

## Contagious Speculation and a Cure for Cancer: A Nonevent that Made Stock Prices Soar

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### ABSTRACT

A Sunday *New York Times* article on a potential development of new cancer-curing drugs caused EntreMed's stock price to rise from 12.063 at the Friday close, to open at 85 and close near 52 on Monday. It closed above 30 in the three following weeks. The enthusiasm spilled over to other biotechnology stocks. The potential breakthrough in cancer research already had been reported, however, in the journal *Nature*, and in various popular newspapers (including the *Times*) more than five months earlier. Thus, enthusiastic public attention induced a permanent rise in share prices, even though no genuinely new information had been presented.

A CENTRAL TENET OF FINANCIAL ECONOMICS is that an asset should trade at the risk-adjusted present value of its expected future cash flows. These expected future cash flows exist in people's minds, and do not normally lend themselves to direct observation.

An equilibrium price in a frictionless market does not tolerate disagreements among market participants: If some people deem the price too low, they will buy the asset; if others think it is too high, they will sell it (short, if necessary). Although the efficient-markets hypothesis predicts that price changes are unpredictable, it associates them with changes in traders' beliefs about future cash flows or the appropriate discount rate. Beliefs change with the arrival of new information. Thus, in hindsight at least, we should be able to ascribe price changes to the arrival of specific new information. We examine this view in the context of a series of news reports in the media pertaining to EntreMed (ENMD), a biotechnology company, and other members of its sector.

The Sunday, May 3, 1998, edition of the *New York Times* reports on a recent breakthrough in cancer research, and mentions ENMD, a company with licensing rights to the breakthrough (Kolata (1998)). The story's impact on the stock prices was immediate, huge, and to a large extent permanent.

The new-news content of the *Times* story was nil, though: the substance of the story had been published as a scientific piece in *Nature* (Boehm et al. (1997)) and in the popular press [including the *Times* itself (Wade (1997))] more than five months earlier, in November 1997.

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Figure 1 charts the price and trading volume of ENMD's stock price between October 1, 1997, and the end of 1998. It gives the distinct impression of a major price movement on and after May 4, 1998 and a relatively small price change in late November 1997. It seems that the market underreacted to the publication of the hard news of late November 1997 and overreacted to the great publicity of the May 3, 1998 *Times* article. On the whole, though, it seems that the no-new-news *Times* article caused the stock price to more than double, on a permanent basis.

By early November 1998, ENMD was trading at the upper 20s and lower 30s. On November 12, 1998, another piece of new news came to light: On its front page, the *Wall Street Journal* reports that other laboratories failed to replicate the results described earlier in the *Times* (King (1998)). ENMD's stock price fell from 32.625 on November 11 to close at 24.875 on November 12—still more than twice ENMD's price on May 1!

