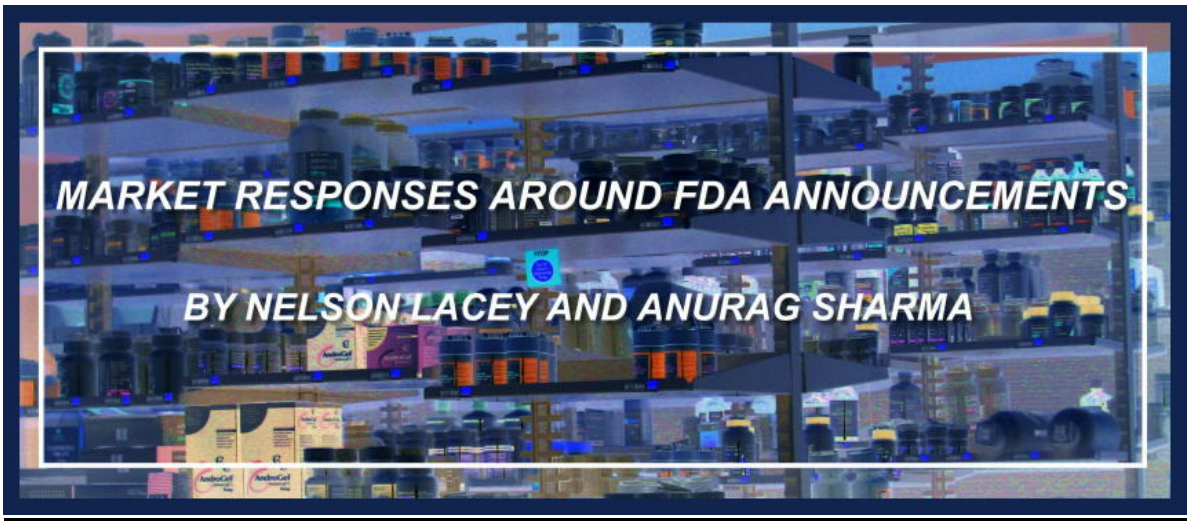

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Peer Reviewed

Abstract

This paper tracks the returns of pharmaceutical stocks at the time of drug approvals and rejections by the Food and Drug Administration (FDA). It follows a previous study by Sharma and Lacey (2004) that demonstrated a link between market valuation and new product development which found that development successes have a different impact than do development failures. In this study these authors place pharmaceutical firms in two samples; good news for positive FDA announcements and bad news for negative FDA announcements. The authors show that the announcement effects are as expected (positive and significant risk-adjusted abnormal returns for the good news sample and negative and significant risk- adjusted abnormal returns for the bad news sample). They find that the fall in value from bad news is orders of magnitude larger than the rise in value from good news. They also find evidence of a market able to discern differences in the treatment potential of approved drugs such that announcements related to new molecular entities are more important than those

that relate to new formulations or applications. Finally, while their results are consistent with an FDA that does a good job of keeping these announcements out of the public arena prior to disclosure, they are able to document evidence of leakages prior to the announcement of bad news.

Introduction

This paper examines returns of pharmaceutical stocks before, during, and just after Food and Drug Administration (FDA) decisions. In this study we are most interested in announcement effects and how (or if) investors react to the release of new public information and if investors are able to discriminate between different types of related announcements. For example, are investors able to get "inside" an announcement and find distinctions between the types of FDA decisions? Asserted by the pharmaceutical industry and reported in the media is that the FDA by and large controls the flow of new drugs to the marketplace.

We construct two data sets, one for FDA approvals, and another for FDA decisions to reject, delay, or request more information about new drugs. By tracking voluntary corporate disclosures about FDA decisions as well as FDA notifications themselves, we are able to isolate the trading of pharmaceutical shares at this decisive time.

We obtained results consistent with prior predictions on the direction of influence: increasing values associated with FDA approvals and decreasing values with rejections. Our results are clean and strong, but they do contain some surprises. For example, even with so much at stake, most of the announcement effects are largely unanticipated, a result consistent with the view that the FDA does an effective job of protecting the regulatory process from the investing public. The one important exception is a statistically significant level of anticipation prior to the disclosure of bad news.[1]

Similar to Dewenter and Warther (1998) with dividend announcements; Kasznik and Lev (1995) with earnings; and Sharma and Lacey (2004) with new FDA announcements, we find that the response to bad news is greater--in our case orders of magnitude greater--than it is for good news. In fact, for bad news, the act of disclosure itself is an important decision for the firm because the FDA does not publish decisions to reject, warn, or request additional information to firms with new drug applications pending.[2] Situations like this beg the question why disclose at all? Skinner (1994) argued that legal liability and reputation costs are key motivating factors. With this in mind, the sample of pharmaceutical firms is in somewhat of a unique position because these firms have little choice, given that new drug development had already established a following among analysts. This would explain the severe decline in value at the time of bad news releases.

