THE MARKET RETURN TO PHARMACEUTICAL PRODUCT APPROVAL

by

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Presented to the Faculty of the Graduate School of

The University of Texas at Arlington in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF ARTS IN ECONOMICS

THE UNIVERSITY OF TEXAS AT ARLINGTON

May 2007

ACKNOWLEDGEMENTS

I would like to thank Dr. Michael R. Ward, Associate Professor, in the Department of Economics at the University of Texas at Arlington, for supervising my thesis and for his continued support and guidance throughout the period of this research. Dr. Ward has been immensely patient with me. His constructive suggestions and intuitive explanations have always helped me find best possible resolution of unforeseen issues. I also would like to thank Dr. Craig A. Depken, II and Dr. Çağatay Koç for the time they spent as members of the committee of my thesis. I also want to thank my friend Mishuk Chowdhury (M.A. in Economics, UTA) for helping me resolve the issues of programming. I would like to express my gratitude to fellow graduate student Mr. Darshak Patel for his valuable opinions about some issues during this research.

Finally, I would like to express my unmixed feelings from the core of my heart to my daughter, Shumaisa Ahmed and to my wife, Dilruba Ahmed for their continuous sacrifice of family-time and *events* of family-entertainments because of my absence, which, eventually, enabled me to accomplish my '*event* study' in this present research.

April 18, 2007

ABSTRACT

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Publication No. _____

Imtiaz Ahmed, M.A.

The University of Texas at Arlington, 2007

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Does the public announcement of approval of New Drugs affect the market valuation of the sponsoring pharmaceutical company? This study will try to find out the technically and intuitively acceptable answer of this question using *event study* methodology. Relatively smaller number of previous studies on this issue found the mixed answers of this question using well-tested methodology of event study. Basing on the notion that the Efficient Market Hypothesis (EMH) is in effect in the pharmaceutical industry, stock and securities market should ideally react quickly (i.e., efficiently) in response to the public announcement of approval of new drug by the Food and Drug Administration (FDA) and the positive abnormal return *may be* expected for the sponsoring pharmaceutical company on and around the event date i.e.,

the day of the public announcement of the new drug approval for marketing. Using the OLS and the 2SLS to carry-out the event study for four-hundred events of eleven pharmaceutical companies ranging twenty-three years, this study has found the mixed outcomes similar to some of the previous studies on this issue. Briefly, the findings of the present study are: (a) Existence of statistically significant positive abnormal returns (AR) for the day following the events. (b) The cumulative abnormal return (CAR) is statistically insignificant for the estimates of the pooled regressions and for some of the individual pharmaceutical companies. (c) No sign of information leakage ahead of the events. (d) Some individual pharmaceutical companies show the existence of statistically significant positive abnormal returns (AR) and the cumulative abnormal return (CAR) for event day and the day after (e.g. Novartis, Abbott). The technical reasons and the intuitive explanations behind these findings will be revealed in the analysis of empirical results and in the concluding remarks of this study.

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CHAPTER 1

INTRODUCTION

In this study an attempt has been made to re-examine the linkage, if any, between the introduction of a new product in the market and the market valuation of the firm introducing the products. This issue will be re-examined in the context of pharmaceutical industry. Research on this particular issue, in the literature of the Pharmaceutical and other industries, is not numerous. There has been a large volume of research on product specific issues such as managerial assessments of market share, sales, profits and payback for the newly introduced products in the market (Sharma and Lacey, 2004) and this research has revealed information about how successful the new products were in the market. But very few studies have evaluated and analyzed the impact of the introduction of the new product, e.g. drugs approved by Food and Drug administration (FDA) in the present context, and the market valuation of the sponsoring (pharmaceutical) company. The present study is not based on the intention to add one more study in that particular area of the Pharmaceutical Industry's research-literature, rather it is inspired by the presence of mixed outcomes of the past studies on this issue and the immense importance of the linkage between the New Drug Approvals (NDAs) by the FDA and the impact on the market valuation of the sponsoring firms through changes in the stock prices of those firms.

1.1 Why is this issue important?

Some scholars found the linkage between firms' ability to generate continuous stream of innovations and its continuation of realization of supernormal profits from the market. This observation revealed the fact that the continuous stream of product innovations provides advantages to the firms to face the competition and keep its existence in the market intact. This linkage enables firms encounter the natural forces of competition and/or changes in the consumption patterns for the existing products of the firms that eventually causes to decline the abnormal profits accrued by the firms (Sharma & Lacey, 2004 and Schumpeter, 1934). The newly introduced product faces "limited direct competition" (Sharma & Lacey, 2004), especially, if the product has, over a certain period of time, patent protection and the product exclusivity rights like the most new drugs introduced in the U.S. But after that protection period expires, the higher profits begin to be eroded because of competition from generic versions of that drug. Competition may even come from the pharmaceutical company who originally introduced that branded drug (Reiffen & Ward, forthcoming). In that case the sponsoring firm may keep the profit stream flowed into their accounts. But the level of profit stream will not be as high as their previous branded version of that particular drug for obvious reasons. In this instance, Schumpeter (1934) argued that firms might be able to keep the sustained flow of higher level of profitability by introducing new products in the market and that is possible by a continuous stream of innovation.

