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EBCAR: An Event-Based Approach to Measuring Strategy?s Impact on Long-Term Financial Performance

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Abstract

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I. Introduction

Some reference to superior financial performance is commonly made in definitions of the field of strategic management and characterizations of its objectives. Of course, the general idea that profit is an important consideration for business has a still broader reach, and its genealogy is more ancient. If, however, we pursue the definition of this thing called "financial performance" in the strategy field, we typically find *lists* of possible measures of financial performance, mostly falling into the two broad categories, accounting-based and stock price-based. Such lists are often accompanied by injunctions against taking any individual entry too seriously. One gets the sense of an implicit agreement that the want of a single strong contender can and should be made up by the aggregate strength of the full field of possibilities.

This situation is hardly surprising, given that the challenge of performance measurement involves both conceptual difficulties and obviously severe empirical constraints. The difficulties arise from many sources, but most fundamentally from the fact that asset values register the effects of time and uncertainty on economic activity. The question of whether "money was made" in an enterprise over some period ending at time T often turns heavily on the values assigned to specialized assets remaining at T – a value that inevitably reflect expectations about the unknown future. In a classic paper, (Dierickx and Cool 1989) persuasively argued that superior performance, as measured by current (accounting) profitability, often reflects a program of "asset accumulation" carried out over extended periods. Such a situation presents maximum difficulties both because of the terminal asset value problem and because of the need to reflect the accumulated costs of past investments in an economically relevant way. Occasionally, a relatively short business history may reach a point of decisive closure such that a confident verdict on how it all turned out can be rendered. While this can happen, it is certainly not the general case; Dierickx and Cool suggested that this subset does not embrace the strategically interesting cases.

The difficulty of identifying an adequate *ex post* measure of financial performance is only amplified when attention turns to the next obvious question – *why* did measured performance turn out that way? Can performance be linked convincingly to identified management choices, organizational attributes and environmental events? Attempts to construct such links confront both the complexity of the relevant causal mechanism and the difficulty of filtering out the contributions of chance events.[1] In practice, these challenges are often elided by the simple device of assigning a date to some plausible cause and then examining the record of measured performance for some period thereafter to establish an apparent effect. This type of argument is known to be fraught with peril, and in fact is probably even more perilous than even

[1] Honda's entry into the U.S. motorcycle market is an intensively discussed example of the difficulty (Pascale 1984) (Rumelt 1996).

the sophisticated observers recognize (Denrell 2004). But in a world where really convincing evidence on important questions is generally hard to come by, its appeal seems almost irresistible. Whether a particular analysis actually deserves some modest credence depends on a number of features, including the conceptual and theoretical basis of the performance measure used and the specific cause under investigation.

In this paper, we pursue the quest for financial performance measures that are conceptually compelling and also have the potential for being linked empirically to strategic decisions and other interesting determinants of financial outcomes. We proceed undeterred by the intrinsic complexities just noted, but with expectations that are rationally restrained and qualified by our recognition of those complexities. Our empirical basis is stock market valuations, and we propose methods that measure relatively precisely the economic advantage that an investor could have realized by investing in a particular company's stock over a particular time period. Our approach owes much to a prior contribution that is relatively neglected but that is, in our view, clearly worthy of respect and emulation. We refer here to the 1992 *J. Finance* paper by George Baker, "Beatrice: A Study in the Creation and Destruction of Value." (Baker 1992). Baker showed that much insight could be gained into the financial performance of a single company by combining sophisticated analysis of the long-term behavior of its stock price with a substantial dose of business history, focused on changes of leadership and strategy. After developing our extensions of Baker's approach, we illustrate its application with an analysis of Medtronic, a medical devices company.

In the following section, we expand on the foregoing discussion of the performance measurement problem and identify the main commitments underpinning our own approach. We then describe a new method and measure for the assessment of company financial performance in the long term, which we call the "Event-Based Cumulative Abnormal Returns," or EBCAR method. Section IV introduces the company, Medtronic, whose performance we analyze in our illustrative application of EBCAR methods. The final section addresses the limitations of our approach, both intrinsic and revealed, and points out the directions for further progress.

II. Assessing Alternative Measures

We seek a general approach to marshaling empirical evidence on "what works" in the domain of strategic management -- by which we mean, evidence regarding which courses of action are conducive to superior financial performance for a corporation. The primary purpose we have in mind is the assessment of claims made in the strategic management field, i.e., the empirical checking of claims that one course of action tends to be superior, in financial performance terms, to another. Empirical evidence necessarily relates to the past; we propose that the chances of detecting a meaningful "signal" are greater when evidence is drawn from a substantial time period and we benefit from the statistical power of a large sample (across time). We hold that the chances of learning something useful from the "lessons of the past" depend critically on taking a

sharply defined, systematic approach to the evidence that is available -- being as open as possible about the limitations of that approach – in short, doing the *ex post* scorekeeping as well as it can be done.

Such an approach to financial performance demands resolution of a number of points. First there is the choice of the actual basis of measurement. There are two broad alternatives, accounting-based measures and measures based on stock performance. Without a doubt, the strongest claim for each references the deficiencies of the other; there is no approach on offer that is free of significant limitations. Accounting practice largely enshrines historical asset valuations of the assets within its scope. More importantly, strategically significant "resources" such as capabilities, knowledge bases and reputations have no accounting representations at all. Perhaps most important, outstanding performance in accounting terms has no direct link to the financial well-being of anybody in particular. The "money made" is not money that one can spend, now or ever. It is not that kind of thing, and was not intended to be. In a sense, of course, you can spend it if you own some stock you can sell, and the market is persuaded by the accounting information that the money has indeed been made.

This brings us to measures based on the stock price. The direct link to the financial well-being of individuals – investors – is certainly much stronger than in the case of accounting measures, though there are some subtleties to be dealt with. There is no problem in principle about the scope of the resource coverage; there is no category of asset, or source of future earning power, that is necessarily incapable of influencing the stock price, assuming its existence is known. Further, these influences reflect assessments that are presumptively forward-looking, since it is future returns investors care about. These are clearly strong points. The drawback, of course, is that the valuations are coming from the market, and rest at bottom on the expectations of investors with diverse information and insight. Instead of a foundation of accounting records and conventions, we have individual psychology – or, worse, mass psychology. Especially in the aftermath of the financial crisis, the level of credence to be placed in this valuation method is controversial at best. One can argue, however, that volatility in the market as a whole does not necessarily undermine the validity of the sorts of measures we will put forward in the context of performance measurement for specific companies.