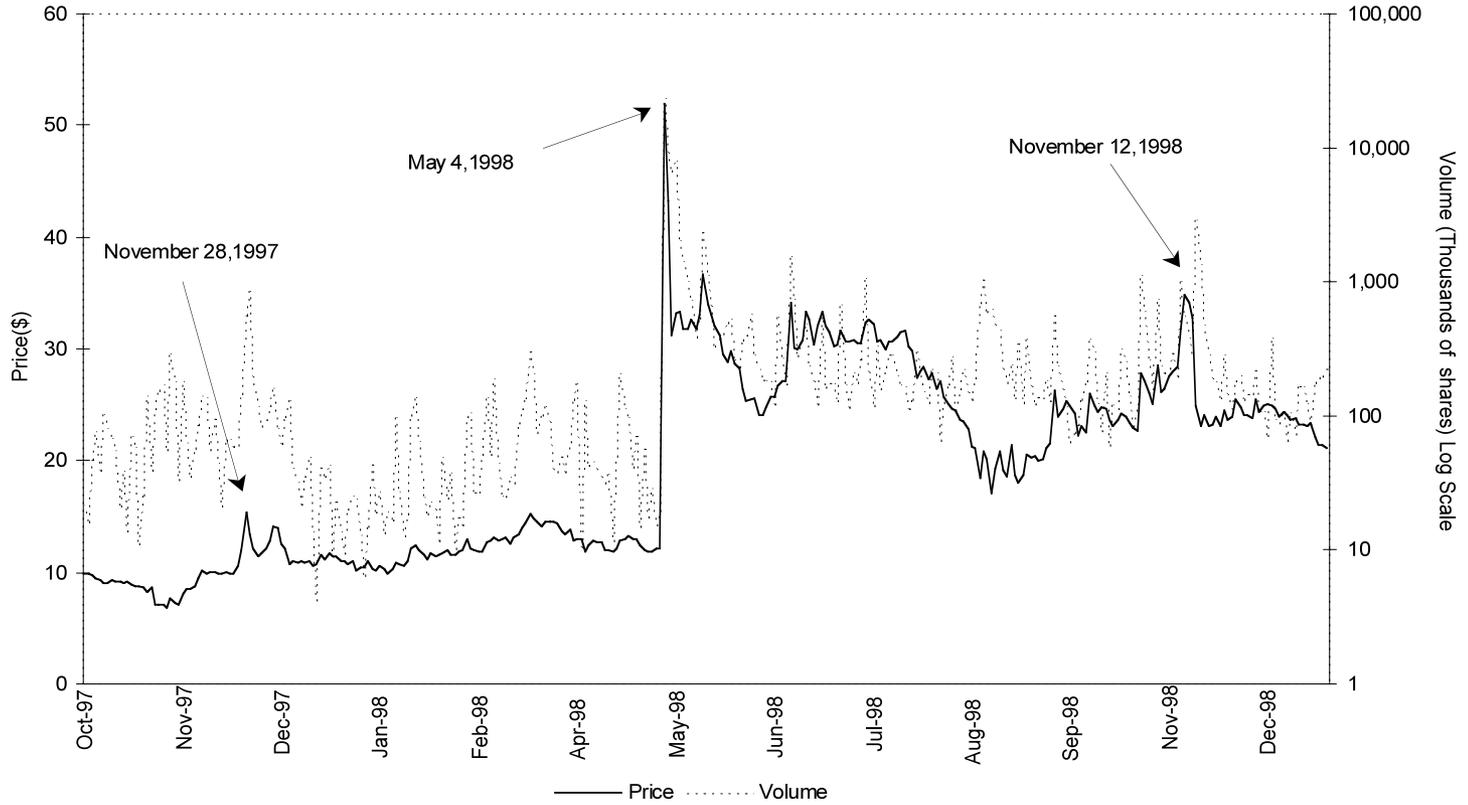
The puzzle is magnified when we consider what happened to other biotechnology stocks on Monday, May 4, 1998. On average, members of the Nasdaq Biotechnology Combined Index, excluding ENMD, went up by an unusual 7.5 percent on that Monday. The returns of 7 of the stocks in the index exceeded 25 percent on a trading volume that was 50 times the average daily volume (the 7 stocks do not include ENMD). On November 28, 1997, when the breakthrough news actually broke, the average return of the 7 stocks was 4.89 percent on a trading volume comparable to the average daily trading volume at the time.

A fundamentals-based approach to stock pricing calls for a price revision when relevant news comes out. Within this framework it is experts who identify the biotechnology companies whose pricing should be most closely tied to do the price revision. These experts follow *Nature* closely, and therefore the main price reaction of shares of biotechnology firms should have taken place in late November 1997, and not been delayed until May 1998.

Our empirical findings are difficult to reconcile with the opening paragraph of this introduction. Stock prices may well be based on the market's expectations of future cash flows. But how are these expectations formed? To what extent do they reflect hard, solid information or spurious publicity? We demonstrate that the latter may be just as important, and at times even more important, than the former.

ENMD provides a very instructive example, although it is merely one firm and the circumstances that we exploit here are unlikely to repeat themselves. This case is interesting because of the magnitude of the price changes, the ability to observe the speed of adjustment, and because the data suggest that the market can both under- and overreact to announcements.

In Section I we describe our data sources, in Section II we report the stock prices of ENMD around the three major event days, in Section III we look at the prices of members of the Nasdaq Biotechnology Combined Index around these days, and concluding remarks are in Section IV.



**Figure 1. ENMD closing prices and trading volume, October 1, 1997, to December 30, 1998.**

## I. The Data

We use *New York Stock Exchange Trade and Quotes* (TAQ) for intraday trading data, prices, and quotes and CRSP for daily return data until December 1997. Some of our 1998 and 1999 data are from CSI, Inc., on Money Central Investor Web Site. Company filings with the SEC provide us with the number of shares outstanding around May 1998 and ownership information. Membership and criteria for membership in the Nasdaq Biotechnology Combined Index are from Nasdaq's web site.

## II. Pricing of Entremed Stock

Entremed is a small biotechnology company with rights to commercialize a potentially cancer-curing process. Major movements in its stock price occurred on November 28, 1997, May 4, 1998, and November 11, 1998. The November 28, 1997, price increase followed the previous day's publication of a *Nature* article describing a major breakthrough in the process. On that day, the *New York Times* and other popular media outlets reported on the *Nature* article. The May 4, 1998, huge price runup followed a prominent front page article in the *Times* about the process and the scientists working to develop it. The November 11, 1998, price drop followed that morning's report in the *Wall Street Journal* that other laboratories had failed to reproduce the original results.

