 (13.3%)	8189 (36.5%)	4296 (19.10%)	4381 (19.5%)	1480 (6.6%)	22,465 (100%)

The number of acquisitions is much greater in the 1995-1999 period than in other periods. The NASDAQ peaked in early 2000 then fell dramatically, losing approximately 75 percent of its peak value by the time it reached its trough in late 2002. The NYSE also fell, although less sharply. During the post-boom period, acquisitions were lower in both IT and non-IT areas, but venture-backed acquisitions actually rose in both areas. Possibly acquisitions became preferred to IPOs as exit vehicles by venture capitalists after the sharp decline in major public stock markets.

We have considerable information about the acquirers from COMPUSTAT, including total assets and other financial accounting measures. The available information about the targets is more limited. The size of the acquisition is available for close to 40% of the observations, allowing the relative importance of these acquisitions to be assessed. The acquisitions considered here, while much smaller than the acquiring firms, are large enough to have a meaningful impact on the acquirers, as implied by Table 3, which provides summary statistics for a variety of transaction characteristics, including information about both the acquiring firm and the target. Nominal values are converted to real 2011 values using the GDP implicit price deflator.

Table 3: Summary Statistics for Acquisitions

Acquirer size is the market value of assets, calculated as the market value of equity 30 days prior to the acquisition plus the book value of debt from the most recent complete year. Target size is the value of the acquisition. These size measures are measured in millions of U.S. dollars and are converted to 2011 values using the GDP implicit price deflator index. The relative target size shows the ratio of target size to acquirer size in percent. We show the 25th, 50th, and 75th percentiles for these variables. The % stock payment measure shows the mean percent of stock in the payment and the final column (acquirer experience) shows the average number of previous acquisitions in the data set by the acquirer.

		Acquirer Size $M 2011 (percentiles)	**Target Size** $M 2011 (percentiles)	**Relative Target Size %** (percentiles)	**%Stock Payment** (average)	**Acquirer Experience** (average)
IT	Non-VC	281; 1083; 5070	7; 19; 47	0.9; 2.8; 7	21	7.2
	VC-backed	806; 4093; 24654	22; 65; 160	0.7; 2.7; 7.4	25	10.4
Non-IT	Non-VC	316; 1034; 3499	8; 21; 56	1; 2.9; 7.8	13	13.2
	VC-backed	638; 2336; 13993	23; 67; 207	1.2; 3.5; 9.9	22	4.8
All	Total	335; 1133; 4231	9; 24; 67	1; 2.9; 7.7	15	11.7

The SDC database reports information such as age, sales, leverage, intangible assets and other variables for a small fraction of target firms. For example, age is reported for only about 8% of the acquisitions and intangible assets are reported for less than 2%. Using these variables would therefore force us to discard the vast majority of our observations or implement some very approximate method of dealing with missing data. Therefore, as we have no reason to believe that treating these variables as omitted variables induces any bias into our analysis, we do not seek to use them as explicit controls.[5]

[5] Officer, Poulsen, and Stegemoller (2007) also focus attention on acquisitions of privately held targets in the SDC database, but restrict attention to large acquisitions for which it is necessary to file an "8-K" or comparable

5. Results

5.1 Informational Asymmetry

The central maintained hypothesis in our analysis is that IT acquisitions have high informational asymmetry. Various measures have been suggested as indicators of informational asymmetry. We have identified four measures that the literature and our own judgment suggest are appropriate here. These are: i) the idiosyncratic volatility of stock returns as suggested by Dierkens (1991); ii) relative trading volume, also suggested by Dierkens (1991); iii) the ratio of balance sheet intangibles to assets, as suggested by Officer et. al. (2007); and iv) Tobin's Q, as suggested by Moeller et. al. (2006). See Boehme et. al. (2006) and the references cited there for a useful discussion of such measures.

Using idiosyncratic stock return volatility reflects the idea that stock prices are easily moved when informational asymmetries are high. This volatility can be measured by the standard deviation of regression residuals in a market model of the type given by equation (1) or, nearly equivalently, by the root mean square error (RMSE) of the regression. The rationale for relative trading volume is that informational asymmetries lead to heterogeneous beliefs and high transaction levels. The intangibles measure reflects the idea that a firm's intangible assets such as intellectual property, reputation, and goodwill are more difficult to value than tangible assets such as buildings or factories and will therefore involve significant informational asymmetry. Similarly, Tobin's Q (the ratio of market value to book value), indicates the extent to which firm value is based on something other than readily understood book values. Such things will be better understood by insiders than outsiders, implying asymmetry. None of these measures is in itself ideal, but taken together and interpreted in context they would seem to provide a reasonable assessment of informational asymmetry.

We take the COMPUSTAT and CRSP databases of publicly traded firms for 2005 and 2006 and calculate these informational asymmetry measures for various industries. The two years provide very similar results and average results are shown. The NAIC codes used to define IT and biotechnology are

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disclosure statement. It is therefore possible to obtain considerable information about targets. However, their sample, while excellent for some research questions, is 735 acquisitions – about 3% of our sample size.

given in the Appendix. We include these two industries and all one-digit NAIC industries with IT and biotech components subtracted out. Using 2-digit industries gives similar results. In Table 4 the industries are placed in order of the sum of ranks over the four measures.