The measures we develop rest ultimately on the stock price data, and in theoretical terms they rest on the semi-strong form of the Efficient Markets Hypothesis. The semi-strong EMH proposes that public information about a company is quickly and appropriately reflected in its price. As with the EMH more generally, it is important to recognize that the claim is *not* that the market is somehow prescient. Rather, the claim is that it hard to demonstrate that one could systematically do better, over a large number of cases, than accept the market valuations. As understood in financial economics, such a demonstration would involve displaying a trading rule that is based on public information and systematically "beats the market." The semi-strong EMH survives this test in the majority of the many simple cases investigated, and in some complex ones – but since the scope of "public information, however processed" is very broad, it is

impossible to exclude the possibility there is a highly profitable trading rule out there, waiting to be found. And indeed, even in the "simple cases" anomalous situations have been noted (Lamont and Thaler 2003). Our stance toward the semi-strong EMH is not that it is assuredly true, but that is credible enough as an interpretive tool to make it worthwhile to explore analytical possibilities that rely on it. Certainly it not a straw man or an opportunistic contrivance of our own, and the issues it presents are broadly debated. [2]

A second significant question about performance measurement relates to the time period. Here our stance is "longer is better," subject to data availability. That is partly because our method makes the answers for sub-intervals readily available, so the question is largely moot, and partly because of the signal strength issue previously mentioned. But it is also because we ascribe some institutional legitimacy to "returns to the long-term shareholder" as a corporate performance criterion, a legitimacy we would not ascribe to "returns to the typical day trader," or "returns to the incumbent CEO who will likely be gone from the scene in a few years." In the latter case, in particular, it is all too likely that some managerial choices favor that interest as against the long-term one. Thus, we do not claim to be measuring success at what (all) managements are trying to do.

A third basic question demanding a clear answer is the origin of the performance scale, which in effect means defining "normal profit" in an appropriate way. Since we are ultimately concerned here with strategic choice at the level of the individual corporation, and with the impact of those choices on the equity investor, it seems that an appropriate "zero" is the average outcome in the population of comparable investments, assessed time period by time period. This means that performance in "the market as a whole" provides the appropriate origin for performance measurement in the individual case, and suggests assessing the returns of an individual stock relative to those of the market portfolio.

A more sophisticated approach is needed, however. The market portfolio has the systematic risk of the market as a whole, reflecting the absence of full statistical independence among the returns on different securities. In general, the market offers some reward for carrying systematic risk. Potentially, the Focal Co. of our inquiry may seem to do well, or poorly, over an extended period, only because it is typically carrying more/ less than the average level of systematic risk. We need, therefore, not merely to market adjust, but to risk-adjust, the returns of Focal stock. In pursuing this objective, we seek to maintain the important virtue of stock price measures, the direct connection to the financial well-being of individuals. To have an appropriately sophisticated interpretation of that connection, our measures should compare the action of investing in Focal Co. with a relevant and feasible alternative that has a similar risk profile.

[2] We are not "true believers" in the semi-strong EMH. If any such exist, they should engage with Michael Lewis's account of the stock-picking methods and results of Dr. Mike Burry, before he turned to the serious business of shorting the subprime mortgage market (Lewis 2010)

Finally, we seek measures that potentially could illuminate not just *whether* investment in Focal was advantageous, but *why* it was advantageous – i.e. what strategic actions contributed to the result. That is the strategic management aspect of the inquiry, the quest for "what works" in terms of strategic action.

The foregoing principles are stated, and discussable, at a level that embraces a wide range of specific measurement methods. To arrive at actual numbers, however, we need specific methods. To that topic we now turn – noting, however, that we have by no means exhausted the principles discussion, which should properly delve into a number of other issues.

III. The Semi-strong EMH and Event-based Performance Measures

As previously noted, the semi-strong form of the EMH proposes that all relevant, publicly available information is fully reflected in the current market price of a security (Fama 1970). Thus, the market reacts to any new public information by adjusting the stock upwards or downwards depending on how the event is expected to impact the long term performance of the firm. This view has led many researchers to adopt the event study methodology, which uses the immediate reaction of the market to announcements of important events, to get a measure of the expected value creation of these events for the firm.[3] Such research involves estimating, for the few days around an event, what the price of the stock would have been if the new information had not appeared, by taking into account the stock's typical co-movement with the market as a whole. The "abnormal return" associated with the event is the difference between the actual return and this estimate. Research using the event study methodology is typically focused on estimating the value creation or destruction in a class of events – regardless of the identities of the firms in which those events occurred.

Here, we use it both in the conventional way and (following Baker) to measure the abnormal return to the long-term investor in a particular stock, over the full period of the data. In the latter case, our calculations aim to fill in the unknown X in a statement of the form, "An investor who purchased the stock of Focal Co. at the start of the data period and held it for the entire period would have realized at the end a return greater by a factor of (1+ X) than if the same sum had been appropriately invested in the market as a whole, assuming such leveraging of the Focal stock investment as would match the systematic risk of the resulting portfolio to that of the market portfolio." As a scorekeeping measure of realized financial performance, the measurement of X responds well to the specifications set forth above, particularly to the requirement for an appropriate origin for the scale.

This formulation of the measurement problem calls out for the application of the Capital Asset Pricing Model in the actual calculations.[4] The CAPM offers a way to think about the returns to the market portfolio and the relationship of that to individual stock returns. This is the path we take – following the lead of

[3] For reviews of such efforts, see e.g. (MacKinlay 1997; McWilliams and Siegel 1997)
[4] For basic theory and methods of CAPM, see (Brealey et al. 2008)

(Baker 1992). We begin with the stock return series for Focal, at the monthly level.[5] Using a beta calculated from the preceding 60 months, we calculate the normal return for each particular month.

We *define* that month's abnormal return factor as the actual return factor divided by the normal return factor. This procedure respects the additive logic of portfolio returns in a period, underlying the calculation for normal returns. It also respects the multiplicative logic of cumulative returns over a series of time periods.[6] Because return factors for individual months must be compounded to calculate return factors for longer periods, it is convenient to work in the natural logarithms of the return factor: If x is the calculated abnormal return for the month, we consider LN(1+x), and from that point forward the calculations for longer periods involve addition rather than multiplication – until the end. At the end we can, optionally, reconvert to more familiar terms, such as an overall change factor or an annual percentage rate. Expressed as a change factor, we call the result LCAR – the Long-run Cumulative Abnormal Return.[7] To this point, our approach differs little from that of (Baker 1992). Baker, however, went on to pursue issues of wealth creation and destruction, while we are exploring an event-based approach to performance measurement.