The cover of the November 27, 1997, issue of *Nature* prominently features the lead headline "Resistance-free cancer therapy" as well as a related image. Inside that issue, Boehm et al. (1997) report on a breakthrough in cancer research achieved by a team led by Dr. Judah Folkman, a well-known Harvard scientist. In a "News and Views" feature in the same issue, Kerbel (1997) explains and comments on the findings, suggesting that, "[T]he results of Boehm et al. are unprecedented and could herald a new era of cancer treatment. But that era could be years away." (p. 335) Reports on the discovery of Dr. Folkman's team appeared also in the popular press, such as the *New York Times* and *Newsday* on November 27, 1997, as well as in the electronic media, such as CNN's *MoneyLine* and CNBC's *Street Signs*. It seems that an effort was made to bring the news to the attention of circles wider than the scientific community.

The November 27 *Times* article appeared on page A28 (Wade (1997)). It, as well as CNN and CNBC, mentioned ENMD. On November 28, ENMD itself issued a press release that covered the news and the company's licensing rights to the proteins developed by the team of Dr. Folkman. The closing price of ENMD was 11.875 on November 26, and on November 28 it was 15.25; thus, the news caused a price appreciation of 28.4 percent, an observation made in the Business Section of the November 29 edition of the *Times*. (The stock market was closed on Thanksgiving, November 27.) The unusually high trading volume on November 28 and December 1 indicates that the market paid attention to the news. On the whole, an adherent of the efficient-market hypothesis would argue that the market digested the news in a timely and robust fashion.

In the months between November 27, 1997, and May 3, 1998, ENMD's stock traded between 9.875 and 15.25, with annualized volatility (i.e.,  $(254 * (\sum_t R_t^2)/T)^{1/2}$ ) equal to 81 percent.

Kolata's (1998) *Times* article of Sunday, May 3, 1998, presents virtually the same information that the newspaper had reported in November, but much more prominently; namely, the article appeared in the upper left corner of the front page, accompanied by the label "A special report." The article had comments from various experts, some very hopeful and others quite restrained (of the "this is interesting, but let's wait and see" variety). The article's most enthusiastic paragraph was ". . . 'Judah is going to cure cancer in two years,' said Dr. James D. Watson, a Nobel Laureate . . . Dr. Watson said Dr. Folkman would be remembered along with scientists like Charles Darwin as someone who permanently altered civilization." (p. 1) (Watson, of *The Double Helix* fame, was later reported to have denied the quotes.) ENMD's stock, which had closed at 12.063 on the Friday before the article appeared, opened at 85 and closed at 51.81 on Monday, May 4. The Friday-close-to-Monday-close return of 330 percent was highly unusual: bigger than all but two of the over 28 million daily returns of stocks priced at \$3 or more between January 1, 1963, and December 31, 1997. Not surprisingly, the *Times* story, and ENMD, received tremendous attention in the national media (print and electronic) in subsequent weeks.

In the May 10 issue of the *Times*, Abelson (1998) essentially acknowledges that its May 3 article contained no new news, noting that "[p]rofessional investors have long been familiar with [ENMD's] cancer-therapy research and had reflected it in the pre-runup price of about \$12 a share." (p. 6) (The *Times* did not question its own editorial choice of essentially rereporting the November 27 article, by a different reporter, with the label, "A special report," on the upper left corner of the front page. Gawande (1998) does that in the *New Yorker's* May 18 issue, which hit the newsstands on May 11.)

Figure 1 gives the distinct impression that, although some of the May 4 price runup was temporary, a substantial portion of it was permanent. ENMD's stock price fell in the days following May 4, to close the week at 33.25—still almost three times higher than its price a week earlier. Moreover, ENMD's closing price did not fall below 20 until late August 1998, and by late fall it had not closed below 16.94, which was 40 percent higher than its May 1 price. During that time, the S&P 500 lost almost 20 percent of its value between mid July and late August; the Nasdaq Combined Biotechnology Index lost almost 24 percent of its value in that period.

On November 12, King (1998), in a front page article in the *Wall Street Journal*, reports that other laboratories had failed to replicate Dr. Folkman's results. ENMD's stock price plunged 24 percent to close at 24.875 on that day. But that price was still twice the closing price prior to the *Times* article of May 4!