Table 4: Indicators of Informational Asymmetry

Industry Group	Turnover	RMSE	Intangibles	Tobin's Q	Sum Rank	Order Sum Rank
Information Technology	1	2	3	1	7	1
Biotechnology	3	1	4	2	10	2
Manufacturing	5	3	5	3	16	3
Trade and Transport	2	4	7	8	21	4
Education and Health	7	5	2	9	23	5
Other Services	9	7	1	7	24	6
Resources	4	6	10	5	25	7
Arts and Entertainment	6	9	6	4	25	7
Investment and Management	8	10	8	6	32	9
Agriculture	10	8	9	10	37	10

Source: COMPUSTAT and CRSP, based on mean of results for 2005 and 2006.

Using one-digit industries as the comparison group, the IT sector has the highest aggregate informational asymmetry score. Consideration of context strengthens this conclusion. For example, in considering intangibles, both "education and health" and "other services" have a high rank reflecting their heavy reliance on human capital as reflected in goodwill and reputation rather than on physical capital. However, this human capital is not a major source of informational asymmetry, whereas the reliance of IT on intellectual property is likely to be associated with strong informational asymmetry.

Biotechnology has the highest idiosyncratic volatility, caused largely by drug development (which is about half of the biotech sector as defined here). In drug development successful events like good trials or regulatory approvals normally cause large idiosyncratic positive shocks, while corresponding negative events cause large negative returns. The associated uncertainty, while high, seems unlikely to reflect much asymmetry as these events must be disclosed quickly and accurately. Therefore, context suggests that the importance of informational asymmetry in biotech might be considerably less than in IT. Even taking the numbers at face value, IT certainly has highest aggregate rank or score. We conclude that the empirical evidence is strongly supportive of the claim that the IT sector has a relatively high level of informational asymmetry.

5.2 Descriptive Results Regarding Abnormal Returns

Figure 1 shows the average daily abnormal returns to acquirers of venture-backed and other targets for a 7-day event window covering the period from 3 trading days before the acquisition announcement to 3 trading days after the announcement. In each case the abnormal return is calculated relative to the market model. The day of the announcement is denoted "0" and earlier days are represented by negative numbers. The announcement normally occurs before the end of trading on the announcement day. Therefore, the impact effect, if any, should occur largely on Day 0. In some cases the announcement occurs after the end of trading, in which case the impact effect would occur on Day 1.

Figure 1: Daily Abnormal Returns to Acquirers for a 7-Day Event Window

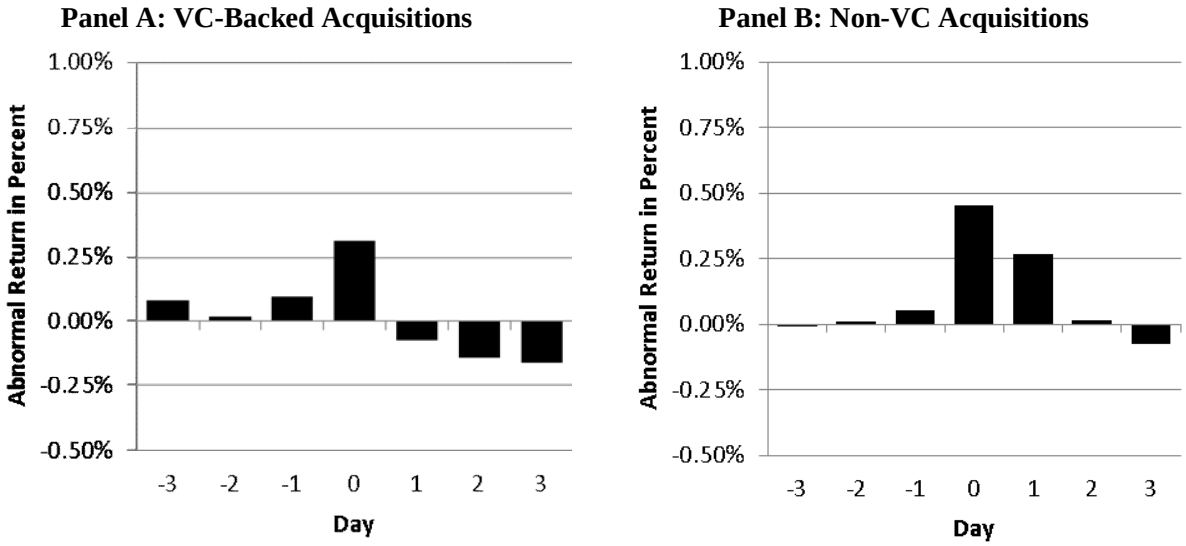
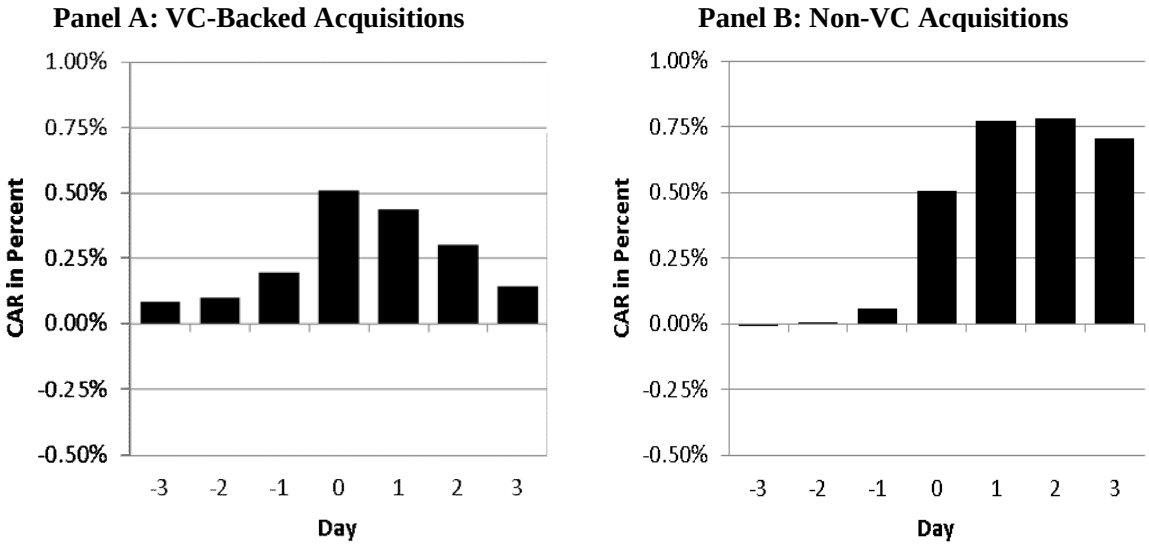