To probe the possible causes of the overall long term performance, we compare this result with that of a calculation closer to the conventional application of event study methods. The first step is to identify a candidate category of strategic events. Such events must be ones that correspond to a precise date at which the occurrence of the event becomes a matter of public record, i.e., there is a date at which the logic of the semi-strong EMH becomes relevant. Further, the definition of the "type" of event, the category, must be sufficiently clear to support the claim that a careful search of the public record will uncover all of the examples. It is convenient to imagine here that we are investigating the bold hypothesis that some particular category of events meeting these criteria actually accounts for substantially all of the strategically significant circumstances that might make Focal Co's stock returns depart from normal. For example, it might be believed that "In Focal's industry, it is innovation that accounts for abnormal returns, and it is alliances the reliably foster innovation." In such a case, we take the events of interest to be the announcement dates of the alliances.

We proceed by identifying all such events. For each event, we apply standard event study methodology to obtain (via calculations based on the CAPM), the estimated normal return for each day of a 3 day event window – i.e., the return that would have been realized if the stock had simply moved with the market in its usual way. To obtain the abnormal return change factor, divide the normal return change factor into the actual return change factor. Adding up the natural log of abnormal return change factors across time yields

[5] "Returns" include price appreciation as well as dividends and other payouts, are appropriately adjusted for stock splits, and so forth.

[6] When x and y are small, the approximation (1+x)/(1+y) = x – y is a good one – but, with monthly data, not good enough to support the type of long run comparative calculations that we wish to make. Thus with x for actual and y for normal, our definition of the monthly rate of abnormal return is (1+x)/(1+y) – 1.

[7] In practice, we often rely on the context to signal the distinction among mathematically interchangeable versions of the same measure – the change factor, the natural log of the change factor, the corresponding percentage rate, etc.

the EBCAR – or more conveniently, the log of the overall "abnormal" change factor for the full time period. Built into this calculation is the assumption that the stock simply moves normally with the market at times that are not in the event windows, and thus the abnormal return averages zero in such periods. The result can of course be converted to an annual percentage rate of return, reflecting return to Focal in excess of the return to the (appropriately leveraged) market as a whole.

As a first step toward drawing conclusions from this analysis, we compare the EBCAR. with the LCAR. The "bold hypothesis" stated above says that they should be equal, that the alliance announcements capture everything that is really "interesting" from the strategic viewpoint of financial performance. This would not mean of course, that computed abnormal returns for periods outside of the event windows would prove to be literally zero. It says that they "don't add up to anything," whereas the alliance announcement events do add up to something, namely, to the whole measured abnormal performance of the stock.

Such a supportive outcome for a bold hypothesis is unlikely to be found. However, beyond the simple bold hypotheses lie more complex hypotheses, to which the same methods can be applied. There are also a variety of ancillary calculations, robustness checks, etc., that are potentially of interest.

Below, we apply the methodology just described above to Medtronic, Inc. one of the leading firms in the medical devices industry. It is ranked 246 in the Fortune 500 and is listed on the NYSE since 1977. We apply the EBCAR analysis scheme with the following categories: (1) technological alliances (2) alliances other than technological (3) FDA approvals of Medtronic devices. The last is included, not as a category of strategic action, but as a check on the methods. Compared to the other two categories, the FDA approvals are probably a stronger candidate for a class of discrete events to which the semi-strong EMH applies.

First, however, we introduce the company itself.

IV. Medtronic in Brief

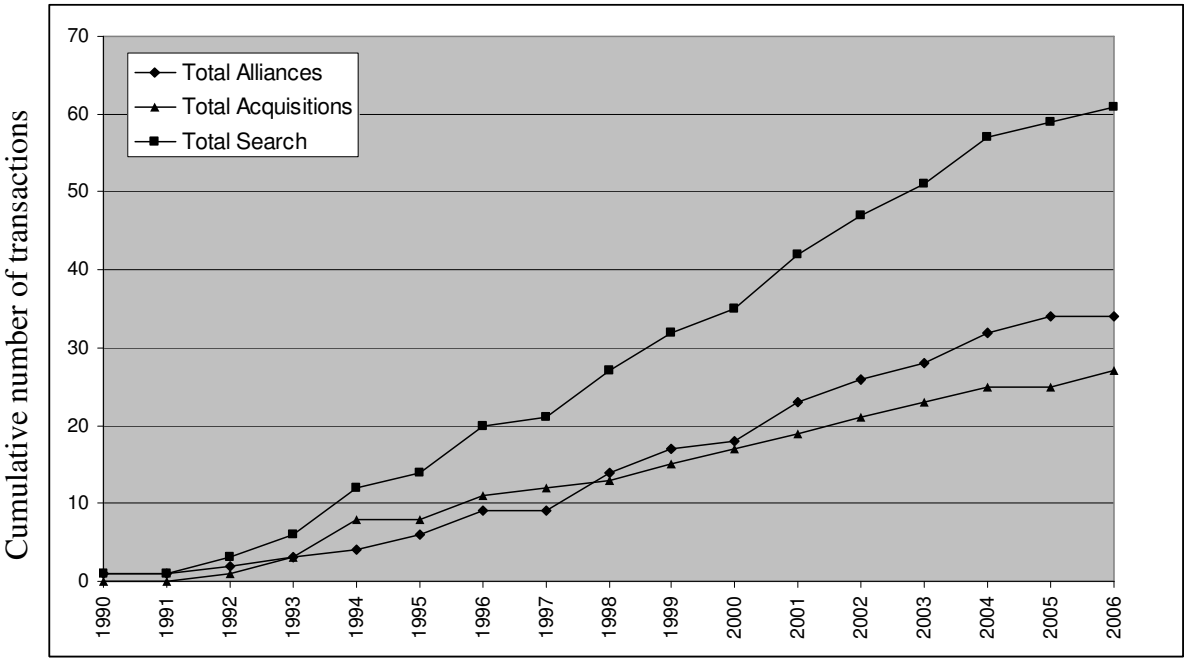
Medtronic Inc. is one of the leading firms in the medical devices industry, with revenues of $13 billion and market capitalization of $ 30 billion in December 2008. The medical devices industry has been subject to rapid growth over the past two decades with new product introductions based on technological advancements accounting for as much as 30% of revenues in many segments[8]. The industry ranked # 7 in degree of volatility of competitive advantage in a recent study of hypercompetition (Thomas and D'Aveni, 2009).[9] Thus Medtronic operates in an intensely competitive industry that is subject to a rapid rate of technological change.

[8] S&P Industry Report, 2005

[9] The two main SIC codes for medical devices, 3845 (Electro-medical & Electrotherapeutic Apparatus); and 3841 (Surgical & Medical Instruments & Apparatus) are on rank number 7 and 12 respectively (of 219 manufacturing SIC codes) in the study by Thomas and D'Aveni (2009) for the years 1990-2000.