The continuous stream of innovation involves the issues of strategic decisions to be taken by the managers of the pharmaceutical companies in the context of the present study. It requires resources to be allocated towards R&D to keep the continuous stream of innovation which is a first prerequisite of the flow of introduction of new products in the market. Managers of the pharmaceutical companies face a difficult situation when they attempt to justify the amount of R&D expenditure to develop a New Chemical Entity (NCE) or a New Molecular Entity (NME) from hundreds of chemical compounds. This R&D expenditure needs to be continued throughout the product-life-cycle of the new drug development until it gets approved or disapproved by the FDA. So, the stock market reaction to the public announcements is very important in the context of corporate strategic decisions for investments.

The development of a new drug and obtaining approval for marketing are subject to a highly rigorous process in the United States and there is a great deal of attrition at each successive stage of clinical trials (Sharma and Lacey, 2004; Neergaard, 2001). It is found in 1990s that it took more than 14 years from synthesis of a new compound to the approval by FDA for marketing according to a study by the Tufts University Center for the Study of Drug Development (Sharma and Lacey, 2004; DiMasi, 2001). The industry trade group PhRMA estimated that the average capitalized costs of developing a new drug entity add up to about $800 million (Sharma and Lacey, 2004; Grabowski et al., 2002). Therefore, the new drug approvals (NDAs) by FDA is a critical *event* for a pharmaceutical company and for the existing and potential shareholders of that company for obvious reasons.

So it is important to capture and analyze the positive, negative or neutral response of the financial market during a certain period of announcements of the approval of a new drug for an sponsoring pharmaceutical company.

1.2 The Expectations from the present study

To reexamine the possible linkages between the introduction of a new drug and the market valuation of the pharmaceutical company as whole, in this study, an attempt has been made to identify the existence of an abnormal return, if any, and to measure the extent of that abnormal return for a firm during a specific period after the announcement date of an approval of a new drug by the Food and Drug Administration (FDA). The previous research on this issue revealed mixed outcomes and left the issue still open for further investigation.

With the backdrop of mentioned scenario the present study is a partial re-examination of findings found in a previous study of relationship between the introduction of a new product and the financial performance of a company. The particular study which has been used as a point of reference was conducted by *Anurag Sharma and Nelson Lacey (2004).* To measure the impact of the NDAs in financial market, the well-tested Event Study methodology is used in this study.

1.3 Organization of the present study

The rest of the paper is organized according to the following sequences: Chapter II will be devoted for the Literature Review and the review is divided into three sub-sections: 2.1 Pharmaceutical Industry Dynamics, 2.2 Issues in Event study and 2.3

NDAs and overall-firm-performances. The sub-section 2.1 will be divided again into three sub-sections: 2.1.1 Structure of the industry, 2.1.2 R&D, 2.1.3 New product (drug) development & approval process. The sub-section 2.3 will include the review of the previous studies that evaluated and analyzed the link between NDAs and the (pharmaceutical) companies' performances. Chapter III will describe the Methodologies adopted in this research in details. Chapter IV will present detail descriptions of the nature of the data and its sources. Chapter V will include the presentation of empirical results and the analysis of the regression results found in this present study. Chapter VI will reveal the concluding remarks of this research.

CHAPTER 2

LITERATURE REVIEW

The literature review is broadly divided into three components: sub-sections are 2.1 Pharmaceutical Industry Dynamics, 2.2 Issues in Events Study and 2.3 The new product (drug) and overall-firm-performances. An overview of the structure of the pharmaceutical industry, detail information on R&D expenditures and an illustrative description of the New Drug development and approval process will be included as sub-sections of the Pharmaceutical Industry Dynamics.

2.1 Pharmaceutical Industry Dynamics

The major features of the pharmaceutical industry includes the possible existence of monopoly power, high prices of pharmaceutical products, possible high margins of profits and huge R&D expenditures of pharmaceutical companies.

In the late 1959, the Kefauver committee report was a spectacular milestone in the history of regulatory reforms in the pharmaceutical industry. The manifestation of confrontation between the committee and industry aroused huge public interest at that time. The report made by that committee and its successors produced numerous subsequent research, debate about the pharmaceutical industry's conduct and performances (Comanor, 1986).

The issues concerned with the pharmaceutical prices and profits were the primary line of investigation of the committee. The committee showed that the prices

generally exceeded the direct cost of the manufacturing. For example, 22 major pharmaceutical firms in 1958, the costs of goods sold were merely 32 percent of total sales (Comanor, 1986). The Kefauver committee claimed this fact alone demonstrates the presence of the monopoly power in the pharmaceutical industry.

The Kefauver investigation led to one of the major event in the pharmaceutical industry, the 1962 Drug amendments that led to a substantial change in the regulations imposed by the Food and Drug Administration. Prior to the 1962 amendments the new drugs were required to be tested for the toxicity only. After the amendments in 1962 the new drugs also were required to show improved efficacy. As a consequence of these amendments, the FDA was given increased authority over the drug evaluation process.