Figure 1 shows that both VC-backed and non-VC acquisitions exhibit positive abnormal returns around the announcement. Panel A, showing VC-backed acquisitions and Panel B, showing non-VC acquisitions both exhibit a marked abnormal return on the announcement day, and the non-VC acquisition exhibit a further abnormal returns the day after, suggesting a trading or information lag for some acquisitions. Overall, there is a clear positive abnormal return for these acquisitions and, as shown later, this effect is statistically significant. The basic pattern can perhaps be seen most clear using the cumulative abnormal returns (CAR), as shown in Figure 2.

Figure 2: Cumulative Abnormal Returns to Acquirers for a 7-Day Event Window



The CAR is sum of daily abnormal returns starting from the beginning of the event window. Panels A and B show the CARs for VC-backed and non-VC acquisitions respectively. In both cases there is a hint of information leakage before the announcement, a significant move on the announcement day, and a modest further return on the day after the announcement. For both sets of returns, the cumulative abnormal return by the 3rd day after the announcement is between 0.5% and 1%. There is considerable similarity between venture-backed and non-venture acquisitions; both sets of acquisitions exhibit a very clear announcement effect, and the non-VC acquisitions in particular closely resembles the pattern of abnormal returns predicted in theory.

The diagrammatic evidence contained in Figures 1 and 2 is weakly supportive for the bargaining hypothesis, which should imply a lower abnormal return for VC-backed acquisitions, particularly given their concentration of investment in high-tech industries. However, to examine the possibility that a winner's curse is playing a crucial role, it is necessary to look separately at the pattern of abnormal returns for IT acquisitions, where we know that informational asymmetries are particularly strong, and non-IT acquisitions.