### III. What Happened to Firms in the Biotech Index?

The news of May 3 (if it can be called news) was idiosyncratic—a burst of optimism about potentially cancer-curing proteins to which ENMD holds property rights. Moreover, it seems that investors qualified to analyze the relation between Dr. Folkman's work and prices of stocks other than ENMD must have been very sophisticated and well informed in cancer research and its commercial implications. These are exactly the people to whom the May 3 *Times* piece was not news. By May 3 they must have heard of, and probably read, the *Nature* pieces of the previous November and various reactions to them. Thus, one could hardly expect unusual price movements of, or unusual trading in, other biotechnology stocks. Nonetheless, the optimism was contagious.

We study the stock-price behavior of members of the Nasdaq's Combined Biotechnology Index, which consists of Nasdaq-listed firms engaged in biomedical research to develop new treatments and cures for diseases. To enter the index, a firm must have a minimal market capitalization of \$50 million. (ENMD is in the index, but excluded from the sample.) We pay special attention to those 7 members of the index with May 4 returns exceeding 25 percent. Then we focus on Bristol-Myers Squibb (BMY), a major pharmaceutical firm with a market capitalization of over \$100 billion in early May 1998. Both the November 27, 1997, and the May 3, 1998, *Times* articles mention it as working with ENMD to develop Angiostatin, one of the proteins at the core of the scientific breakthrough. According to ENMD's press release of November 28, 1997, it and BMY had forged a strategic partnership in December 1995.

An equally weighted portfolio of the 134 stocks of the Nasdaq Combined Biotechnology Index returned 7.5 percent on May 4, and the median stock price in that group rose 1.6 percent. (This 7.5 percent is unusual: The absolute values of 506 of the 507 daily returns of this portfolio in the period from 1996 to 1997 were less than 6 percent.) Figure 2 depicts the return of the equally weighted index around May 4 as well as the average trading volume in its member stocks and the fraction of stocks with returns exceeding 5%. The value-weighted return on the index was 1.43 percent, more than 1 percent higher than the 0.29 percent Nasdaq's return on May 4.

Next, we consider the seven biotech stocks whose May 4 returns exceeded 25 percent. A search in the ABI Inform database turns up no mention of these firms from May 1 through 4. Returns of three of these exceeded 100 percent, returns of two were between 50 percent and 100 percent, and returns of another two firms were between 25 percent and 50 percent. A comparison of these returns with the extreme return distribution reported in Table I shows how unusual the returns of these seven biotechnology stocks were, and, especially, how unprecedented their clustering was. For instance, Table I shows that among all the members of the Biotechnology Index, only one stock price more than doubled in a day in 1996 and 1997, and only twice did four firms return more than 25 percent on the same day. (These eight returns were between 25 percent and 46 percent.)



Figure 2. Biotech Index Performance around May 4.  $R > 5\%$  is the fraction of stocks with daily return exceeding 5 percent.

Table I

**Frequency of Extreme Returns and Comovements of Returns of Members of the Nasdaq Combined Biotechnology Index Companies**

Number of firm-days on which very high or very low daily returns ( $R$ ) were realized for members of the Nasdaq Combined Biotechnology Index in 1996 and 1997. Total number of firm-days in the sample is 56,800, distributed over 507 trading days. For example, in 1996 and 1997, there was only one day when three members of the Nasdaq Combined Biotechnology Index experienced a daily return above 25 percent.

No. Firms per Day	$R > 100\%$	$R > 50\%$	$R \leq 50\%$	$R > 25\%$	$R \leq 25\%$
1	1	12	4	88	41
2				7	3
3				1	
4				2	

To assess how permanent the price changes of the seven stocks were, we look at the returns of a value-weighted portfolio of the seven stocks for the week and two weeks beginning on Friday, May 1. These returns were 35 percent and 27 percent, respectively. Thus, more than a third of the 75 percent value-weighted May 4 return on these 7 stocks did not disappear for at least 2 weeks. In dollar terms, May 4 saw the 7 stocks appreciate in value by \$185 million, and \$66 million of this appreciation did not disappear until Friday, May 15.

To appreciate the challenge of detecting contagion and comparing stock price movements in response to news and to no news, it is worth looking at the stock price of Bristol-Myers Squibb (BMY), a very big firm and a likely beneficiary of ENMD's success if it materializes.

Table II focuses on four important days and reports BMY's returns, excess returns, trading volume, relative trading volume, and the frequency of observing such numbers or larger in 1996 and 1997. February 10, 1999, is included because on the previous evening both ENMD and BMY announced a modification of the research agreement between the two companies regarding Angiostatin, and on that day ENMD's stock price dropped from 24.5 to 12.875.