Medtronic's beginnings were as a cardiovascular device company (mainly pacemakers)[10] and it remained a pacing company through the 1970s and 1980s. A gradual expansion into other device segments followed and the firm diversified into many new, non-cardiovascular device areas in the next two decades. In 2006, it was active in around twelve device areas such as neurology, orthopedics, ENT and diabetes management. The expansion into newer device segments has often been through a strategy of acquisitions and technological alliances (Figure 1). Thus, corporate development activities have been an important part of Medtronic's strategy.

Figure 1: Medtronic's External Search (Cumulative Number of Alliances, Acquisitions and Total)



We divide the history of Medtronic into four phases for the purpose of this study. These phases were identified based on points of transition in strategy of the firm and correspond to trends in the strategy and also roughly to CEO tenures. The phases (described briefly in the following pages) are as follows:

[10] A pacemaker is implanted under the skin near the collarbone; it monitors the heart rate and administers an electric impulse (through leads attached to the heart) to stimulate the heart in case of an abnormally slow, or no heart rate

Phases in Medtronic's Strategy (1985- 2006)

Phase I	1985 to 1989	Winston Walin takes over as CEO in 1985, retires in 1991
Phase II	1990 to 1995	William George takes over as CEO in 1991
Phase III	1996 to 2000	William George continues as CEO
Phase IV	2001 to 2006	Art Collins takes over as CEO in 2001

The abnormal returns of Medtronic's stock (based on LCAR calculations) over these twenty-two years and individually in the four phases are summarized below (CAGR is "compounded annual growth rate"):

	Years	**CAGR (annual)**
Phase I	1985-89	18.5%
Phase II	1990-95	20.9%
Phase III	1996-00	13.2%
Phase IV	2001-06	-4.4%
First three phases	1985-00	17.7%
Overall	1985-06	11.2%

In Phase I William R. Wallin was named president and CEO in 1985. Research spending doubled between 1985 and 1988, going from $37 million to $75 million, and diversification (i.e. entry into device segments other than pacing) was a corporate goal. Till 1985, for thirty-five years after its founding, Medtronic was mainly a bradycardia pacing[11] company, addressing too-slow heartbeats with pacemakers. Almost all of its revenues came from this segment in 1985, with a miniscule portion from heart valves, and neurology devices. By the end of the decade, Medtronic had moved beyond its position as a pacemaker manufacturer and had entered new areas within the cardiovascular device area such as cardio-pulmonary and interventional vascular.

In Phase II, Medtronic focused on building its existing device segments and on developing applications of its existing technologies. William George, who served as the COO for the previous two years became CEO in May 1991. The company recognized the importance of technological leadership, and emphasized internal R&D by spending up to 10% of sales on R&D "primarily in our established businesses, but also in other areas that fit us" and also established a corporate venture function in 1992 to build a portfolio of internal ventures and external investments. The firm also recognized the need to access technology from outside the organization, both through acquisitions and alliances, and states this explicitly as a strategic activity in the mid-1990s. It acquired six companies in this phase to gain new technologies for its existing

[11] Bradycardia: A heart rhythm disorder characterized by a too-slow heart-beat (less than * beats per minute); addressed by pacemakers described earlier

businesses, thus broadening the product lines in these segments. Most of the company's nine alliances during this phase developed new applications of its neurological technologies.

In Phase III the firm was focused on developing new growth platforms for the company based on acquisitions. At the same time, spending on R&D increased significantly. Medtronic acquired twelve companies (or parts of companies) in this phase mostly to enter newer device segments such as gastroenterology, ENT, urology etc. Medtronic's technology alliances in this phase complemented the acquisition strategy, and also continued the focus of the previous phase on exploring recombinations of technologies in neurology. Overall, the firm made a concerted effort to enter a new area (Spinal devices) and to gain a stronger foothold in an existing area (Interventional vascular devices).

Phase IV is the only phase when the abnormal returns of the company experienced a negative growth rate. Art Collins took over as CEO of the company in 2001; he had been COO for eight years before this. Internal development and external acquisition of technology continued to be a key strategic activity. The firm's annual reports mention information technology and biotechnology as newer areas to enhance their traditional medical device offerings. It also moves in a direction to span the entire continuum of patient care from early diagnosis, to surgical or interventional procedures, to post-procedure patient monitoring. The firm acquired sixteen companies in this phase, focusing primarily on entering and building its new device segments. It entered a total of four new areas. Other acquisitions in its existing segments led to only incremental additions to existing technologies and businesses. The company also entered into ten alliances in this phase mainly to explore new technologies in its existing segments. Although the firm entered many new device areas in this phase, it lacked the focus and the concerted effort of Phase III and seems to have spread its resources thinly over several new device areas.

Thus, over the years, Medtronic has employed alliances and acquisitions as a strategic lever to gain new technologies, enter new device areas and improve existing device areas. Its strategy over the four phases has been associated with varying levels of performance.

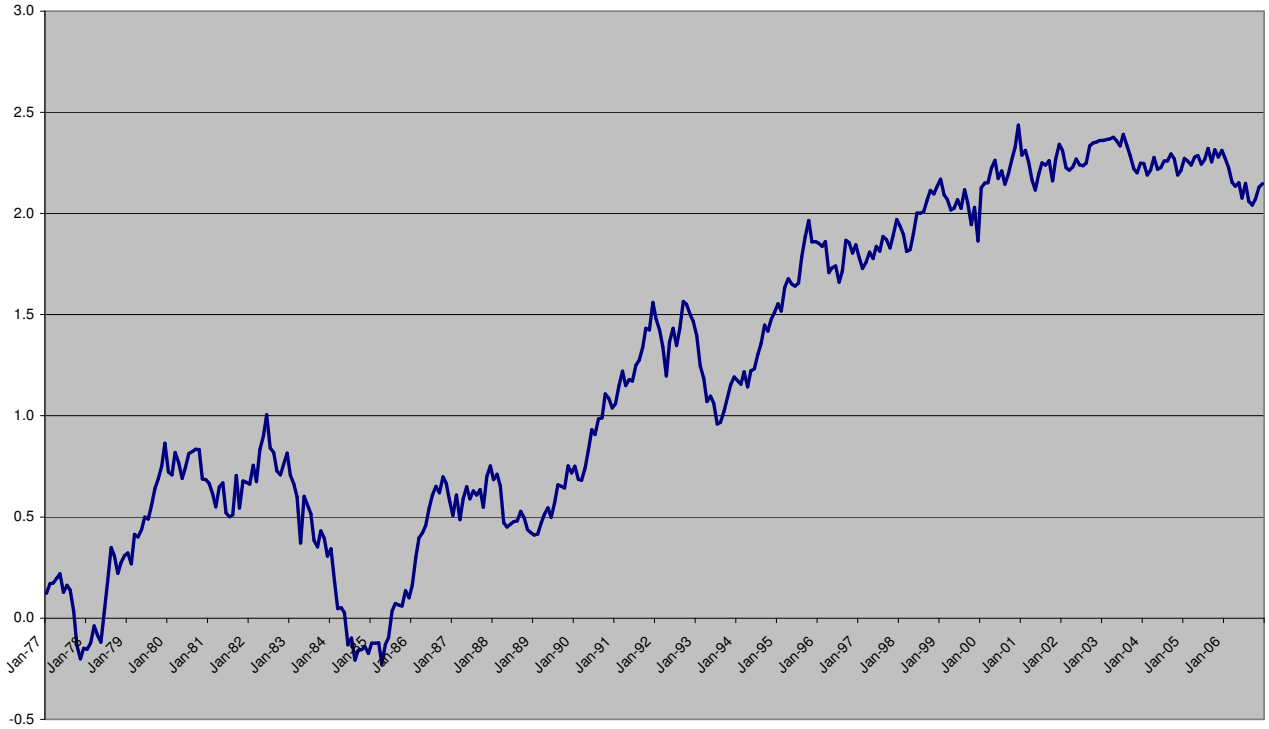
V. LCAR and EBCAR Calculations for Medtronic