Figure 3: Cumulative Abnormal Returns for IT Acquisitions

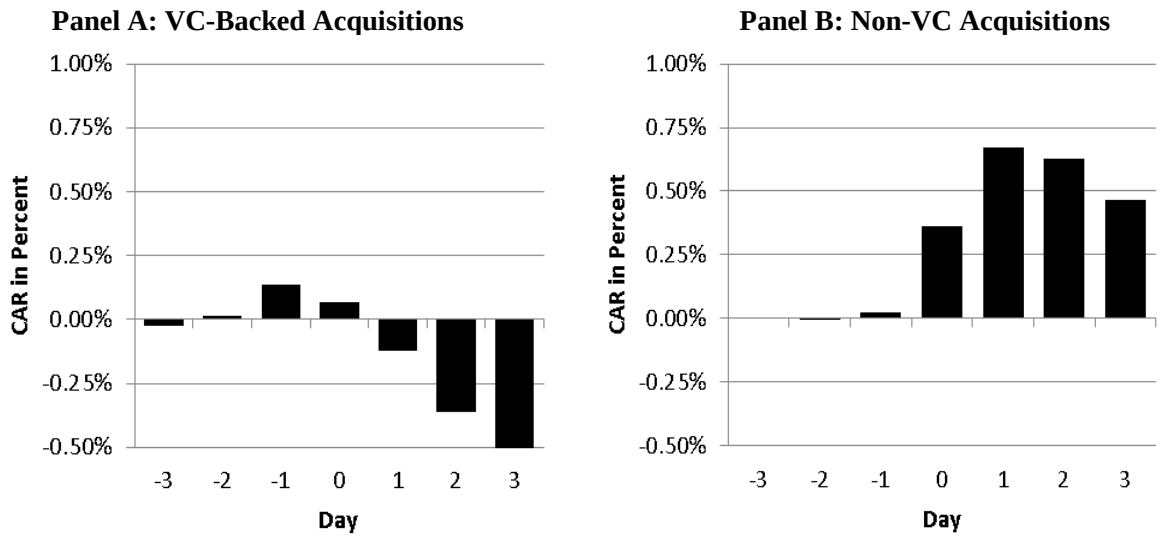


Figure 3 shows a striking contrast between VC-backed and non-VC acquisitions for targets in IT sector. The VC-backed acquisitions, shown in Panel A, exhibit only very small positive abnormal returns, on the day before the announcement day and announcement day, followed by a negative cumulative abnormal return that reaches -0.5% by the end of the third day following the acquisition. This suggests that acquirer's are perceived as overpaying for VC backed IT firms. Panel B shows that acquirers of IT companies **not** backed by venture capital experience relatively large cumulative abnormal returns with a classic event study pattern. Not much happens before the announcement. There is a large and significant positive effect on the announcement day of close to a third of a percentage point, and a further positive effect of comparable size the day after the announcement. At the end of the third day after the announcement, the average cumulative abnormal return is has stabilized at about 0.5%. This strong difference between VC-backed and other acquisitions in the IT sector is supportive of the our hypothesis that venture capitalists provide value-added bargaining contributions for their client firms, resulting in higher acquisition prices in presence of informational asymmetries and correspondingly lower short run returns to acquirers.

In the following section we use more formal statistical techniques to examine the effect of venture capital on acquisition returns.

5.3 Univariate Results

We first consider whether the abnormal returns to acquisitions are statistically significant. We also consider whether the main features of the comparative abnormal returns are robust to variations in the length of the event window. The basic method involves constructing the average cumulative abnormal return. Under the null hypothesis of no effect arising from the event, the average CAR has mean zero and, invoking the central limit theorem, is asymptotically normal. The average can be divided by the estimated standard deviation to obtain a standard normal variable that can be used for significance tests. There are several ways to approach calculating the standard deviation. The most standard method, referred to by McKinlay (1997) as the basic method, uses the estimation period to get an estimated standard deviation for each acquirer's abnormal return, then aggregates these estimates in the usual way to get an estimate of the standard deviation for the average CAR.

However, this method is subject to some potential problems. First, as pointed out by Patell (1976), this method should be adjusted to account for the fact that the event period is out-of-sample with respect to the estimation period and therefore contains prediction error. Accordingly, Patell (1976) suggest that it might be better to rely on cross-sectional variation across events rather than on aggregated time series variation for each acquirer to estimate a standard deviation. Furthermore, as pointed out by Boehmer et. al. (1991) it is possible that the event might change the variance of the abnormal return. Boehmer et. al. suggest a method that combines both cross-sectional and time-series information in constructing the estimated standard deviation. We have used the basic method described by McKinlay, the Patell method, and the Boehmer et. al. method. All methods yield essentially the same pattern of significance. In Table 5 we report the McKinlay standard errors. We make the plausible assumption that the estimation window (250 trading days for most acquirers) and the number of acquisitions (approximately 20,000) are large enough to justify using asymptotic variance estimates to obtain z-scores. In table 6, which employs a *t*-test, and table 7 and 8, which use Ordinary Least Squares regression, we report the Patell standard errors.

Table 5: Average Abnormal Returns to Acquirers (in Percent)

	VC (z-score)	Non-VC (z-score)	Both (z-score)
All Acquisitions	n = 2,275	n = 20,719	n = 22,994
2-Day Window	0.24 (3.6)***	0.72 (34.8)***	0.67 (34)***
3-Day Window	0.34 (5.0)***	0.77 (37.4)***	0.73 (36.9)***
7-Day Window	0.14 (2.1)**	0.71 (34.3)***	0.65 (33)***
IT Acquisitions	n = 1,380	n = 3,375	n = 4,755
2-Day Window	-0.26 (3.0)***	0.65 (10.4)***	0.39 (7.5)***
3-Day Window	-0.14 (1.6)	0.68 (10.8)***	0.44 (8.6)***
7-Day Window	-0.5 (5.7)***	0.47 (7.4)***	0.18 (3.6)***
Non-IT Acquisitions	n = 740	n = 16,886	n = 17,726
2-Day Window	1.15 (10.7)***	0.73 (34.2)***	0.76***
3-Day Window	1.29 (12.1)***	0.79 (36.9)***	0.82***
7-Day Window	1.3 (12.1)***	0.77 (35.9)***	0.80***

*** and ** denote significance at the .01 and 0.05 levels, respectively. The 2-day window consists of the announcement day and the following day. The 3-day and 7-day windows are symmetric around the announcement.

Table 5 shows that acquisitions of privately-held targets yield statistically significant abnormal returns for the combined set of acquisitions (last column) for the 2-day window including the announcement day and the following day, for the 3-day symmetric event window, and for the 7-day symmetric window. This significance comes through strongly with large *z*-scores. However, the underlying subsets (VC-financed and non-VC financed acquisitions) are quite different: The non-VC subset shows better performance than the VC subset for IT acquisitions, while non-IT acquisitions exhibit the opposite pattern.

