Survivor Bias In Firm Specific Longitudinal Studies: The Case Of ERP Systems

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ABSTRACT

Researchers in the field of accounting and finance often use event studies to measure the impact of various business decisions on the market value of stock. They argue that market reaction to the event is predictive of the future effect on the company. Sometimes researchers would like to follow up on these initial event studies to see if the market was correct in its predictions. However, many times the original sample used for the event study does not survive intact into future time periods, which then raises the issue of survivor bias. This paper examines one such event study in which the markets react favorably to announcements that ERP systems are being implemented. However, only 55% of the firms in the original sample survive through 2009, making any follow-up study subject to the survivor bias argument. The study examines the circumstances related to the non-survivors and, using proxies for the missing data, concludes that the results of a follow-up study would not have been impacted by survivor bias.

Keywords: Survivor Bias; Event Studies; Longitudinal Studies; ERP Systems

INTRODUCTION

Researchers in many academic fields face the issue of survivor bias when examining various phenomena occurring over time. In medical research, the term takes on a literal meaning with patient survival the obvious desired outcome. In other fields, such as accounting and finance, survivor bias generally refers to the exclusion of companies from performance studies because they no longer exist. Although many of these studies assume that companies are missing because they have failed, non-survival may not necessarily be an indication of failure. It is possible, for instance, that in examining the financial results for a sample of firms over an extended period of time, firms that drop out from the sample may do so, not because they have failed, but because they have been extremely successful and were acquired by a larger firm for a premium price.

This paper is motivated, in part, by an event study (Hayes, Hunton and Reck, 2001) that measures the stock market reaction to announcements made by firms implementing ERP systems. They find an overall favorable reaction to the announcements, indicating that capital markets expect the ERP investment to have a positive impact on future value. Subsequent studies have used this same sample, some supplemented with additional announcements, to examine other issues related to ERP systems, including firm performance (Hunton, Lippincott and Reck, 2003), earnings management (Morris and Laksmana, 2010), internal control (Morris, 2011), and shareholder value (Morris, 2011). In most of these subsequent studies, a number of firms included in the initial Hayes et al. (2001) study have been excluded because they are no longer publically traded, which raises a question as to whether the results are being influenced by survivor bias.

This study examines reasons for non-survival and uses those reasons to develop proxies for missing data which are used to estimate abnormal returns for these non-survivors. It then uses these abnormal returns and those of the survivors to measure the effect of survivor bias in testing whether the original event study accurately predicted future returns. The results provide evidence that survivor bias does not impact the conclusion that subsequent abnormal returns support the original event study.

These results should be of interest to a number of academics that use longitudinal studies to measure various events. They provide insights into the importance of understanding the nature of non-survivors in longitudinal studies prior to assuming that survivor bias may be impacting the results in a particular direction.

PRIOR RESEARCH & RESEARCH QUESTIONS

Discussions of survivor bias are found extensively in the finance literature beginning as early as the 1980s where Blieberg (1986) argues that because poorly performing portfolios tend to be eliminated when their managers are replaced, the remaining universe available for study "is the universe of finishers." He goes on to say that "the best we can do is simply to be aware of the nature of the universe." Raftopoulos (1987), in a discussion of Blieberg's paper, points out that "a cumulative historical comparison that seeks to include defunct portfolios would somehow have to make assumptions about what their performances would have been up to the present…" and goes on to offer alternative approaches using proxies based on portfolios without survivor bias. Brown, Goetzmann, Ibbotson and Ross (1992) use economic modeling to show that truncation by survivorship gives rise to apparent persistence in performance. This persistence can be strong enough to account for the strength of evidence favoring return predictability in mutual funds. Malkiel (1995) estimates the effect of survivor bias on mutual funds, documenting significant differences between funds that survived from 1982 to 1991 and those that did not. Kothari, Shanken and Sloan (1995) take issue with a study by Fama and French (1992) that finds two variables (ME and BE/ME) capture much of the cross-section of average stock returns, arguing that their results are influenced by survivor bias in the Compustat database that they use. Using an alternative data source (Standard & Poor's industry level data), Kothari et al. (1995) find that BE/ME is, "at best, weakly related to average stock return. In a follow-up paper, Fama and French (1996) argue that survivor bias does not materially impact their results because it is less important in value-weighted portfolios and for large stocks used in their study. Citing these discussions, Barbee, Mukherji and Raines (1996), in a study focused on two alternative measures (S/P and D/E), exclude data prior to 1978 in order to "avoid the effects of survivor bias in the Compustat tapes." Loughran and Ritter (1996) argue that Conrad and Kaul (1993) introduce survivor bias in their study of low-priced stocks by requiring that all firms selected for their sample have complete returns for 36 months. In a study of commodity trading advisors (CTAs), Schneeweis, Spurgin and McCarthy (1996) find that in the year before dissolution, the average non-surviving CTA had -27% annualized returns, which was consistent with earlier studies. Because of these prior studies, subsequent studies often use sample data sets that are free of survivor bias (Carhart, 1997; Elton, Gruber and Blake, 2001), while other studies try to account for the survival effect when analyzing their results (Dussauge, Garrette and Mitchell, 2004; Shamsie, Phelps and Kuperman, 2004; Rich, 2006; Liu, 2008), some using an econometric technique developed by Heckman (1979) that estimates omitted variables.