Review of Related Literature

The literature on the wealth effects of new products and of FDA decisions is limited, but there have been several notable attempts to understand such effects. Eddy and Saunders (1980), for instance, studied the connection between shareholder returns and product innovation, although they were unable to tease out changes in monthly stock returns in response to new products announcements. Chaney, Devinney, and Winer (1991), on the other hand, found a small positive effect on the stock price during a 3-day window around the announcement date of new products--but still the effects they found were smaller than what they had anticipated. Sharma and Lacey (2004) found strong positive returns for pharmaceutical firms around the announcement date of favorable FDA decisions.

In regard to negative events, such as product recalls and withdrawals, the reported results are generally consistent with the expectation that shareholders lose considerably. In one of the early studies, Jarrell and Peltzman (1985) tested shareholder wealth effects for producers of drugs and autos. They found that news of such events results in large losses for shareholders --reflecting not only losses directly attributable to recall, but also from spillover damage to the goodwill of the firms. Such losses, they contended, would sufficiently deter managers from producing substandard products. Bromily and Marcus (1986) did yet another study on auto industry recalls, and they, too, found negative abnormal returns, although the effects in their study were smaller than those reported by Jarrell and Peltzman --insufficient, in the view of the authors, to significantly affect managerial behavior. Upon examining why drug recalls result in large losses for shareholders, Marcus, Swindler, and Zivney (1987) found that the implied standard deviation of stock returns from the Black Scholes option pricing model increased significantly for their sample of firms from which came their 32 examples of drug recalls.

Along the same lines, a similar study was executed by Davidson and Worrell (1992) with a focus on non-automotive product recalls and replacements. They, too, found negative abnormal returns for announcements of product recalls-- but much bigger negative returns for products that the firms took off the markets. Dranove and Olson (1994) studied drugs that were recalled accompanying the announcements that they had dangerous side effects. They found that, for the 23 American pharmaceutical companies that recalled their dangerous drug, the sales of their other drugs were unaffected. Among other things, they found compelling evidence that shareholder wealth suffered as a result, not only for the companies announcing the recall, but also for their competitors.

Three additional studies in recent years have focused on estimating wealth effects to shareholders when the decisions affecting the firm critically

involve the Food and Drug Administration. In a paper on announcement of FDA decisions from 1962 through 1989, Bosch and Lee (1994) worked with a sample of 194 approvals, 18 rejections, and 121 disciplinary actions on products that ranged from drugs, food additives, and medical devices. They found strong wealth effects for their sample, indicating statistically positive response to approvals; stronger negative response to rejections; and negative response to announcements of FDA disciplinary actions such as injunctions and recalls. Their event study results were not clean, however, as they found that the effects were present 3 days before negative event announcements; thereby indicating leaks of information.

Ahmed, Gardella and Nanda (2000) again studied the wealth effects of drug withdrawals pursuant to reports of adverse drug reactions. They, too, found that the shareholders of drug producers incur substantial losses upon the announcement of drug withdrawals. The adverse reaction to drugs was a particularly notable feature in their results going above and beyond simple withdrawing of the drug, but focusing instead also on the negative goodwill arising from a faulty product that created a shadow of trouble for the company.

Ten years after Bosch and Lee (1994), Sharma and Lacey (2004) reported the results of a study with a much larger sample of 344 drug approvals and 144 adverse FDA drug-related decisions during the 1990s. They confirmed the results of Bosch and Lee (1994) in that the financial markets reacted strongly to approvals, and they reacted even more strongly to negative event announcements. Yet, their results did not find the information “leaks” found by Bosch and Lee (1994), as the statistically significant abnormal returns were concentrated in the -1 to +1 window. This paper, while using a similar data set and similar investigative tools, goes beyond the investigation of an overall signal (approvals versus rejections) to examine a secondary set of regulatory signals, such as time period, the type of regulatory review, and the type of drug.