Using a *t*-test framework, Table 6 reports results concerning the hypothesis that the mean abnormal return for VC-backed acquisitions differs from the mean abnormal return for non-VC acquisitions.

Table 6: *t*-Tests for Differences in Abnormal Returns – VC-backed vs. non-VC Acquisitions

This table forms the abnormal return to VC-backed acquisitions minus the abnormal return to non-VC acquisitions. It can therefore be read as showing the effect of VC for all acquisitions, IT acquisitions, and non-IT acquisitions.

	All Acquisitions (n=22,995)			**IT Acquisitions (n=4,755)**			**Non-IT Acquisitions (n=17626)**		
Event Window	**Diff. in Means**	**Std. Error**	***t*-stat**	**Diff. in Means**	**Std. Error**	***t*-stat**	**Diff. in Means**	**Std. Error**	***t*-stat**
2-Day Window	-0.48	0.15	-3.14***	-0.91	0.23	-3.99***	0.41	0.26	1.61
3-Day Window	-0.43	0.18	-2.44**	-0.82	0.27	-3.04***	0.50	0.29	1.71*
7-Day Window	-0.56	0.24	-2.31**	-0.97	0.34	-2.87***	0.53	0.48	1.11

*** and ** denote significance at the .01 and .05 levels, respectively. Significance tests are based on the two-sided alternative hypothesis that the means differ, allowing for unequal variances. The sum of IT and non-IT acquisitions does not quite equal the total because there is a (relatively small) number of acquisition without industry identifiers.

Columns 2 through 4 of Table 6 show that VC-backed acquisitions have statistically significant lower abnormal returns than non-VC acquisitions -- and the difference is a nontrivial half a percentage point -- of comparable magnitude to the entire aggregate abnormal return. Columns 5 through 7 show that this entire negative effect of VC-backing is due to the IT acquisitions. In fact, as shown in the last three columns, VC-backing has a positive (albeit not strongly statistically significant) effect.

Table 6 shows the key result of the paper in the starkest possible form -- there is a dramatic difference in the effect of VC backing in IT acquisitions, where informational asymmetries are high, and in other acquisitions, where informational asymmetries are less significant.

The effects just described apply to all event windows reported here, and are similar for other short-run event windows. Very little changes if a 5-day window, a 9-day window, or an 11-day window is used. The 3-day window is, arguably, the most relevant window as it picks up the effect of any information leakage on the day before the announcement and the effect of any short-term lags that shift some of the impact effect to the day following the announcement, and it is less likely to be contaminated by other events than longer windows. Also, the results themselves suggest that essentially all relevant announcement effects occur within the 3-day window. Accordingly, in subsequent sections using

regression analysis to explain the pattern of abnormal returns, we use the 3-day cumulative abnormal return as the dependent variable.

5.4 Other Influences on Abnormal Returns

VC-backed IT acquisitions appear to have significantly lower returns than other IT acquisitions. In other words, the presence of venture capital seems to imply that investors anticipate an acquisition price premium due to venture capitalists in the IT sector, but not in other sectors. As the IT sector is characterized by high levels of informational asymmetry, this result is consistent with our main hypothesis – that VCs are believed by investors to contribute to a winner's curse phenomenon in which VC's induce acquirers to overpay for acquisition targets in markets where informational asymmetries are high. However, it is possible that this apparent effect might be partially due to other variables. In this sub-section we use a multivariate regression framework to consider the influence of other factors that might affect abnormal returns. These factors[6] include: timing, represented by year fixed-effects; the industry of the acquirer, represented by the acquirer's 2-digit NAIC industry codes; the size of the acquirer, the size of the target; the means of payment; acquirer experience; and other factors.

We expect year fixed-effects to be important given the boom and bust cycles exhibited by the IPO market and the acquisition market over the period studied and given the variation in the relative importance of VC activity over time. Acquirer industry fixed-effects at the 2-digit level run the risk of absorbing some of the effect from in return generated by an acquisition of targets from IT and other sectors that we wish to identify, but correct for potentially important other cross-industry differences. Size might important for several reasons, including adjusting for the relative importance of the acquisition. These are all standard controls.

As for means of payment, the two primary methods of payment are stock in the acquiring company and cash. However, other financial instruments may also be used, including bonds, convertible securities, warrants, etc. It has been observed, as in Chang (1998) and Officer et. al. (2007), that whether

[6] In measuring these factors we use both market data and accounting data from financial statements. An assessment of the relationship between such accounting data market valuations is provided by Hand (2005, 2007). The results suggest that accounting data is useful in predicting market valuations.

cash or stock is used affects acquisition returns. This might occur because different methods of payment reflect different characteristics of the acquisition or because different methods of payment give rise to different incentive effects. In our regression analysis we use the percent of stock in the payment mix as an explanatory variable. Stock is somewhat more commonly used in IT and for venture backed acquisitions.