Most of these earlier studies focus on standard portfolios of mutual funds or other similar pre-assigned bundles of related data. Little, if any, research focuses on firm specific survivor bias issues, other than to acknowledge survivor bias as a limitation. This paper addresses that gap in the literature by following up on a prior event study (Hayes et al., 2001). It measures the impact that survivor bias may or may not have on subsequent longitudinal studies that compare the original reaction by the market in the event study to the actual results experienced by the shareholders over time.

Like other event studies, the Hayes et al. (2001) study measures the reaction of the market to the announcement by using cumulative abnormal returns over a two-day window surrounding the announcement date. According to the efficient market hypothesis, the market will incorporate the anticipated impact of the announcement into the share price within a narrow window of a few days (Ang and Zhang, 2004). Therefore, if the market views the announcement as good news, positive abnormal returns would be expected. Conversely, if the market views the announcement as bad news, negative abnormal returns would be expected. Since Hayes et al. (2001) found significant positive abnormal returns, they conclude that shareholders view the investment in ERP as good news.

Since this type of study only provides insight into the expectations of the shareholders at that point in time, it doesn't answer the question as to whether or not the ERP system was, in fact, a good investment. One way to answer that question is to follow up this type of study with an analysis of actual results over an extended period of time following the implementation. Morris (2011) uses long-horizon buy-and-hold returns in such a study that includes firms from the original Hayes et al. (2001) sample, plus additional firms implementing ERP systems in subsequent years. However, of the 91 firms from that original sample, 36 of them did not have required data available for the five-year period following implementation, so they were excluded from the study (i.e. non-survivors). Since the original event study concluded that investors in these firms reacted favorably to the

announcement that an ERP system was being implemented, natural follow-up questions could be stated as follows:

RQ1: "Was the original reaction of the capital markets to these announcements predictive?"

RQ2: "Does survivor bias impact the results of this follow-up analysis?"

In other words, if someone were to have invested in each of these firms on the date of the announcement and held onto that stock through some future date, would that have been a good investment as predicted by the market on the event date?

METHODOLOGY

To test these research questions, the study first uses long-horizon abnormal returns for the survivors to establish a baseline, which represents a typical follow-up study that excludes non-survivors. If abnormal returns are significantly positive, then one could conclude that the initial reaction of the market to the announcement was predictive. If the abnormal returns are significantly negative, then one could conclude that the initial reaction was not predictive. The following model, adapted from Ang and Zhang (2004), is used to calculate abnormal returns:

$$Ab\,\mathrm{Ret}_{im} = \mathrm{Ret}_{im} - Bm\,\mathrm{Ret}_{im} \quad (1)$$

where $AbRet_{im}$ is the abnormal return for firm *i* in month *m*, Ret_{im} is the return for firm *i* in month *m*, and $BmRet_{im}$ is the return for a benchmark of firm *i* in month *m*. Individual returns are monthly holding period returns from the Center for Research in Securities Prices (CRSP) database. The CRSP value weighted index for the same month is used for benchmark returns. Abnormal returns are calculated for all available months following the original announcement through December 2009.

The study then examines non-survivors to determine why they did not survive. If they filed for bankruptcy, then one could argue that the ERP investment probably does not provide a benefit to shareholders and exclusion from the sample creates a positive bias. On the other hand, if they were acquired by another company at a premium price, one might conclude that the ERP investment has a positive impact on shareholder value and exclusion from the sample creates a negative bias. Table 1 summarizes the status of firms from the original Hayes et al. (2001) sample as of December 2009. Of the original 91 firms, only 50 (54.9%) have survived, assuming survival is defined as having data available in the CRSP database. Of the non-survivors, 13 firms (14.3%) have merged with firms that are publically traded with data available in CRSP, eight firms (8.8%) have been acquired by other firms that are not publically traded, 12 firms (13.2%) have been delisted and either taken private or are now trading in over-the-counter (OTC) markets, and six firms (6.6%) have filed for bankruptcy. Data for two of the firms cannot be located at all, so their survival status is unknown.

To measure the effect of survivor bias, assumptions have to be made with respect to the firms that did not survive. It is reasonable to assume that shareholders who invested in the 13 firms that merged with other publically traded firms would probably have ended up with shares of stock in the new firm. Therefore, for purposes of this study, the abnormal returns generated by the successor firm are used as a proxy for those months following the merger date. For those that were acquired by firms that are not publically traded, a reasonable assumption would be that the original shareholders were probably cashed out and would have re-invested the proceeds into other shares of stock. For this study, those investors are assumed to earn returns at the benchmark rate for months following the acquisition. Most of the firms that have been delisted appear to have been struggling, and since delisting generally happens because firms no longer meet the minimum financial requirements of the exchange, it is assumed for this study that the original investment is lost at the point where delisting occurs. A similar assumption is made with respect to those firms that file for bankruptcy, and for both groups, zero return is used as a proxy for months following either the delisting or the bankruptcy filing dates.