The Process of FDA New Drug Approval

Our study is motivated by the FDA drug approval process and by the way that financial markets sort out announcements related to the approval or rejection of new drugs. The FDA’s authorization has changed significantly over the last 100 years, starting with public safety (circa 1906 coinciding with the book *The Jungle* by Upton Sinclair) to the adding of effectiveness to its charge (circa 1962 coinciding with the tragedy resulting from thalidomide being used by pregnant women) and more recently to reforms instituted in the decade of the 1990’s. The Pure Food and Drug Act of 1906 had the effects of developing standards for the strength, quality, and purity of drugs and to prohibit the false and misleading labeling of drugs. Adding efficacy almost 60 years later expanded the size and scope of the agency and resulted in the lengthening and expense of the drug approval process. The more recent reforms were instituted in order to shorten the regulatory lag, especially for the most promising of new drugs. The Drug Price

Competition and Patent Term Restoration Act of 1984--also known as the Waxman-Hatch Act--and the FDA Modernization Act of 1997 are examples of such reforms.

The FDA regulatory process encompasses many phases of testing and clinical (human) trials. For a typical pharmaceutical firm the procedure begins with basic research, the screening of thousands of new chemical compounds, most of which never exit the lab. It is only the few most promising compounds that become candidates for pre-clinical trials, and only a small percentage of these promising compounds survive human clinical trials. The decision to enter a compound into the clinical trial phase is noteworthy, as considerable resources must now be committed, first in small sample testing of safety and dosage with healthy volunteers; next for effectiveness and side effect testing with patients; and finally for large groups of patient volunteers to confirm safety and effectiveness. Out of clinical trials come the formal review and finally the FDA decision.

Phase I trials are the first-stage of testing in human subjects where a relatively small group of healthy volunteers are selected to test the drug. This phase includes trials designed to assess the safety and tolerability of a therapy. If initial safety of the therapy has been confirmed, the drug moves from Phase I trials to Phase II trials, where controls are performed on larger groups in order to determine the efficacy of the therapy. Success in Phase II will then allow the drug to move to Phase III, where studies are performed on randomized control groups in order to confirm the efficacy of the new therapy. It should be noted that Phase III trials are expensive and time-consuming.

A drug leaving Phase III of human clinical trials triggers a new drug application (an NDA) and is a potential data point in our study. Because our study centers on public announcements, we spotlight only those drugs that have worked their way through all three phases of clinical trials. Estimates by Murphy (2001) indicate that approximately 25 percent of drugs that move into Phase III make it out successfully, and that the overall process of drug testing takes years to develop. A study by Dimasi, Hansen and Grabowski (2003) shows that the out of pocket costs per approved drug exceeds $400 million.

Sample and Research Design

Our FDA sample of 344 approvals and 103 rejections and other bad news originates from the universe of pharmaceutical/biotechnology firms identified by the Recombinant Capital Database and the Yahoo Biotech Industry Database. Two sets of screens were applied. First, drug approvals must have been posted on the FDA website, and firms associated with non-approvals must have announced a delay, warning, rejection, or decision to abandon. Rejections and other bad news were gathered through a Lexis/Nexis search by company.

Second, it was required that the firm be included in the DataStream International database. A total of 424 approvals and 144 non-approvals survived these two initial screens. Two further screens were then employed. The surviving firm must have had sufficient daily stock return data around the event date (a total of 321 days of returns over the period event day -310 to event day +10), and all surviving firms must have been free from other potentially important news around the event date. A search was made for any public announcement for firms in our data base within a 3-day window of the FDA announcement, and firms were removed if any non-FDA public announcement was found.

Approvals

We performed a Lexis/Nexis search of all 344 surviving approvals firms for any FDA related announcement. At least one announcement was found for all but 25 of those in the approvals sample. Three types of announcements--all voluntary disclosures by the firm--were typical: (1) that the panel assembled by the FDA has recommended approval; (2) that the firm has received a letter of approvable from the FDA; and/or (3) that the FDA has approved the drug for marketing. The earliest announcement date was recorded.

In addition, we tagged FDA drug approvals in two ways: by therapeutic differentiation and by treatment priority. The FDA numerical scheme for therapeutic differentiation places a drug into seven categories that range from being a new molecular entity to being a drug already legally marketed but without an approved NDA. The treatment priority tag results in a drug designated either as a priority review (P designation) or a standard review (S designation). Priority review is reserved for drugs that appear to represent an advance over available therapy, while standard review is performed for drugs that appear to have therapeutic qualities similar to those of already marketed drugs.

Rejections

Our non-approvals sample is built through voluntary disclosures of bad news relating to an FDA decision on a drug. Because the FDA web site does not keep track of decisions to delay, warn, or reject, we performed a Lexis/Nexis search on all firms in the Recombinant and Yahoo database.[3] We categorized the announcement as being most severe (e.g., rejection of the application) to less severe (e.g., warning).