The experience of the acquirer has been shown by Conn et. al. (2004) that acquirer experience tends to reduce the abnormal returns to acquisitions - a finding that we confirm using our larger and more up-to-date data set. The literature on acquisitions has identified other variables that might be used as controls, but there are no other variables that we have access to that have a significant effect on returns.

5.5 Multiple Regression Results Explaining Abnormal Returns

We now consider the effect of venture capital and other factors on returns to acquisitions in a multivariate regression[7] framework. Each acquisition is one data point. The dependent variable is the abnormal return, and for this we use the 3-day cumulative abnormal return. This choice reflects Figures 1 and 2 and Table 5, which show that a window including the announcement day along with the preceding day and the following day captures the impact of the announcement effectively. Also, this relatively short window should contain little contamination from other factors that might affect acquirer stock prices. Using other short run windows yields similar results. The "treatment" variable is a fixed effect showing the presence of venture capital. The regression is of the form:

$$CAR = \alpha + \beta V + \gamma C + \varepsilon \qquad (3)$$

where CAR is the 3-day cumulative abnormal return, V is a venture capital indicator variable with coefficient β, C is a vector of control variables, γ is a vector of associated coefficients, and ε is an independent random error term with mean 0.

Our preferred interpretation of this approach is that the control variables are exogenous explanatory variables. It is then appropriate to treat the residual effect of venture capital as reflecting the

[7] Our univariate analysis estimates the effect of venture capital on acquisition returns using two-sided *t*-tests for differences in mean CARs (assuming unequal variances). This is very similar to a univariate regression of the form $CAR = \alpha + \beta V + \varepsilon$, where V is the venture capital indicator. For the univariate case, the *t*-test formulation allows a clear and economical presentation of results. When including (continuous) control variables, explicit multiple regression is necessary.

corrected effect of venture capital. An alternative view is that some of the control variables are affected by the presence of venture capital in the sense that they reflect choices made by venture capitalists. If so, then looking just at the residual impact of venture capital to assess the overall effect of venture capital is conservative and any associated multicollinearity among explanatory variables serves only to reduce apparent statistical significant. We do not anticipate any endogeneity problem arising from feedback from the dependent variable to control variables.

5.6 Regression Results for the Full Sample

We start by analyzing the full set of acquisitions and then consider the IT and non-IT sub-samples separately. Table 7, below, shows the main regression[8] results for the full sample.

Specification 1 shows the basic stylized fact that is the starting point of our paper: The presence of venture capture has a significant negative effect on abnormal returns to acquirers. Specification 2 shows that this negative effect survives and is essentially unchanged by correcting for the means of payment (fraction of stock), the experience of the acquirer (number of previous acquisitions), year fixed effects, and industry fixed effects. These controls are highly significant but have little impact on the VC effect. and 2 illustrate the main regression findings.

The main result of the paper is shown in specifications 3 and 4 where we include an IT-VC interaction term. This is an indicator variable that takes on the value 1 when the acquisition is in the IT sector and venture capital is present in financing the acquired enterprise, and 0 otherwise. When this term is included, the VC indicator becomes positive - indicating that the point estimate of the default effect of venture capital is actually positive, although the coefficient is significantly different from zero from a statistical point of view. The interaction term is then interpreted as the effect of venture capital in IT, relative to this default effect. The IT-venture-capital effect is negative, quite large in magnitude and is statistically significant at almost the .01 level in specification 3 and at better than the .01 level in specification 4, where we control for the size of the acquirer.

[8] All regressions use ordinary least squares with the robust option as implemented in STATA 11 to correct for possible heteroskedasticity.

Table 7: Explaining Cumulative Abnormal Returns to Acquisitions Using Full Sample Regressions

This table reports results for the estimation of equation (3). The dependent variable is the 3-day cumulative abnormal return to the acquisition in percentage points. Each cell contains the coefficient estimate and, in parentheses, the t-statistic. Values significant at the 0.01, 0.05, and 0.1 levels are identified by ***, **, and *, respectively. The explanatory variables of particular interest are "VC-backed", which is an indicator variable taking on the value 1 for VC-backed enterprises and 0 otherwise, and the VC/IT interaction, which takes on the value 1 for acquisitions that are both VC-backed and with an IT target and therefore shows the differential effect of VC-backing for IT acquisitions relative to the general effect of VC-backing in other (non-IT) sectors. The control variables are: the fraction of the payment made in stock; the number (#) of previous acquisitions made by the acquirer (experience); size of the acquirer (log assets), the relative size of the acquisition compared to the acquirer, and year and industry fixed effects.