Table 1: Summary of Sample Firm Status

Firms with data in CRSP as of 12/31/2009 (survivors)	50	54.9%
Firms merged with other firms in CRSP database	13	14.3%
Firms acquired by firms not in CRSP database	8	8.8%
Firms delisted from major exchanges and/or taken private	12	13.2%
Firms that filed for bankruptcy or reorganization	6	6.6%
Firms for which records cannot be found/verified	2	2.2%
Total firms from original Hayes et al. (2001) study	*91*	*100.0%*

RESULTS

Table 2 provides a summary of the abnormal return statistics for the 89 firms for which data, or the proxy data discussed above, are available from the announcement date through December 2009. The first column shows data for the 50 survivor firms, the next four columns provide data for the 39 non-survivor firms, and the last column summarizes data for all 89 firms.

Table 2: Summary of Abnormal Return Statistics

	Survivors	Merged	Acquired	Delisted	Bankrupt	All Firms
Number of firms	50	13	8	12	6	89
Average months	149.9	146.5	150.0	144.6	149.8	148.7
Total firm months	7,496	1,904	1,200	1,735	899	13,234
Mean monthly return	0.0056	0.0095	0.0028	-0.0028	-0.0107	0.0037
Median monthly return	-0.0006	-0.0048	0.0000	-0.0130	-0.0130	0.0000
Standard Deviation	0.1207	0.1753	0.0728	0.2122	0.1263	0.1420
Minimum	-0.7906	-0.6044	-0.3958	-0.6903	-0.6370	-0.7906
Maximum	1.5910	2.9387	0.5815	4.9605	1.5016	4.9605
Standard Error	0.0014	0.0040	0.0021	0.2122	0.0042	0.0012
T-Statistic*	4.040	2.370	1.330	0.540	2.550	3.020
P-Value*	<0.001	0.018	0.185	0.589	0.011	0.003

** Mean monthly return not equal to zero 2-tail*

The mean abnormal monthly return for the 50 survivor firms is 0.56%, which is statistically significant at the p<.001 level using a 2-tail t-test vs. the null hypothesis that the mean is equal to zero. Based on these initial results, one could conclude that market reaction in the event study accurately predicted the future because investors who purchased shares of stock in firms implementing ERP systems at the time of these announcements and held on to them through December 31, 2009 would have experienced a 0.56% better average monthly return than if they had invested in the average of all the firms in the CRSP database. Most follow-up studies would only include these 50 survivor firms, which would then raise the issue of survivor bias. Specifically, how much are the results being influenced by the fact that 39 firms are dropped from the sample? Most studies would probably caution that lack of data for non-survivors may be providing a positive bias to these results.

The results for the 13 firms that merged with other publically traded firms show a mean monthly abnormal return of 0.95% that is statistically significant at the p=0.018 level using a 2-tail t-test. This provides evidence that the exclusion of these 13 non-survivors would not bias the results in the direction assumed above, since the average monthly returns are at least as high as those of the survivors. The results for the eight firms acquired by non-publically traded firms show a 0.28% average monthly abnormal return; however, the results are not significantly different from zero using a 2-tail t-test (p=0.185). Therefore, the exclusion of these firms from the study would probably not have a significant impact either way on the overall conclusion. Likewise, the results for the firms that have been delisted are not significantly different from zero, so their exclusion would probably not have a significant impact on the results, although they are negative at -0.28%. The six firms that filed for bankruptcy show a negative average monthly return of -1.07% that is significant at the p=0.011 level using a 2-tail t-test. Exclusion of these firms would bias the results in the direction assumed; however, since there were only six of them, it is doubtful that the impact would be significant in the overall results.

The final column confirms this by showing that for all 89 firms, abnormal average monthly returns would have been 0.37%, which is significantly different from zero using a 2-tail t-test at the p=0.003 level. Although the average monthly abnormal return of 0.37% for the total sample is less than the 0.56% in the survivor sample, both would support the results of the original event study since both returns are significant at the p<0.01 level.

CONCLUSIONS

This study examines survivor bias in a firm specific longitudinal case where 45% of firms used in an initial event study are no longer available for inclusion in a follow-up study. A typical follow-up study would caution that "the results may be influenced by positive survivor bias," assuming that only the successful firms survived. However, this study finds that some of the non-survivors did not survive because they were either acquired by, or merged with, another firm, indicating that they very well may be successful. Using reasonable proxies to measure the contribution of the non-survivors shows that the initial follow-up results would not have been biased in this case. Although these results represent only one instance and are not generalizable to all follow-up studies, they do suggest that researchers should not just arbitrarily dismiss results as being influenced by survivor bias. For longitudinal studies like this, it is important to investigate why certain firms do not survive and measure the results accordingly. This study also provides supporting evidence for the conclusions offered in the original event study.

AUTHOR INFORMATION

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