Table II suggests that only May 4 was unusual for BMY's stock. Its trading volume soared, and its return was 3.12 percent, much higher than the NYSE's 0.14 percent return on that day. Although that return is marginally unusual compared with BMY's daily excess returns in 1996 and 1997, it amounts to a \$3.3 billion appreciation in the company's market capitalization—more than four times the dollar appreciation in ENMD and the seven biotech stocks with the highest return on that day *combined*. A search in the ABI Inform database suggests the absence of other significant news directly relevant to BMY on May 2, 3, or 4. Therefore one could attribute at least part of BMY's price rise on May 4 to the *Times* article of the previous day. On the whole, then, we can rule out BMY's price reaction on days when new

**Table II**  
**Daily Returns, Excess Returns, Trading Volume, and Relative Trading Volume for Bristol-Myers Squibb (BMY)**

Excess return is the return of BMY in excess of that of the NYSE. Fraction of 1996 and 1997 excess returns higher is the fraction of the 507 1996 and 1997 daily excess returns that were higher than BMY on that day. Fraction of 1996–1997 volume ratios higher is the fraction of the 507 1996 and 1997 daily (BMY volume)/(NYSE volume) ratios that were higher than the similar ratio on that day.

Date	Return	Excess Return	Fraction of 1996–1997 Excess Returns Higher	Volume (Thousands of Shares)	(BMY Volume)/(NYSE Volume) (%)	Fraction of 1996–1997 Volume Ratios Higher
11/28/97	0.40%	0.04%	0.774	1,607	0.85	0.502
05/04/98	3.12%	2.98%	0.044	8,671	1.57	0.024
11/12/98	-1.29%	-1.14%	0.367	1,805	0.27	1.000
02/10/99	-0.20%	-0.55%	0.680	5,825	0.81	0.559

news about ENMD came out—November 28, 1997, November 12, 1998, and February 10, 1999—and argue that both the high return and high volume of May 4 suggest some stock market reaction to the *Times*' no-new-news article. Although BMY's return on that day is miniscule compared with that of ENMD and a few other biotech stocks, it translates to an increase in market capitalization that dwarfs that of those biotech stocks.

That news about a breakthrough in cancer research affects not only the stock of a firm that has direct commercialization rights to the development is not surprising; the market may recognize potential spillover effects and surmise that other firms may benefit from the innovation. Moreover, the market may interpret the news as good for other firms because it may suggest that the research and development conducted by these other firms is closer to commercial fruition. However, the news did not break on May 4, 1998, but on November 27, 1997. And the people with the expertise to evaluate the spillover effects closely follow the news within the scientific community, probably read *Nature*, and pay attention to the coverage of biotechnology in the *Times* even when the relevant material appears well inside the newspaper.

The motivation and identity of the people who traded the seven stocks so aggressively on May 4 is puzzling. If they are experts on the fundamental aspects of biotechnology, they could and should have traded five months earlier. If they are stock market experts with no special understanding of biotechnology, it is unclear how they picked these particular seven stocks. Perhaps they speculated on noise trader behavior, but why with these stocks?

#### IV. Concluding Remarks

The circumstances surrounding ENMD are unusually clean, affording a crisp examination of the relevance of the efficient market hypothesis to the pricing of ENMD stock. On November 27, 1997, news was made public, and on May 3, 1998, ENMD enjoyed tremendous publicity that looked like news, but commentary on this news quickly revealed that it was not new at all.

The very prominent and exceptionally optimistic Sunday *New York Times* article of May 3, 1998, enables us to document a very strong, and permanent rise of ENMD's stock price that was caused by no new news. And the optimism was contagious, as other biotechnology stocks reacted similarly in direction, if not in magnitude. Moreover, these market reactions contrast with those that took place five months earlier and seven months later when new news came to light; ENMD's reaction was much milder and contagion seemed minimal, if it took place at all.

The cleanliness of the circumstances exploited in this study is rare. But the evidence is suggestive for our general understanding of the determinants of security prices. Prices probably move on no new news, and the movements may be concentrated in stocks that have some things in common, but these need not be economic fundamentals.

The possible arbitrariness of stock prices implies that capital markets may allocate funds in a somewhat arbitrary fashion. For instance, ENMD would have raised capital on very different terms before and after the May 3, 1998, publication of the *Times* article.

To the skeptical reader we offer the following hypothetical question: What would have been the price of ENMD in late May 1998 if the editor of the *Times* had chosen to kill the May 3 story?

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