Another milestone in the pharmaceutical industry was in 1984, when a new law introduced FDA's use of Abbreviated New Drug Applications (ANDA) for drugs approved after 1962. This new law required only a demonstration of "bioequivalence" to get market approval for new supplier of chemicals previously approved (Comanor, 1986). This new law of 1984 was known as the Waxman-Hatch Act of 1984 which extended the patent life of many brand-name drugs but eased the approval requirements for generic versions when the patent expires (Ward, 1992). The ultimate net effects of the Waxman-Hatch Act of 1984 on the trends of R&D expenditure in the pharmaceutical industry is ambiguous because of the incentives were on opposite directions. But the consumers got more choices in the drug market because of the increased number of generic drugs and thereby got benefited as a consequence of this Waxman-Hatch Act of 1984 (Ward, 1992).

2.1.1 Structure of the Industry

In 2006, the global spending on prescription drugs exceeded $600 billion for the first time ever despite the fact that the overall growth slowed in the North America and Europe (Wikipedia.org, 2007). The sales of prescription medicines worldwide rose 7 percent and that fetched $602 billion. The United States still accounts for most like other years, with $252 billion in annual sales. U.S. sales grew 5.7 percent (Wikipedia.org, 2007 and IMS health). In 2004 the U.S. comprised approximately 45 percent of the pharmaceutical market worldwide. In the same year US sales grew to $235.4 billion, which was a result of growth rate of 8.3 percent compared to 11.5 percent growth from the year 2002 to 2003 (Wikipedia.org, 2007). The following table shows the revenue, R&D, net return and the number of employees of the top twenty pharmaceutical companies in 2004 (MedAdNews, September 2005, Wikipedia.org, 2007):

Table 2.1 The top twenty pharmaceutical companies in 2004 ($M & Number)

Rank 2004	Company	Revenue	R&D	Net Income	Employees
1	Pfizer	52,516	7,684	11,361	115,000
2	Bristol-Myers Squibb	47,348	5,203	8,509	109,900
3	GlaxoSmithKline	37,318	5,204	7,886	100,619
4	Sanofi-Aventis	31,615	4,927	6,526	96,439
5	Novartis	28,247	4,207	5,767	81,392
6	Hoffmann-La Roche	25,163	4,098	5,344	64,703
7	Merck & Co.	22,939	4,010	5,813	62,600
8	AstraZeneca	21,427	3,803	3,813	64,200
9	Abbott Laboratories	19,680	1,697	3,236	50,600
10	Johnson & Johnson	19,380	2,500	2,388	43,000
11	Wyeth	17,358	2,461	1,234	51,401
12	Eli Lilly	13,858	2,591	1,810	44,500
13	Bayer	10,554	1,299	750	113,060
14	Amgen	10,550	2,028	2,363	14,400
15	Boehringer Ingelheim	10,146	1,532	1,104	35,529
16	Baxter International	9,509	517	388	48,000
17	Takeda	9,330	1,285	2,636	115,000
18	Schering-Plough	8,272	1,607	-981	109,900
19	Astellas Pharma	7,904	1,213	566	100,619
20	Procter & Gamble	7,786	n/a	7,257	96,439

2.1.2 R & D

In 1962, one of the focus of the Kefauver committee investigation was on the role of research and development in the pharmaceutical industry. Although the committee admitted that there is a large amount of expenditure for the pharmaceutical research comparing to other industries, the committee claimed the fact that there had been little of social value resulted from industry laboratories (U.S. Senate Report 1961, pp. 115 – 41). It identified the sources of most of the important discoveries were derived from work outside the industry, and the commercial laboratories in the industry were concerned largely with "molecule manipulations" which implies the new drugs were therapeutically similar to those already in the market. If so, the duplicative research could be eliminated without impairing the flow of important new drugs (Comanor, 1986).

These arguments were rejected by pharmaceutical industry and the industry claimed that most of the new drugs extensively used in medical practice came from industry research laboratories. This debate led, in subsequent years, to a considerable effort to explore the determinants and effects of the research and development in the pharmaceutical industry (Comanor, 1986).

In a recent report of Congressional budget office (CBO) it was mentioned that the pharmaceutical industry is one of the most research intensive industries in the United States. Pharmaceutical firms invest as much as five times more in research and development, relative to their sales, than average U.S. manufacturing firm (CBO Study, 2006, pp: 19). CBO report on the R&D in Pharmaceutical Industry also mentioned that

over past 25 years, R&D intensity has grown by about 50 percent. Most of that growth occurred in the 1980s and since then, the R&D intensity of the pharmaceutical industry remained around 19 percent according to the pharmaceutical industry's trade association, Pharmaceutical Research and Manufacturers of America (PhRMA, 2006).

U.S. pharmaceutical companies spent, in 1980, a total of $5.5 billion (in 2005 dollars) on research and development of pharmaceuticals and medicines, according to the National Science Foundation (NSF). That expenditure had grown to more than $17 billion by the year 2003 and this is an average increase of 5 percent per year in real terms (CBO Study, 2006, pp: 17).