Sample Characteristics

Reported in Table I (below) are the characteristics of our sample. For approvals, the sample by year is at a maximum of 76 (1n 1996) to a low of 10 (in

2000), with the average being 34.[4] For all 344 approval firms, we find that more than 80 percent of our data points reflect new drugs or new formulations as opposed to already marketed drugs, and that about the same percentage of the drugs in our sample have gone through a standard (as opposed to a priority) FDA review. More specifically, the FDA numerical scheme signify seven different chemical types, where *Type 1* is a new molecular entity, or an active ingredient that has never been marketed in the United States; *Type 2* is a new derivative, or a chemical derived from an active ingredient already marketed (a "parent" drug); *Type 3* is a new formulation, or a new dosage form of an active ingredient already on the market; *Type 4* is a new combination, or a drug that contains two or more compounds, the combination of which has not been marketed together in a product; *Type 5* is an already marketed drug product but a new manufacturer, or a product that duplicates another firm's already marketed drug product; *Type 6* is an already marketed drug product, but a new use, or a new use for a drug product already marketed by a different firm; and *Type 7* is a drug already legally marketed without an approved New Drug Application (an NDA). The ratio of good news announcements to bad news announcements is about three to one. Bad news announcements are split about evenly between rejections on the one hand and decisions to delay and/or requests for more information on the other.

We report descriptive characteristics of our sample in Table 2 (below) in order to see, if generally, there are important differences in the characteristics of the sample. These data are taken from the Compustat database and represent annual values. We investigate risk, size and leverage as these are important distinguishing characteristics between companies. We chose R&D to investigate the potential for research intensity of the sub-samples to be different.

While the beta and price-to-book ratios of the good news is similar to that of the bad news firms, we find that good news firms are larger, commit more resources to research and development, and use less debt. These data suggests a correlation between the type of firm that files an NDA with the FDA, and the outcome of the application. That is, smaller firms appear to be saddled with a higher incidence of drug application failure, although the risk of the two samples, as measured by beta, is essentially the same.

Table 1
Breakdown of Events

This table reports the characteristics of the pharmaceutical firms in our sample. For chemical composition, a total of 341 events were admitted (3 firms in the sample were without an FDA chemical tag). The FDA numerical scheme signifies seven different chemical types as described in the text. The FDA tag of P indicates a priority drug review, and an FDA tag of S indicates a standard review.

Year	Approvals	Chemical Composition				FDA Tag			Bad News	Rejects	Other
		1 or 2	3	4 to 7		P	S				
1991	21	13	6	2		7	14		2	2	0
1992	22	6	11	5		6	16		6	0	6
1993	22	7	10	5		3	19		3	2	1
1994	31	9	14	8		8	23		6	3	3
1995	38	16	11	11		6	32		12	9	3
1996	76	33	37	6		17	59		6	4	2
1997	50	18	23	9		7	43		12	7	5
1998	39	17	17	4		13	26		28	16	12
1999	35	15	17	1		10	25		25	12	13
2000	10	2	6	2		2	8		3	0	3
Totals	344	136	152	53		79	265		103	55	48
%		40%	44%	16%		23%	77%			53%	47%

Table 2
Characteristics of the Sample

The time period investigated spans from early 1991 through early 2000. The measures of central tendency are medians; so extreme points are removed. We report beta, the debt to equity ratio, the price to book ratio, total assets, net sales, and research and development expenditures for both FDA Approvals and FDA Rejections. The same firm can appear in our summary data more than once for firms with multiple events over different fiscal years. However, multiple events for the same firm in the same fiscal year appear as only one observation because these are annual ratios.

	Beta	Debt to Equity	Price to Book	$ Assets Millions	$ Sales Million	$ R&D Millions
Panel A: Good News						
Median	0.88	17%	5.66	7,142	5,711	609
Max	2.39	308	139.55	34,322	35,284	2,860
Min	-0.31	0	-59.89	9	0	1
Standard Deviation	0.413	46.400	14.400	8,323	7,549	669
Panel B: Bad News						
Median	0.83	38%	6.13	3,757	3,441	341
Max	1.92	400	32.28	30,879	31,077	2,433
Min	-0.22	0	-59.89	0	0	1
Standard Deviation	0.480	63.147	9.731	7,476	7,173	663
Difference Between Means	$t = 0.96$	$t = -3.13$**	$t = -0.38$	$t = 3.92$**	$t = 2.78$**	$t = 3.59$**

** indicates significance at the 1% level

Methodology

We utilize an event study methodology to measure the market's response to FDA decisions. Abnormal returns are measured using the market model, and we use standard cumulative abnormal return (CAR) methodology (See, for example, Brown and Warner (1980).). Standard and Poor's 500 composite return index as reported by DataStream International is used as the market index.