Data sources. Data on the firm's strategic actions was collected from several sources like key word searches of main news sources in Factiva (that led to a significantly large number of pages of text), the Lexis Nexis database, Business and Industry database, SDC, the company's website and the company's annual reports from 1988 to 2006. We obtained from the CRSP database the Medtronic stock price data underlying the LCAR and EBCAR calculations, including the returns for the value-weighted market index. Betas and normal returns are generated using Eventus, both provided by Wharton Research Data Services (WRDS).

LCAR Chart**.** Figure 2 shows Medtronic's LCAR from the year it listed on the NYSE, 1977 to 2006.

Figure 2: Medtronic LCAR (1977- 2006)

LCAR (natural log)



Values shown in the chart are the natural log of the cumulative change factor as of the end of the indicated month, starting from zero at the end of December 1976.

The terminal value of LCAR in the chart above is 2.148. Exponentiating this value gives a return factor of 8.57. This translates into a CAGR of abnormal returns from 1977 to 2006 of 7.42% (i.e., divide the terminal value of LCAR by the number of years, exponentiate and subtract 1). The LCAR terminal value for

the window of this study, i.e. 1990-2006 is 1.283 in the natural log, which translates into a terminal return factor of 3.608 and CAGR of abnormal returns of 7.84%.

EBCAR calculations. To illustrate the concepts and computations, we now provide an overview of the calculation of EBCAR, using alliances as the candidate event category.

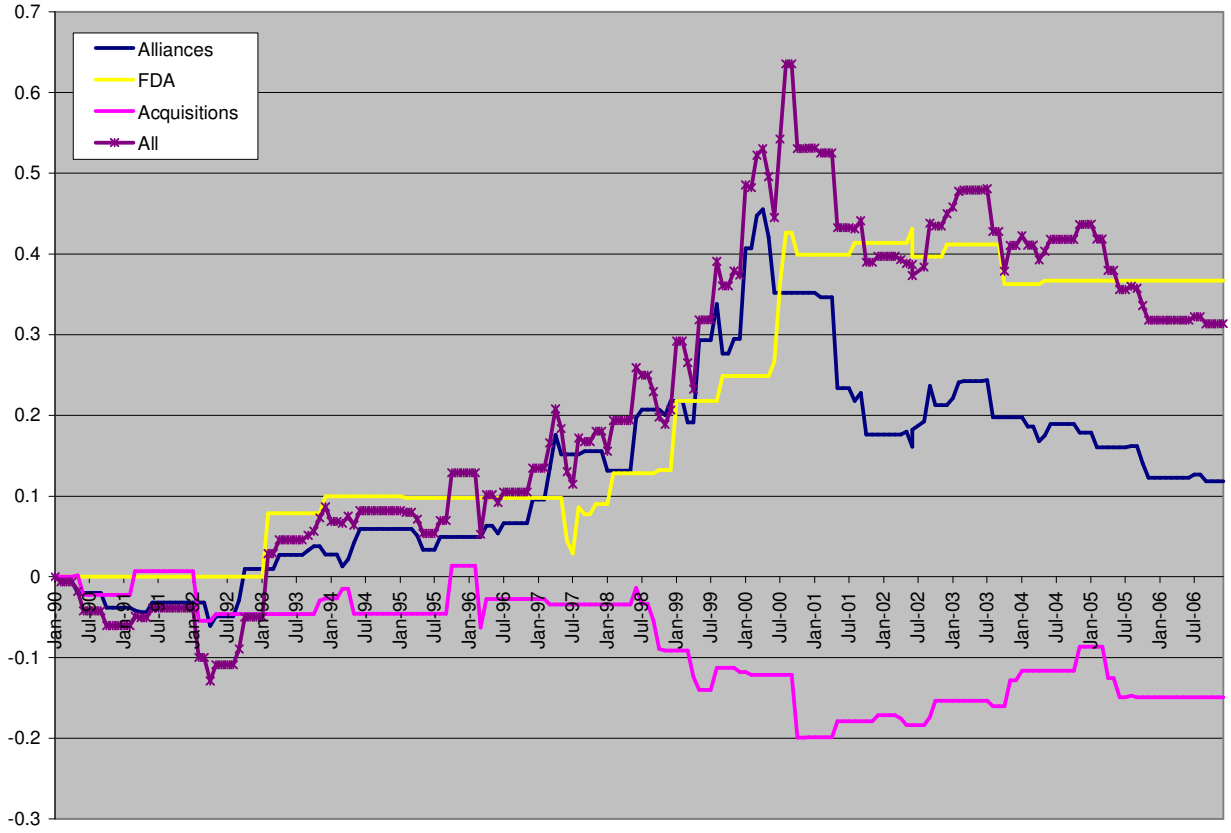
1. We identify all the firm's alliances, which for the purpose of this analysis means identifying first possible date of announcement of the alliance from the various data sources discussed earlier.
2. Obtain the cumulative abnormal return (CAR) in the three day window surrounding the event[12] i.e. day -1, day 0 (day of the event), and day +1: This is done, by dividing the actual change factor over the window by the normal change factor computer using CAPM.
3. Cumulate the abnormal return change factor for events occurring in each particular month, by adding logged values of change factors..
4. Cumulate this monthly return series month by month to to get the monthly return series.
5. This monthly series then gives us the abnormal return to the stock for alliances events.. Thus, EBCAR (allliances) is the log of the overall "abnormal" change factor for alliances, for the full time period.
6. This calculation process is repeated for any event category of interest, e.g. acquisitions or FDA approvals.