Explanatory Variables	**1**	**2**	**3**	**4**	**5**
VC-backed	-0.43 (-2.44**)	-0.47 (-2.50**)	0.28 (0.98)	0.32 (1.13)	0.32 (0.88)
Fraction Stock	-	0.68 (3.41***)	0.63 (3.16***)	0.61 (3.00***)	0.06 (0.28)
Experience	-	-0.31 (-8.09***)	-0.31 (-7.99***)	-0.31 (-8.04***)	-0.29 (-3.75***)
IT	-	-	-0.35 (-1.89*)	-0.35 (-1.85*)	-0.06 (-0.24)
IT-VC Interaction	-	-	**-1.00 (-2.53**)**	**-1.05 (-2.64***)**	**-1.41 (-2.56**)**
Acquirer Assets	-	-	-	0.74 (-1.87*)	-0.48 (-2.10**)
Relative Size of Acq.	-	-	-	-	0.16 (2.68***)
Year Fixed-effects	no	yes	yes	yes	yes
Ind. Fixed-effects	no	yes	yes	yes	yes
Constant	0.77 (15.5***)	-0.35 (-0.22)	-0.35 (-0.22)	-0.35 (-0.22)	-0.13 (-0.06)
# Obs.	22,994	22,961	22,356	22,113	9,609
R-Squared[9]	0.000	0.009	0.009	0.009	0.016

The final specification includes a control for the size of the acquisition. However, this variable is available for only about 45% of the observations, so we lose more than half the data set when we include it. Including this control does not materially affect the main results.

[9] The R^2 statistics are quite low, as is common in event studies of this type. As noted in Wooldridge (2003, p. 196) a very small R^2 statistic in no way undermines significance tests and is to be expected in many situations.

5.7 Comparative Regression Results for IT and Non-IT Acquisitions

Table 7, above, shows the main results of our analysis. However, the specifications impose the restriction that the regression equations for IT and non-IT targets have the same set of control variables, the same coefficients on the control variables, the same constant, and the same error structure. It would be possible to allow for different coefficients by using more interaction effects, but more flexibility is allowed by running separate regressions for IT acquisitions and non-IT acquisitions. Results are reported in Table 8.

Table 8: Comparative Regression Results for IT and non-IT Acquisitions

This table reports results for the estimation of equation (3) for IT acquisitions (specifications 1-3) and for non-IT acquisitions (specifications 4-6). The dependent variable is the 3-day cumulative abnormal return to the acquisition in percentage points. Each cell contains the coefficient estimate and, in parentheses, the t-statistic. Values significant at the 0.01, 0.05, and 0.1 levels are identified by ***, **, and *, respectively. The explanatory variable of particular interest is "VC-backed", which is an indicator variable taking on the value 1 for VC-backed enterprises and 0 otherwise. Other variables are as in table 7, except for "Related Acq." which is an indicator variable taking the value 1 if the acquisition is either horizontal or vertical (i.e. is not conglomerate) and 0 otherwise. For acquisitions of IT targets, the "Related Acq." variable takes the value 1 if the acquirer is also an IT firm and 0 otherwise.

	IT Acquisitions		**Non-IT Acquisitions**	
Regressors	**1**	**2**	**3**	**4**
VC-backed	-0.61 (-2.05**)	-0.63 (-2.10**)	0.25 (0.86)	0.29 (1.01)
Fraction Stock	0.65 (1.42)	0.67 (1.46)	0.67 (3.13***)	0.63 (2.92***)
Experience	-0.30 (-2.87***)	-0.30 (-2.89***)	--0.31 (-7.49***)	-0.31 (-7.56***)
Acquirer Assets	-	-0.11 (1.07)	-	-0.12 (-2.60***)
Year Fixed-effects	yes	yes	yes	yes
Ind. Fixed-effects	yes	yes	yes	yes
Constant	3.6 (2.3**)	3.6 (2.3**)	-0.37 (-0.23)	-0,36 (-0.22)
# Obs.	4743	4723	17,613	17,390
R-Squared	0.016	0.016	0.011	0.011

The picture that emerges from table 8 is very consistent with the results in table 7, although some new points of interest are present. The primary result is the role of venture capital is negative and significant for IT acquisitions but is not significantly different from zero, with a positive point estimate for non-IT acquisitions. These findings are robust to the inclusion of any reasonable combination of control variables in our data set, including those shown in table 8. The difference between the VC effect

for IT and non-IT acquisitions is therefore strong and robust. This is consistent with the results in table 7, with the diagrammatic evidence presented in figures 1, 2 and 3, and with the *t*-tests shown in Table 6. Over a 3-day event window the presence of venture capital in an IT target firm appears to lower the expected cumulative abnormal return by something exceeding a full percentage point – on the order of magnitude of the entire abnormal return to acquirers. This effect is both plausible and economically meaningful.

The effect of venture capital for non-IT acquisitions is not significant. Venture capitalists might contribute many things to non-IT enterprises, but bargaining for higher acquisition prices is probably not one of them.

6. Robustness Checks

7.1 Inclusion of Biotechnology with IT

The analysis presented so far is strongly suggestive that VC-backing has a different effect in IT acquisitions than in other acquisitions. Accordingly, the results are consistent with our hypothesis that the venture capitalists are able to extract surplus from acquirer through bargaining when informational asymmetries are high, as in IT. However, there are additional checks that can be undertaken to assess the robustness of the main results.