Our market model parameters are estimated using a 300-day period (day -310 through day –11), and our 21-day event period includes a pre-announcement day period (day –10 through day –2) and a post-announcement day period (day +2 through day +10). We report average abnormal returns and average cumulative abnormal returns as well as the associated tests of significance.

The raw data represents the return index for individual equities reported by DataStream International. The return index reports the growth in the value of the equity over a single trading day, including dividends.[5] For any day "***t***" in our event window, we average the abnormal return over the sample and use the standard t statistic to test the null hypothesis that the mean day "***t***" buy and hold abnormal return for our sample of "***n***" firms is equal to zero. This test represents the average day "***t***" abnormal return divided by the average standard deviation of returns measured over the estimation period (300 total days from event day -310 to event day -11).[6] We cumulate the day "***t***" abnormal returns over different intervals to obtain cumulative abnormal returns (CARs).[7] The ***z*** statistic is used to test whether or not the CAR is significantly different from zero.

Findings

Shown in Table 3 (below) are our primary findings of market responses to FDA announcements. Approvals are marked in event space as the FDA's notification date for marketing approval, while rejections are voluntary corporate disclosures of bad news relating to the development of a new drug. Examples of rejections and other bad news include the decision to halt the development of a drug; the decision to warn the company about some aspect of the drug's development; the request for additional information; or a post-marketing issue. Unlike approvals, the FDA does not publicly announce bad news.

Table 3 (below) shows the full sample of approvals (n=344) and then, separately, for priority drug reviews (n=79) and standard reviews (n=265). Shown are 11-day abnormal market model returns and cumulative abnormal returns over selected windows. Approvals show statistically significant and unanticipated share price responses that are absorbed quickly and that dampen beyond day +1. Cumulative abnormal returns are statistically significant at the 1 percent level for every event window except that of the pre-announcement (day –

10 to day –3) and post-announcement (day +3 to day +10) windows, indicating an event effect but no evidence of leakage or persistence around FDA drug approvals.

Our analysis of FDA tags point to a market that is able to discern differences in the treatment potential of an approved drug. Event day abnormal returns are approximately three times larger for priority treatment drugs, consistent with the view that while all drug approvals represent a new stream of cash flows to the firm, priority review drugs come with the expectation of magnified streams. Indeed, the cumulative returns for those tagged as priority indicate that there may have been an initial overreaction to the approval announcements, as the cumulative abnormal return is negative and significant in this post-announcement window.

For rejections and other bad news the results are striking. The full sample (n=103) shows negative and highly significant daily abnormal returns in each of the three days in the event window. The full sample of bad news shows three-day cumulative abnormal returns of close to negative 13 percent (z-statistic approaching 20). In contrast to approvals, however, the anticipation of the bad news is highly statistically significant. Large negative stock market returns on the day before the announcement is indicative of leakage into the hands of some investors prior to public disclosure and is supportive of strong-form market inefficiency.[8]

As with approvals, investors are able to categorize bad news by type of announcement. News of outright rejection (n=41) signals a stock market reaction over twice that--and sometimes over three times that--of other bad news announcements (n=62). Given that our rejection sample reports a one-day stock price reduction of over 10 percent combined with day +1 over 17 percent, it's clear that these negative FDA decisions have unambiguous and devastating implications for pharmaceutical firms.

Table 3: Abnormal Returns Around FDA Announcements

Abnormal return is assessed using a market model. The event date is either the FDA approval date or the date of a bad news disclosure relating to an FDA drug review. The estimation period runs from 310 days prior to the event date up to 11 days prior to the event date, and the event window runs from 10 days prior to 10 days after the announcement date. The time period of the sample runs from 1991 to 2000. Companies were admitted if their stock return history is sufficient to provide an estimate of expected return and returns throughout the 21-day event window. There were a total of 344 events were admitted for approvals and 103 events for rejections and other bad news. The sub-sample of P represents a priority review (drugs that appear to represent an advance over available therapy), while the sub-sample of S represents a standard review (drugs that appear to have therapeutic qualities similar to those of an already marketed drug). For bad news, the table shows results for rejections and, separately, for other bad news such as warnings, need for additional information, and post-market issues. Test statistics are computed as shown in endnotes 5 through 7.