EBCAR Chart. Figure 3 shows the EBCAR series for a few event categories from 1990 to 2006. Event category 'Alliances' comprises all the inter-firm agreements that Medtronic entered into over these years, both technological and non-technological. 'Acquisitions' comprises of the complete set of firms it acquired. 'FDA approvals' comprises of announcements of approval from the FDA of original Pre-Market Approval applications, for Class III devices (devices that "usually sustain or support life, are implanted, or present potential unreasonable risk of illness or injury"). The fourth line, 'All together' is the EBCAR based on all the above mentioned events, and governance changes over this time period.

[12] We also obtain CAR in the five day window surrounding the event

Figure 3: Medtronic EBCAR Series (1990- 2006)

EBCAR (natural log)



A noteworthy feature of Figure 3 is the rise in the alliances and total series to a peak around the year 2000, and the subsequent decline. The acquisitions path is striking for its relative constancy except for the period July 1998 to January 2001, during which it appears that the market quite consistently took a negative view of Medtronic's acquisitions, and in some cases an extremely negative view. The impact of these events on the cumulative track is not undone in the following years, which were marked by a flat trend similar to 1990-1998, though with somewhat greater volatility.

Considering that the "tech" / "dot com" bubble in the stock market peaked in early 2000, the foregoing patterns come under some suspicion as a possible artifact. As a tech stock, Medtronic might be expected to be more highly correlated with other tech stocks than with the broader market. Betas computed against the broad market might then yield underestimates of the likely movement in an individual tech stock when tech stocks generally move strongly relative to the market as a whole – creating measured abnormal returns in a stock like Medtronic. This hypothesis is certainly worthy of further investigation, since we do have a major negative move in LCAR in this period that is not associated with events, in addition to the negative tilt of the

acquisition events. However, this "tech bubble" story is called somewhat into question by the fact that the EBCAR series for FDA approvals shows little if any sign of such an effect – moving sharply opposite to the acquisitions series in 2000-2001, for example. Possibly the explanation for the acquisitions results is not a flaw in the measurement, but rather, the market's negative assessments of specific acquisitions were colored by the its dim view of the idea of investing money in tech companies at that time – and no such taint affected the reaction to FDA approvals.

Table 1 shows the final return factor of the EBCAR series of the event categories described above. These return factors are obtaining by exponentiating the terminal value of the EBCAR series from 1990-2006, shown in Figure 3 above (i.e. by exponentiating the value of the EBCAR series in December 2006, the last point in the series). Alliances, FDA approvals, and all events put together have a return factor greater than 1 indicating an overall positive return, while acquisitions has a return factor smaller than 1 indicating an overall negative return.

Table 1: Terminal Values of EBCAR series from 1990- 2006

Event Category	Terminal Return Factor
Alliances	1.05
Acquisitions	0.75
FDA approvals for products	1.56
Alliances, Acquisitions, FDA approvals & Governance changes	1.26

Statistical tests. We conduct t-tests for some obvious hypotheses, to check whether the overall result shown in the table might simply be where a mean-zero stochastic change process, with independent draws, happened to wind up.[13]

Hypothesis 1: LCAR = 0

We test this for the overall series i.e. from 1990 to 2006, as well as individually for the phases. For this testing, LCAR is calculated from 1990-2006, and thus Jan 1, 1990 is the origin for the cumulation (instead of Jan 1977 as in Figure 2).

The results are summarized in Table 2. In the case of the overall series, and for Phase II and Phase III, the t test indicates that the LCAR is significantly different from zero. For Phase IV, the test indicates that the LCAR is not significantly different from zero.

[13] The data set underlying these tests have yet to be updated for some minor corrections that are already reflected in the charts.

This last result brings us to another point about stock market valuation of strategy. It is conceivable that at some point, the market has figured out the firm's strategy or its dynamic capability so that significant positive impact for familiar news developments becomes harder to come by. The market expects the firm to continue with its strategy, or exercise its dynamic capability, and new information on this front fails to "surprise" the market; the expectation is already built into the stock valuation. Hence the company receives a flat valuation after this point. We pursue this issue further in the discussion below.

Hypothesis 2: EBCAR = 0

We conduct the t test for some of the strategic events. The results are summarized in Table 3. The t tests indicated that for each event, except for acquisitions, over the entire time period, EBCAR was significantly different from zero. Thus, the strategic events that we identify for Medtronic do seem to have an influence on performance.

Hypothesis 3: EBCAR = LCAR

We conduct the t test for some of the strategic events. The results are summarized in Table 4. The t tests indicated that for technology alliances, acquisitions and for the two put together, we reject the null that EBCAR = LCAR. This indicates that none of the events makes up LCAR in its entirety. Figure 18 shows LCAR minus EBCAR of alliances, acquisitions, FDA approvals and governance put together. It indicates that a large portion of the LCAR is not explained by the EBCAR of these event categories.

Table 2: Hypothesis 1: LCAR = 0

	Hypothesis to be tested	**t ratio (difference of means test)**	**p value**	**Conclusion**
Overall	LCAR = 0	2.083	0.039	Significant Difference
Phase II* (1990-95)	LCAR = 0	2.322	0.023	Significant Difference
Phase III (1996-2000)	LCAR = 0	1.901	0.062	Significant Difference
Phase IV (2001-06)	LCAR = 0	-0.607	0.546	No Significant Difference

- **Testing starts at 1990 because a reliable set of events can be built only starting this year (at least using typical sources of data like Factiva)**

Table 3: Hypothesis 2: EBCAR = 0

	Mean	SD	n	t ratio (difference of means test)	Conclusion
Overall (1990-2006)					
Technology alliances	0.000061	0.001765	6209	2.700	Significant Difference
Acquisitions	0.000005	0.003124	6209	0.122	No Significant Difference
FDA Approvals	0.000077	0.003215	6209	1.876	Significant Difference
All Alliances	0.000089	0.003109	6209	2.250	Significant Difference
All Alliances & Acquisitions	0.00009	0.00443	6209	1.665	Significant Difference
Phase II					
Technology alliances	0.000065	0.001991	2191	1.526	No Significant Difference
Acquisitions	0.000049	0.001636	2191	1.391	No Significant Difference
FDA Approvals	0.000012	0.001262	2190	0.455	No Significant Difference
All Alliances	0.000076	0.002034	2190	1.748	Significant Difference
All Alliances & Acquisitions	0.000125	0.002609	2191	2.235	Significant Difference
Phase III					
	Mean	**SD**	**n**	**t ratio (difference of means test)**	**Conclusion**
Technology alliances	0.000033	0.001348	1827	1.049	No Significant Difference
Acquisitions	-0.000025	0.004278	1827	-0.252	No Significant Difference
FDA Approvals	0.000261	0.005434	1827	2.051	Significant Difference
All Alliances	0.000218	0.004164	1827	2.242	Significant Difference
All Alliances & Acquisitions	0.000193	0.006027	1827	1.371	No Significant Difference
Phase IV					
Technology	0.000079	0.002092	2191	1.768	Significant