One issue concerns whether attention should be focused on IT as the only sector characterized by informational asymmetries. As shown in Section 6.1, while IT is the sector with the strongest evidence of informational asymmetries, biotechnology (BT) also exhibits apparent informational asymmetries. Furthermore, biotech is also a major recipient of venture capital investment. Accordingly, it would be reasonable to combine IT and biotech into the "information asymmetry" category. We have carried out this analysis and obtain similar results to those shown in table 7. In an effort to save space we do not report a full table here. However, we note that aggregating biotech and IT has little effect on the results. There are about 947 biotech acquisitions – only about 20% of the number of IT acquisitions. Therefore, it is perhaps not surprising that aggregating biotech with IT has not have a major effect on the results – simply on the basis of relative numbers. However, taken by itself, biotech has results that are intermediate

between IT and non-IT, as we would expect if biotech is characterized by an intermediate level of informational asymmetry. Therefore, we see role of biotech as supportive of our basic hypothesis.

6.2 Other Robustness Checks

We have also undertaken a variety of other robustness checks that we do not report here. In particular, we tried a variety of regression specifications in addition to those reported here and we used a variety of short run windows in addition to the 3-window. We also used different models (i.e. other than the market model) to estimate abnormal returns, we tried using a "hi-tech" category that includes IT, biotech and other high technology enterprises, and we tried alternative estimation techniques.

7. Discussion and Conclusions

We present the hypothesis that one role of venture capitalists is to aid in the acquisition process and that venture capitalists are particularly good at obtaining high acquisition prices under conditions of asymmetric information. If investors understand this process and if the IT sector is characterized by high levels of information asymmetry then it follows that venture capitalists would be associated with lower abnormal returns to acquirers of IT enterprises.

We believe that this hypothesis is supported by the data. First, using various measures established in the literature, IT does appear to be the sector with the highest level of information asymmetry – the sector where acquirers have a hard time assessing the true value of the enterprise in comparison to what is known by insiders. We then show that striking result that venture capital is associated with lower abnormal returns (and hence higher acquisition prices) in IT, but has a positive (although insignificant) effect in other areas.

Our findings are consistent with the widely held view that acquirers often suffer from a "winners curse" phenomenon when informational asymmetries are present. More broadly, our introduction posits that venture capitalists occupy a market niche based largely on their ability to manage informational asymmetry. Our analysis of acquisitions provides an example of this general insight. Our paper presents a consistent picture in which the specialized skills of venture capitalists in dealing with informational

asymmetries can explain the striking asymmetry in the effect of venture capital on acquisition returns across sectors.

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Appendix: Definition of the Information Technology and Biotechnology Sectors

Table A1: Information Technology (based on 6-digit NAIC codes)

NAIC	NAIC Description	Acquisitions
334111	Electronic Computer Manufacturing	48
334112	Computer Storage Device Manufacturing	46
334113	Computer Terminal Manufacturing	15
334119	Other Computer Peripheral Equipment Manufacturing	107
334210	Telephone Apparatus Manufacturing	84
334220	Radio and Television Broadcasting and Wireless Comms.	97
334290	Other Communications Equipment Manufacturing	62
334413	Semiconductor and Related Device Manufacturing	331
334611	Software Reproducing	1,194
334613	Magnetic and Optical Recording Media Manufacturing	8
335921	Fiber Optic Cable Manufacturing	7
335929	Other Communication and Energy Wire Manufacturing	3
423430	Computer and Computer Peripheral Eqpmnt. and Software	96
443120	Computer and Software Stores	41
454111	Electronic Shopping	41
511210	Software Publishers	1,053
517110	Wired Telecommunications Carriers	218
517210	Wireless Telecommunications Carriers (except Satellite)	141
517410	Satellite Telecommunications	5
517911	Telecommunications Resellers	4
517919	All Other Telecommunications	40
518210	Data Processing, Hosting, and Related Services	135
519130	Internet Publishing and Broadcasting and Web Search	45
519190	All Other Information Services	5
541511	Custom Computer Programming Services	240
541512	Computer Systems Design Services	394
541513	Computer Facilities Management Services	98
541519	Other Computer Related Services	196
611420	Computer Training	11
811212	Computer and Office Machine Repair and Maintenance	5
Total		**4,770**

Table A2: Biotechnology (based on 6-digit NAIC codes)

NAIC	NAIC Description	Acquisitions
325412	Pharmaceutical Preparation Manufacturing	149
325413	In-Vitro Diagnostic Substance Manufacturing	38
325414	Biological Product (except Diagnostic) Manufacturing	93
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	106
334516	Analytical Laboratory Instrument Manufacturing	48
334517	Irradiation Apparatus Manufacturing	78
339112	Surgical and Medical Instrument Manufacturing	195
339113	Surgical Appliance and Supplies Manufacturing	58
541380	Testing Laboratories	43
541711	Research and Development in Biotechnology	8
621511	Medical Laboratories	98
621512	Diagnostic Imaging Centers	14
Total		**928**

We believe that our IT definition is relatively precise. On the other hand, accurately identifying the biotech sector in the NAIC system is notoriously difficult. The biggest problem is that most biotech firms are classified as 541710 in the 2002 NAICS, which is "R&D" and so includes many non-biotech R&D enterprises as well. In the 2007 NAICS update we were able to find an additional 8 firms that reported NAIC code 541711 (a newly added biotech code) as their sector of primary operation. However, there are still many biotech firms hidden in agriculture, food preparation, chemicals, as well as other areas. Some analysts distinguish between pharmaceuticals and (other) biotech, but we include both.