In 2005, the U.S. federal government spent more than $25 billion on health-related R&D according to the CBO study (2006, pp: 12). Only some of this spending is explicitly related to the development of new pharmaceutical products. Much of it is allocated to basic research on the mechanisms of disease, which facilitates the search for news drugs by the pharmaceutical industry (CBO study, 2006).

The cost of developing a new drug depends on the type of the drug being developed, the likelihood of failure, and whether the drug is based on a molecule not used before in any pharmaceutical product (i.e., a new molecular entity or NME) or instead is an incremental modification of an existing drug (CBO study, 2006).

According to the report (GAO report, 2006) of the U.S. Government Accountability Office (GAO) to Congressional Requesters, the number of New Drug Approvals (NDAs) submitted to, and approved by, FDA has not been commensurate with the investments and the R&D costs which the pharmaceutical industry reported as

substantial increases annually. The GAO report (Nov. 2006) mentioned that from 1993 through 2004, the pharmaceutical industry reported annual research and development expenses steadily increased from nearly $16 billion to nearly $40 billion (inlation-adjusted). This is a 147 percent increase. But, in contrast, the number of NDAs submitted annually to FDA increased at a slower rate i.e., 38 percent over this period. During this period the number of NDAs submitted to FDA for NMEs increased only by 7 percent. Although FDA approved most NDA applications i.e., 76 percent overall, the numbers of NDAs and NDAs for NMEs it approved annually have generally been declining since 1996 (GAO report, 2006).

With this scenario of high R&D intensity and, relatively, the lower rate of new drugs introduced in the market grew the interest of stakeholders of the pharmaceutical industry and the New Drug Approval by FDA has become one of the highly watched and sensitive issue in the stock and the securities markets.

2.1.3 New Drug development & approval process

Center for Drug Evaluation and Research (CDER) of FDA is responsible for carrying out the review process for all drugs including NDAs. The following self-explanatory illustration (fda.gov, 2007) shows *The New Drug Development Process:*

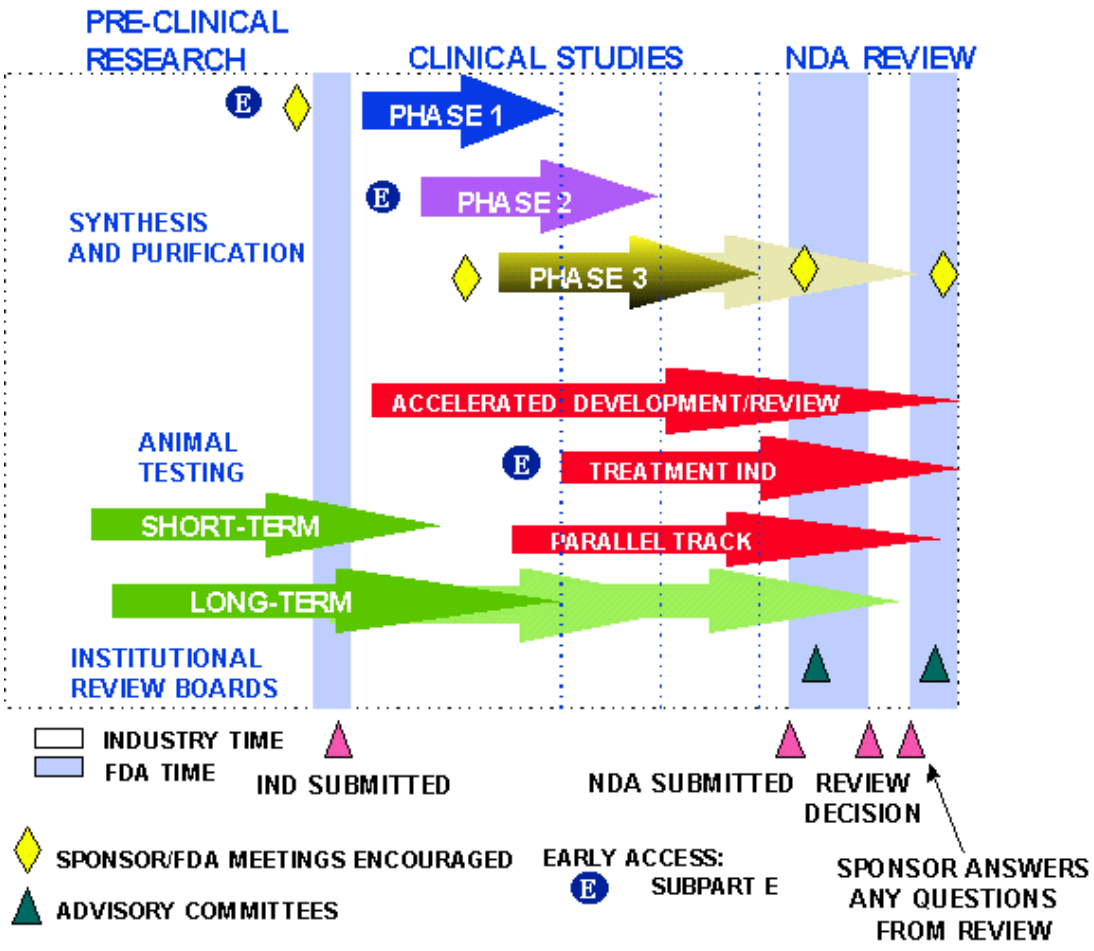

Figure: 2.1 “Steps from Test Tube to New Drug Application Review”