Alliances					Difference
Acquisitions	-0.000014	0.003119	2191	-0.208	No Significant Difference
FDA Approvals	-0.000013	0.001742	2190	-0.348	No Significant Difference
All Alliances	-0.000007	0.002962	2187	-0.106	No Significant Difference
All Alliances & Acquisitions	-0.000021	0.004300	2191	-0.224	No Significant Difference

This table is based on 5 day CAR

Table 4: Hypothesis 3: EBCAR = LCAR

	t ratio (difference of means test)	**p value**	**Conclusion**
Technology alliances	2.163	0.031	Reject Null
Acquisitions	2.304	0.022	Reject Null
FDA Approvals	1.560	0.120	?
Technology alliances & Acquisitions	2.366	0.018	Reject Null

This table is based on 5 day CAR

Learning mechanisms and trends in CAR values. The t-tests are based on the supposition that the CARs for particular alliances or acquisitions can be treated as independent draws from a distribution characteristic of the event category. While this is useful for the purpose of ruling out a "pure noise" interpretation of the data, there are several reasons to question the simple specification. As noted above, one might in particular expect that the market's reaction to any type of event would be damped over time, as expectations concerning such events became more firmly established and individual announcements therefore came to contain less of a surprise factor.

In recently reported work, Arikan and McGahan (Arikan and McGahan 2010) use event-study methods on a large sample of firm histories, seeking evidence of market awareness of the capability-building efforts of firms. As they discuss, the causal channels linking firm activities and market reactions to those activities are potentially quite complex. Firms learn about the profitability of different activities, about how to pursue them effectively, and about the market's reaction to these activities. The market learns (in various time frames) about the quality of a firm's strategic options and how to judge them, and about the firm's capabilities. Arikan and McGahan find evidence that investors do learn about firm abilities to execute programs of alliances and acquisitions, and this learning occurs quite early in the activity sequence.[14] The result is that event-study measures of market response to announcements are damped over time, but do not tend to zero.

VI. Tentative Conclusions and Research Directions

Neither our general methods nor our specific results for Medtronic can be reasonably assessed on the basis of our single application. The example certainly confirms our expectation that the "bold hypothesis" – a single event category accounting for a large proportion of the abnormal return – was not likely to survive the measurement process. Consider that even the FDA approvals – which are obviously highly relevant to performance -- contribute abnormal return at an annual rate of only 2.65% over the 1990-2006 period, whereas the overall abnormal return is 7.85%. It should be noted that the FDA approvals are substantially an *ex post* measure, as opposed to something like the announcement of an alliance, and a relatively strong link to performance should be expected on that ground. An important part of our planned work for the future is to take earnings forecasts and announcements and treat them as EBCAR event categories. Even more than FDA approvals, earnings are an *ex post* measure, close to "performance" itself. The analysis should provide valuable perspective on the results for true "strategic events" of a forward-looking nature, whose implications are subject to much more uncertainty. In the longer run, even more perspective could be obtained by extending EBCAR methods to a wide range of companies.

[14] The authors take pains to limit their sample to firms for which the entire record of alliances and acquisitions is available, by picking up firms after the IPO, and excluding firms that had pre-IPO experience with alliances and acquisitions.