News	All Approvals (n = 344)		Approvals Tag Of P (n = 79)		Approvals Tag of S (n = 265)		All Bad News (n = 103)		Drug Rejects (n = 41)		Other Bad (n = 62)	
	AR %	t-stat	AR %	t-stat	AR %	t-stat	AR %	t-stat	AR %	t-stat	AR %	t-stat
Day –5	0.033	0.27	-0.048	-0.16	0.057	0.43	-0.184	-0.46	0.019	0.03	-0.319	-0.64
Day –4	0.069	0.57	0.385	1.33	-0.025	-0.19	0.333	0.83	0.038	0.06	0.529	1.06
Day –3	0.009	0.08	-0.413	-1.42	0.136	1.02	0.047	0.12	-0.152	-0.23	0.178	0.36
Day –2	0.191	1.57	0.554	1.91	0.083	0.63	0.617	1.54	0.904	1.34	0.427	0.86
Day –1	0.205	1.67	0.484	1.67	0.121	0.91	-2.757**	-6.85	-3.947**	-5.87	-1.970**	-3.95
Day 0	0.477**	3.91	1.011**	3.48	0.319 *	2.40	-6.530**	-16.23	-11.167**	-16.61	-3.465**	-6.94
Day +1	0.881**	7.22	1.682**	5.80	0.643**	4.84	-3.466**	-8.62	-5.916**	-8.80	-1.846**	-3.71
Day +2	0.103	0.85	-0.367	-1.26	0.244	1.83	-0.448	-1.11	-0.929	-1.38	-0.131	-0.26
Day +3	-0.103	-0.85	-0.159	-0.55	-0.087	-0.65	-0.217	-0.54	-0.315	-0.47	-0.152	-0.30
Day +4	0.072	0.59	-0.294	-1.01	0.181	1.36	0.058	0.15	-0.118	-0.18	-0.175	0.35
Day +5	0.139	1.14	-0.315	-1.08	0.244 *	2.07	-0.376	-0.94	-0.078	-0.12	-0.574	-1.15
	CAR %	z-stat	CAR %	z-stat	CAR %	z-stat	CAR %	z-stat	CAR %	z-stat	CAR %	z-stat
Day -10 to -3	0.009	0.05	0.000	0.00	0.011	0.06	-0.351	-0.62	2.047*	2.15	-1.936**	-2.74
Day +3 to +10	-0.100	-0.57	-0.860*	-2.09	0.127	0.67	-0.095	-0.17	-1.743	-1.83	0.996	1.41
Day 0 to +1	1.359**	7.87	2.692**	6.56	0.961**	5.12	-10.000**	-17.57	-17.082**	-17.97	-5.311**	-7.53
Day -1 to 0	0.682**	3.95	1.494**	3.64	0.440*	2.34	-9.287**	-16.33	-15.113**	-15.90	-5.535**	-7.70
Day -1 to +1	1.563**	7.39	3.176**	6.32	1.082**	4.71	-12.754**	-18.31	-21.029**	-18.06	-7.281**	-8.42

** denotes statistical significance at the 1 percent level using a two-tailed test
* denotes statistical significance at the 5 percent level using a two-tailed test

Table 4: FDA Approvals and Secondary Effects

Abnormal return is assessed using a market model. The event date is the FDA approval date. The estimation period runs from 250 days prior to the event date up to 11 days prior to the event date, and the event period runs from 10 days prior to 10 days after the announcement date. The time period of the sample runs from 1991 to 2000. Companies were admitted if they had stock return history sufficient to provide an estimate of expected return and returns throughout the 21-day event window. The test statistics are computed as shown in endnotes 5 through 7. ** indicates significance at the 1 percent level

For Chemical Type: A total of 341 events were admitted (3 firms in the sample were without an FDA chemical tag). The FDA numerical scheme signify seven different chemical types; **1** = a new molecular entity, or an active ingredient that has never been marketed in the U.S.; **2** = a new derivative, or a chemical derived from an active ingredient already marketed (a "parent" drug); **3** = a new formulation, or a new dosage form of an active ingredient already on the market; **4** = new combination, or a drug that contains two or more compounds, the combination of which has not been marketed together in a product; **5** = already marketed drug product but a new manufacturer, or a product that duplicates another firm's already marketed drug product; **6** = already marketed drug product, but a new use, or a new use for a drug product already marketed by a different firm; and **7** = drug already legally marketed without an approved New Drug Application (an NDA)**.**

For Calendar Year: A total of 344 events were admitted. The break point was chosen to analyze a later time period corresponding (approximately) to the advent of the World Wide Web.