The regulation and control of new drugs in the United States has been based on the New Drug Application (NDA) since 1938. Every new drug has been the subject of an approved NDA before commercialization in the U.S. drug market (fda.gov, 2007). The data gathered during the animal studies and human clinical trials of an Investigational New Drug (IND) become part of the NDA. The objectives of the NDA are to provide sufficient information to permit FDA reviewer to reach the following key decisions:

(a) Whether the drug is safe and effective in its proposed use(s), and whether the benefits of the drug outweigh the risks.

(b) Whether the drug's proposed labeling (package insert) is appropriate, and what it should contain.

(c) Whether the methods used in manufacturing the drug and the controls used to maintain the drug's quality are adequate to preserve the drug's identity, strength, quality, and purity.

The required documentation for an NDA is designed in such a way that is supposed to provide the drug's whole story, including what happened during the clinical tests, what are the ingredients of the drug, what are the results of the animal studies, how the drug behaves in the body, and how it is manufactured, processed and packaged. The following steps provide summaries on NDA content, format, and classification, and the NDA review process:

(i) The evaluation of Benefit vs. Risk i.e., How CDER Approves New Drugs is based on U.S. drug laws.

(ii) CDER assures that safe and effective drugs are available to the American people according to The New Drug Development section of the CDER Handbook.

(iii) New Drug Application (NDA) Review Process (self-explanatory) Chart (fda.gov, 2007) provides a general overview of CDER's new drug application review process, including how CDER determines the benefit/risk profile of a drug product prior to approval for marketing:

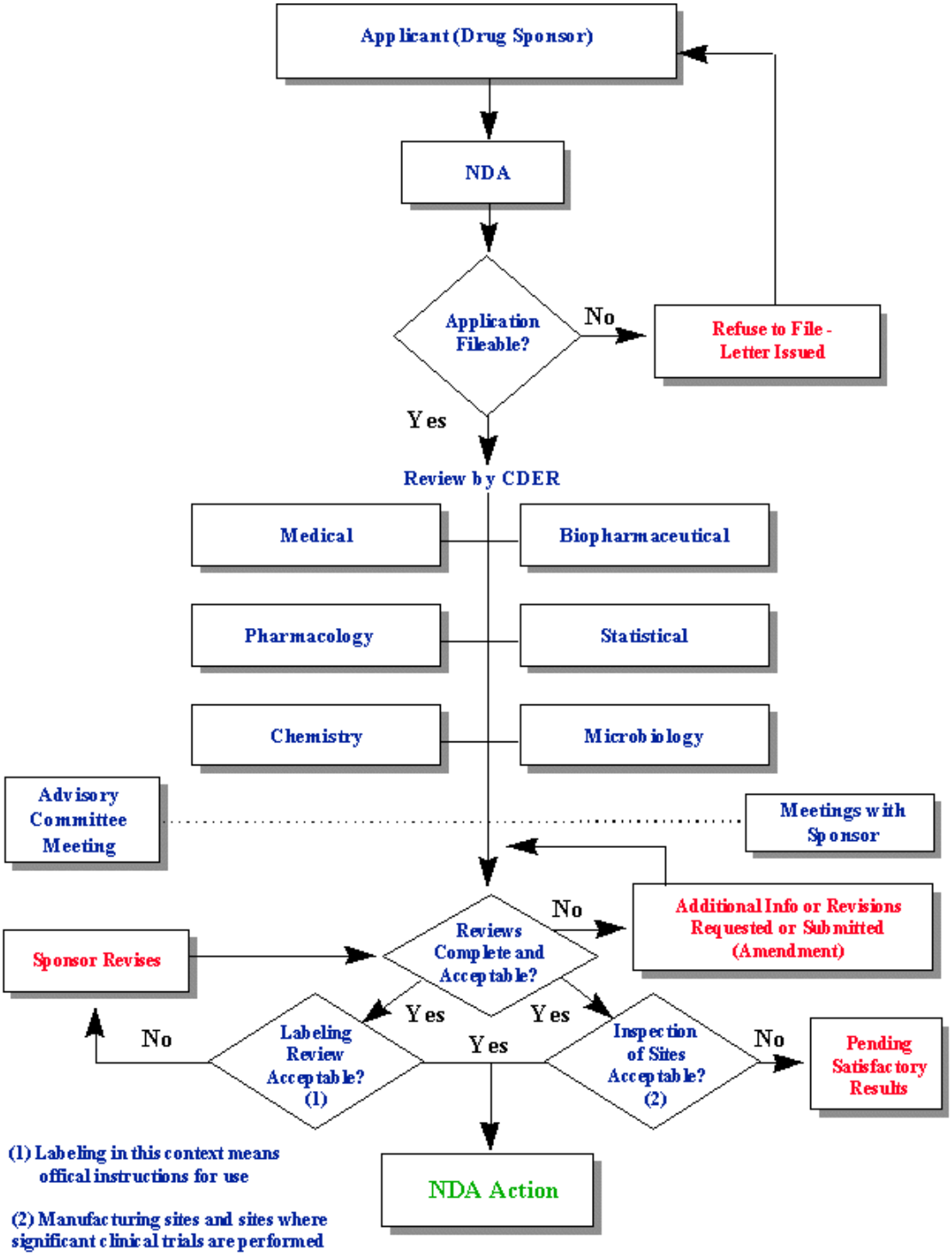

Figure 2.2: "New Drug Application (NDA) Review Process Chart"

2.2 Issues in Event study

An event study measures the impact of a specific event on the value of a firm using the data of financial market. Numerous disciplines such as Accounting, Marketing, Finance, Financial Economics and Regulatory Economics etc. have been using the event study methodology to evaluate the impact of any event on firm's stock prices and return. One of the main reasons behind the usefulness of the outcome of the event study is the effects of an event are presumed to be reflected immediately in security prices given the rationality in the marketplace (MacKinlay, 1997). So, a measure of the economic impact of an event can be constructed using the stock prices observed over a relatively short period comparing to the requirement of many months' observations to evaluate a direct productivity related measures (MacKinlay, 1997).

MacKinlay (1997, pp: 13) mentioned that the very first usage of the event study methodology could be traced back in the published study on the issue of "common stock split-ups" conducted by James Dolley in 1933. The next milestone of the event study is the published article of the research on "the adjustment of stock prices to new information" by Eugene Fama et al. (1969). The methodological framework for the event study used by Fama et al. (1969) has still been used today by the researchers of different disciplines (MacKinlay, 1997).

Chaney et al. (1991, pp: 580) put the logic behind the event study methodology is "a natural outgrowth of the rational expectations/efficient markets tradition in the financial economics". The Efficient Market Hypothesis (EMH) has been at the heart of the theoretical background when researchers conducted the empirical studies to see how

the financial market responded efficiently (and quickly) in valuing publicly traded firms. This change in valuation of firm happens through the changes in stock price which is a reflection of changes in all publicly available information (Sharma & Lacey, 2004, pp: 299). A change in security prices is regarded as an unbiased reflection of changes in the expected future cash flows of the firm, because the securities prices reflect all available information about the firm and also any new information received by the market is supposed to be incorporated instantaneously into the stock price in an efficient market. So, the event study methodology allows the researchers to investigate the price behavior of the firm's stock price around the time when a new information is received in the market about an event that affects the firm's cash flow and that, essentially and explicitly, is a test of the underlying change in the unbiased market forecast of the firm's future income (Chaney et al., 1991, pp: 581).

2.2.1 A Model of a typical Event Study

With the backdrop of notions of the event study methodology there might be three categories of events for a firm or industry and those could be either good news (positive impact) or a bad news (negative impact) or no news (zero or no impact). An event study, typically, tries to examine return behavior for firms/industries experiencing common type of events such as stock-split or public announcements of approval of any new product those could be marketed by the sponsoring firms only after the approval. These events might take place at different points in calendar time or they might be clustered at a particular date or in a particular month such as regulatory events affecting an industry or a subset of the population of firms (Khotari & Warner, 2006).

For a typical model (Khotari & Warner, 2006, pp: 09) of an event study, t = 0 represent the time of the event and, e.g., for each sample security ' i', the return on the security for time period ' t' relative to the event, R_{it}, is:

$$R_{it} = K_{it} + e_{it}$$

Where K_{it} is the "normal" (i.e., expected or predicted return given a particular model of expected returns), and $e_{it,}$ is the component of returns which is abnormal or unexpected. So, given this decomposition of returns, the abnormal return, $e_{it,}$ is the difference between the observed return and the predicted return:

$$e_{it} = R_{it} - K_{it}$$

Which implies the $e_{it,}$ is the difference between the return conditional on the event and the expected return unconditional on the event. So, the abnormal return is a direct measure of the unexpected change in security-holder's wealth associated with the event. Typically, the security is a common stock unless it is defined otherwise by researchers. Before an abnormal return is defined, a model of normal returns, i.e., expected returns unconditional on the event but conditional on other information, must be specified (Khotari & Warner, 2006, pp: 10). A variety of expected return models have been used in the event studies and the common forms of expected return models are (a) Mean-Adjusted Returns Model, (b) Market-adjusted Return Model and (c) Market Model (Dyckman et al., 1984, pp: 04):

(a) The Mean-Adjusted Returns Model: This model doesn't account for market-wide factors and risk explicitly. The predicted return for a security is equal to a constant which is estimated by averaging a series of past returns.