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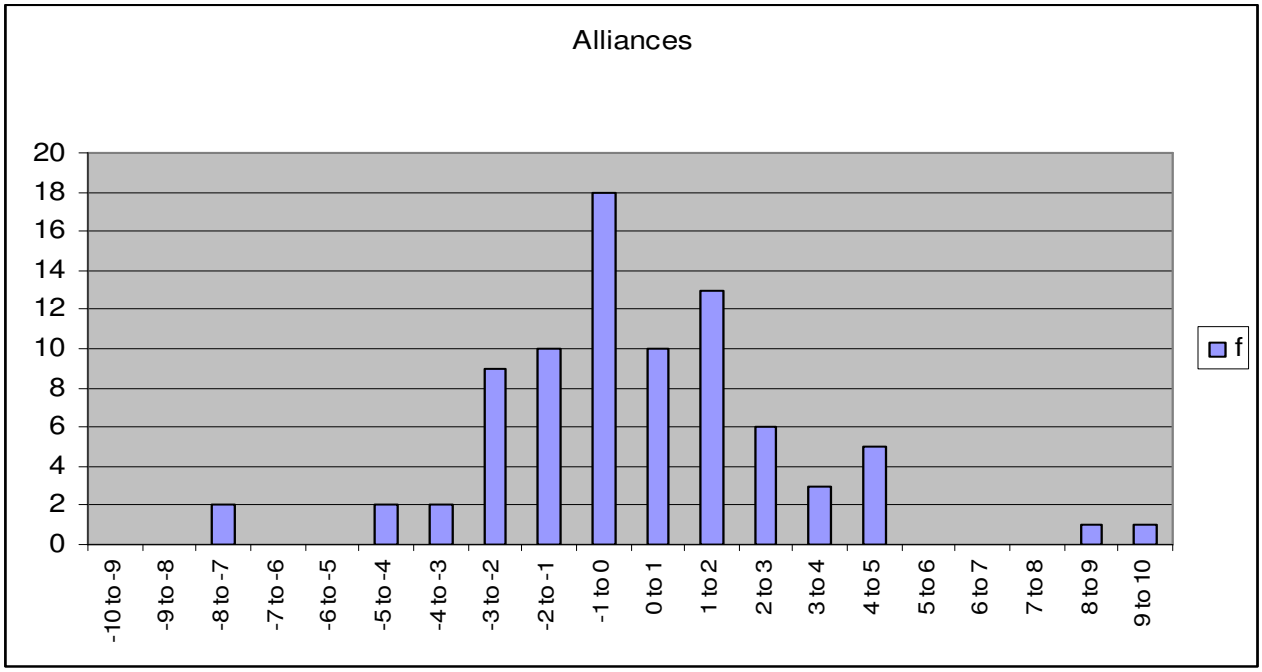
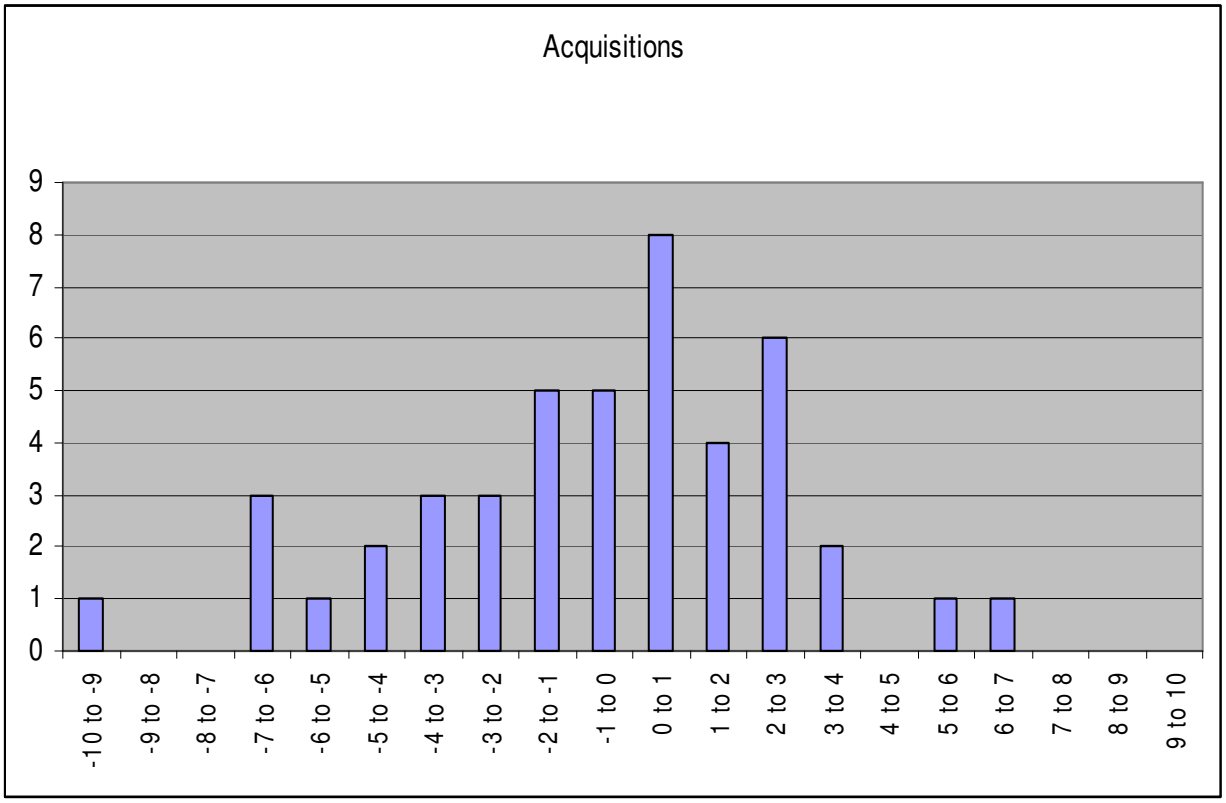
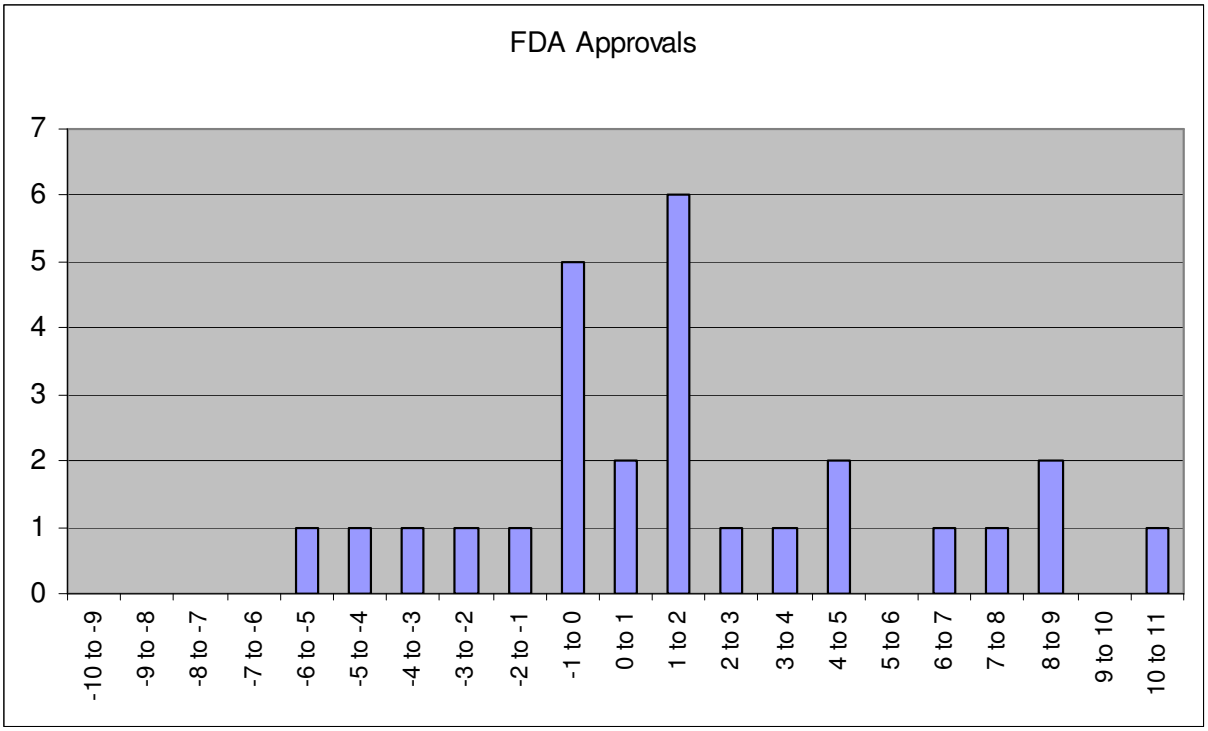
Appendix: Histograms of 3-Day CAR Values.

(Horizontal Axis Shows Percentage Point Bins)






FDA Approvals
7
6
5
4
3
2
1
0
-10 to -9
-9 to -8
-8 to -7
-7 to -6
-6 to -5
-5 to -4
-4 to -3
-3 to -2
-2 to -1
-1 to 0
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
6 to 7
7 to 8
8 to 9
9 to 10
10 to 11