For Momentum: A total of 344 events were admitted. Momentum is defined as the pattern of stock returns just prior to the FDA announcement. For the five successive stock returns from event day –6 through event day –2, a positive momentum is indicated for firms with four or more positive returns; a negative momentum is indicated for firms with four or more negative returns; and zero momentum is indicated for firms with less than four positive or negative returns.

Table 4: FDA Approvals and Secondary Effects (Continued)

** denotes statistical significance at the 1 percent level using a two-tailed test
* denotes statistical significance at the 5 percent level using a two-tailed test

Event Analysis	N	Days -10 to – 3	Day –2	Day –1	Day 0	Day +1	Day +2	Days +3 to +10	Days 0 to +1	Days -1 to 0	Days -1 to +1
Sorted By Chemical Type:	341										
Drug Types 1 and 2	136	0.11	0.08	0.19	0.33	1.02**	-0.05	0.54*	1.35**	0.52	1.54**
		(0.42)	(0.44)	(0.98)	(1.72)	(5.31)	(0.27)	(2.00)	(4.97)	(1.91)	(4.63)
Drug Type 3	152	-0.06	0.31	0.42	0.79**	0.93**	0.12	-0.60*	1.72**	1.04**	1.97**
		(0.22)	(1.56)	(1.24)	(4.02)	(4.72)	(0.62)	(2.16)	(6.17)	(3.72)	(5.76)
Drug Types 4 through 7	53	-0.04	0.18	0.20	-0.12	0.43	0.43	-0.13	0.31	0.07	0.50
		(0.11)	(0.74)	(0.81)	(0.50)	(1.77)	(1.77)	(0.38)	(0.90)	(0.22)	(1.20)
Sorted By Calendar Year:	344										
1996 and Earlier	210	-0.46*	0.34**	0.19	0.30*	0.76**	0.40**	-0.04	1.05**	0.49**	1.24**
		(2.51)	(2.58)	(1.47)	(2.29)	(5.81)	(3.09)	(0.23)	(5.73)	(2.65)	(5.52)
1997 and Later	97	0.75*	-0.03	0.23	0.76**	1.08**	-0.36	-0.19	1.84**	0.99**	2.06**
		(2.21)	(0.15)	(0.95)	(3.19)	(4.53)	(1.52)	(0.57)	(5.46)	(2.93)	(5.00)
Sorted By Event Momentum	344										
Negative Momentum	49	-3.99**	-1.17**	0.52	0.49	-0.11	0.18	0.96*	0.39	1.01*	0.90
		(8.82)	(3.67)	(1.61)	(1.54)	(0.33)	(0.55)	(2.11)	(0.85)	(2.24)	(1.62)
Positive Momentum	55	3.15**	0.10	-0.10	-0.48	1.78**	-0.40	0.22	1.30**	-0.38	1.40**
		(7.46)	(0.33)	(0.33)	(1.61)	(5.98)	(1.33)	(0.84)	(3.08)	(0.91)	(2.71)
Zero Momentum	240	0.11	0.29*	0.17	0.69**	0.88**	0.20	0.17	1.57**	0.86**	1.74**
		(0.51)	(1.99)	(1.12)	(4.72)	(5.95)	(1.38)	(0.84)	(7.54)	(4.13)	(6.81)

FDA approvals sorted by secondary effects

The FDA classifies drugs according to their molecular design and inventiveness using a seven-digit numerical scheme beginning with 1 (most important) and ending with 7 (least important). We position chemical types into three groups, the first being drugs with the greatest potential scientific breakthrough (Types 1 and 2); the second being drugs with the next greatest potential (Type 3); and the third being the drugs with the least potential (Types 4 through 7). Our results, shown in Table 4 (above), conform to prior expectations, at least in the sense that market participants discriminate between chemical types. FDA approvals associated with chemical Types 4 through 7 (the least potential) are associated with insignificant abnormal returns in each event day and in each event window. By contrast, chemical Types 1, 2, and 3 show statistically significant abnormal returns of roughly equivalent magnitudes within the event window. These abnormal returns are unanticipated and the news is absorbed almost instantaneously into the stock price.