(b) The Market-Adjusted Return Model: In this model the expected firm return is equal to the market return for that period. The expected returns are constant across the securities but not across time.

(c) The Market Model: The market model assumes a stable linear relation between the market return and the security return. In the market model, the expected firm return is a linear function of the market return using an OLS beta (Dyckman et al., 1984).

The abilities of these three models to detect accurately the existence of abnormal performance are similar although there are some preferences for the Market Model are found in the literature (Dyckman et al., 1984, pp: 29).

2.3 New Product (drug) and overall-firm-performances

One of the studies on the issue of announcements of new products and the impact on market valuation of sponsoring firms was conducted by Eddy and Saunders (1980) using the announcements of new products in the market for 66 firms during the period 1961 to 1969. Eddy and Saunders (1980) used the Funk and Scott Index to identify the announcement dates of new product and ISL Daily Stock Price Index to collect the information on stock price, dividend and market data. The "Market Model" was used to capture the return-generating process for common stocks. For each of the 66 firms in their sample, the least-squares regression parameters were estimated using

returns twenty months before and after the announcement date. Eddy and Saunders (1980) did not find *any effect* of new product announcements on stock returns either prior to or after the dates of the announcement, i.e., no significant abnormal returns in the stock market around the dates of announcement of a new product in the market. Eddy and Saunders (1980) reported that the t-tests to both the average residuals and cumulative average residuals showed no statistically significant ($p = .05$) deviations from zero. According to the researchers, these findings are same for the total number of observations and for different sub-sets of the observations as well. Eddy and Saunders (1980) reported that the market model was a good fit but doubted that the "effects were obscured by noise in the error term". Despite their findings that the investors are not responsive to individual new product announcements, Eddy and Saunders (1980) argued that investors do consider a firm's overall new product policy in general valuation process and "this is consistent with what one would expect in an efficiently functioning marketplace" (Eddy and Saunders, 1980, pp. 96).

Later in 1990, Woolridge and Snow investigated the linkage between the inception of new products and stock market reaction as a part of their research on much broader issue, which is *Stock Market Reaction to Strategic Investment Decisions*. Woolridge and Snow (1990) used 767 announcements made by 248 companies in 102 industries. Using "Market-Adjusted Returns Approach" (MARA) of Event Study methodology, Woolridge and Snow (1990) found the evidence of positive reaction of stock market to the news of product and/ or market diversification. But the cumulative abnormal returns declined between days 0 and 10. The cumulative abnormal return

disappeared completely when observed during – 1 day to + 10 day window (Woolridge & Snow 1990 and Sharma & Lacey, 2004, pp 299). Woolridge and Snow (1990) argued that the lack of a statistically significant effect is a reflection of efficient market because the no significant price reaction may indicate that "investors anticipated such moves and stock price already reflected this information" (Woolridge & Snow 1990, pp: 359). The lack of significant cumulative abnormal returns could also imply that the new information was simply ignored in the financial markets. Perhaps the stakeholders in the financial market did not see any value in the announcement of new product and /or market diversification (Sharma & Lacey, 2004, pp: 299).

In another study, on impact of new product introductions on the market value of firms, Chaney, Devinney and Winer (1991) mentioned that the usage of monthly returns in Eddy and Saunders' (1980) study was a serious limitation because those were "not precise enough to reflect the impact of new products on security prices" (Chaney, et al., 1991, pp: 582). In this study also the well-tested Event-Study was adopted as methodology. The announcement of introduction of new products introduced during 1975 to 1984 by 231 firms listed in either the American Stock Exchange (AMEX) or the New York Stock Exchange (NYSE) had been used in this study. The stock returns were collected from the database of the Center for Research in securities Prices (CRSP) at the University of Chicago. The announcement dates of new products were collected from the Wall Street Journal Index for the years 1975 to 1984. Chaney, et al., (1991) found an aggregate impact of the announcement of a new product was approximately 0.75 % over 3-day period. Chaney, et al, (1991, pp: 607) emphasized that this estimate

does not reflect the total value of the product to the firm but a kind of a measure of the formation of a consensus of the value of product to the firm. Authors mentioned that possibility of information leakage about the new product may cause the smaller effects in the stock market instead of an anticipated larger effect out of the announcement of a new product introduced in the market (Chaney et al., 1991, pp: 593).

In one of the latest study in similar area of research, Sharma and Lacey (2004) argued that in all of these three studies, mentioned earlier, researchers "had difficulty cleanly isolating the effects" in the stock market due to the announcements of introduction of new product (Sharma & Lacey, 2004, pp: 299). Authors explored the linkage between the development of new product and the changes of the market valuation of the firms (pharmaceutical companies). As a part of their exploration they found the clear existence of the abnormal returns during a specific period of time around the date of public announcement of the approval of new drug by FDA. This public announcement of the approval of new drug is a positive event for that company in the stock market. Their findings were consistent with the findings of some of the previous studies on the issue of linkage between innovation and the overall performance of the firm (e.g., Geroski et al., 1993; Roberts, 1999). Sharma and Lacey (2004) investigated the effects of both positive and the negative events on the level of profit of the firms. Negative events are the denial of the application of new drug by FDA. FDA doesn't publish publicly the denials of the applications for the new drugs. But as a requirement of the regulations of Securities and Exchange Commission (SEC) companies are obliged to inform the shareholders any information which may have

positive or negative effects on the market value of the share of that company. Sharma and Lacey (2004) collected the data on the denial of the applications of new drugs from the Lexis/Nexis database.