FDA Approvals sorted by calendar year

Table 4 (above) shows abnormal returns by calendar year. Our full sample runs from 1991 through 2000, and we use the year 1996 to separate an early period from a more recent period. We chose the year 1996 in order to (roughly) correspond to the time when the World Wide Web and financial news networks became sources of information to the investing public. We find differences in both the magnitude (higher abnormal returns in the more recent period) and timing (effects earlier in the event window in the more recent period) of the abnormal return. Event day effects that had occurred between days +1 to day +2 for 1996 and before have moved foreword by one day for 1997 and after, consistent with a market with faster and more accessible news compared with an earlier time regime.

Approvals sorted by momentum

Examined in Table 4 (above) are the effects of momentum -- the build-up of stock return just prior to the event – as an early signal of FDA action. For raw returns over days –6 through –2 in event time, positive momentum occurs if four or more of those returns are positive; negative momentum occurs if four or more of those returns are negative; and zero momentum occurs if less than four of those returns are positive or negative.

Results for the zero momentum sample and the positive momentum sample are similar to those shown for the full sample of approvals. For negative momentum however, the positive and statistically significant announcement effects disappear and actually turn significantly negative in the period just prior to

the FDA drug approval announcement. This is unanticipated, as one could even envision a stronger positive announcement effect for this sub-sample given a greater element of surprise and a sharper announcement effect. The lack of a momentum factor is further evidence that the FDA protects their disclosure of good news from the market.

Conclusion

This paper provides evidence that drug announcements by the FDA affect the value of pharmaceutical firms' stock. We find statistically significant abnormal returns among 344 new drug approval decisions and 103 rejections and other bad news announcements. We also find that the change in return is absorbed almost instantaneously over the event window, is largely unanticipated, and shows little or no persistence. These return patters are consistent with the view that FDA drug decisions are important because the typical pharmaceutical firm commits years of research and development and millions of dollars in efforts to move a drug from basic research through clinical trials and, finally, to FDA-sanctioned marketability.

Further, we show that the market response associated with bad news is orders of magnitude greater than the response around good news announcements. Considering that negative news disclosures are voluntary (the FDA does not release decisions to reject, suspend, delay, or request additional information.), these results are consistent with the notion that firms who release bad news have little choice but to make the news public. Additionally, for bad news announcements, we document negative and significant abnormal returns prior to the public release of the news, a finding consistent with strong form market inefficiency for these events.

For FDA drug approvals, investors of pharmaceutical firms are capable of discerning differences in chemical composition, FDA review priority, time period, and return momentum. Positive average changes in stock value are strongest for drugs afforded priority FDA review and for drugs identified as new molecular entities, new derivatives, or new formulations. We document a stronger announcement, as well as an announcement effect, that takes place sooner in event time in the more recent years studied (1997 through 2000), as well as an announcement effect that comes sooner in the more recent years studied.

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ENDNOTES

[1] We use the qualifier here because leakage prior to the corporate disclosure may be unrelated to the FDA's process of informing the firm. For example, the FDA may be following standard procedure, but managers inside the firm may be trading on the information prior to the public announcement.

[2] While this statement is true in practice, the 1997 Food and Drug Administration Modernization Act contains a provision that calls for an expanded database on clinical trials, and this provision could be interpreted to include information about a manufacturer's plan to discontinue a drug. The impact of this provision has been small, perhaps because the law provides no penalties for violations.

[3] In addition we hired a professional librarian to perform an independent search of bad news announcements that relate to our event. We took this step in order to confirm our findings but also to potentially increase the size of the sample.

[4] Although there is a jump in approvals in 1996, and rejections in 1998, there is nothing unique about those years with regard to the FDA.

[5] We calculate the abnormal return for firm *i* on day *t* as:

$$AR_{it} = R_{it} - E(R_{it})$$

where AR_{it} is the day *t* buy and hold abnormal return for security *i*, R_{it} is the *t* period buy and hold raw return, and $E(R_{it})$ is the *t* period expected return for security *i.* In this research expected returns are estimated by the market model where the returns on security *i* are linearly related to returns on a market portfolio, and beta is the risk factor:

$$E(R_{it}) = \alpha_i + \beta_i R_{mt}$$

[6] The test statistic for a daily abnormal return is given by:

$$ARt = \frac{\frac{1}{n}\sum_{t=1}^{n} ARt}{\frac{1}{\sqrt{n}}\frac{1}{300}\left(\sum_{t=-11}^{-210}(ARt - \overline{AR})2\right.}$$

[7] The test statistic for a cumulative period is given by:

$$CAR_{t,t+k} = \sum_{K=t}^{t+k} AR_K$$

[8] Another potential explanation is that news dates reported on Lexis Nexis lags the date news is released to the market. Therefore, the negative returns reported on day -1 could in fact be an event day effect.