Sharma and Lacey (2004), like the previous researchers, conducted the event study analysis using 344 new drug approvals (NDAs) and 41 outright rejections of new drug applications by FDA. Three hypotheses had been tested by Sharma and Lacey (2004): (a) Stock market responses efficiently to the public announcements through the stock price of the sponsoring firms. (b) Positive events bring the rewards and negative events bring the penalties to the firms and (c) Financial losses are greater in magnitude in case of the negative events comparing to the gains in case of the positive events. Sharma and Lacey (2004) found statistically significant results which show that the capital market responded efficiently (as expected) after the public announcement of a new product development and approval for marketing. The implications of their empirical results showed the "successes are rewarded by increase in firm value and failures are punished by sharp drop in the value of the firm" (Sharma & Lacey, 2004, pp: 305).

One of the sources of inspiration behind the present study is the mixed outcomes of analysis of event studies in the context of public announcement of the *events* for publicly traded companies. In the present study, the negative events (ie, denials of NDAs by FDA) are excluded because of the limitations of the time and resources.

CHAPTER 3

METHODOLOGY

In this study the Event-Study analysis will be the methodology to identify the abnormal return and its extent during a specific period of time for the firms of pharmaceutical products who got the approval of New Drugs by FDA.

The public announcement of an official approval of a New Drug has been considered as an Event in the stock market. Different windows of event will be considered e.g.: three-day, five-day windows for the event. For example the three-day window is formulated as the day of the event and the day before and the day after the event. Dummy variable will be created for this three / five day window of event. Different duration of the window of the event dates will provide the information on any kind of leakage of public announcement prior to the actual announcement and it will also help get the information about the length of sustenance of the abnormal return and its complete disappearances. The sample size for the regression will be ninety days prior and after the event. This period will be extended to the three hundred days for an alternate scenario of estimation of the coefficients. Firms' return will be regressed on dummy variable of the event-window and on the value-weighted returns (market returns). Constant term is included in the regression. Multiple events (multiple approvals of New Drugs) of a single firm and the events across the firms will be included in the regression over the sample period.

3.1 Model Specifications

Measuring the impact of the *event* on firm's financial performance requires the computation of the abnormal return:

$$AR_{i\tau} = R_{i\tau} - E(R_{i\tau} \mid X_{\tau})$$

$AR_{i\tau}$, $R_{i\tau}$, and $E(R_{i\tau} \mid X_{\tau})$ are the abnormal, actual and normal returns respectively for the time τ. X_{τ} is the conditioning information for the normal return model. The constant mean return model and the market model are the two common choices for modeling the normal return. The market model assumes a stable linear relation between the market return and the security return (MacKinlay, 1997). In the present study the market model will be used.

Basic model of regression for the analysis of the event date studies in the present study is as follows:

$$RET_{it} = \alpha + \beta_1 D_i + \beta_2 VWR_{it} + \varepsilon_{it}$$

Where RET_{it} is the (holding period) Return, D_i is the dummy variable for the event-date-window and the VWR is the Value Weighted Return (market return). α and the ε_{it} are the constant and the error terms of the regression model respectively.

D_i = 1 for the window of the event-dates and otherwise equals zero. So, the statistical significance of β_1 will reveal the impact of the *event* on the return of the firm through the changes in the stock price and therefore the (holding period) return.

Followings are the modified version of the model (2SLS) which may rule out the possibility of any kind of undue effect of the *event* on the estimate of coefficient of value weighted return (market return):

$$RET_{it} = \alpha + \beta\, VWR_{it} + \varepsilon_{it}$$

To generate the $\hat{\beta}$ for the sample $\tilde{t} - 310$ to $\tilde{t} - 11$ where the $\tilde{t} = 0$ is the event-date. This selection of 300-day prior to the 11 days of event-date is used to get a beta estimate for the value weighted return (market return) which may not be affected by the *event*. This beta coefficient estimate will be used in calculation of the series of abnormal returns.

To calculate the abnormal return:

$$AR_{it} = RET_{it} - \hat{\beta} VWR_{it}$$

Now the estimation of the coefficient for the event-date window will be done by regressing the abnormal return on the constant term and the dummy variable for the event-date:

$$AR_{it} = \alpha_0 + \gamma D_i + \varepsilon_{it}$$

For the sample $\tilde{t} - 11$ to $\tilde{t} + 11$ where the $\tilde{t} = 0$ is the event-date (announcement of the NDAs by FDA).

In both the models, the regressions have been done for the pooled data of 11 firms ranging January 1982 to December 2005 and for the individual firm to get the firm specific Beta coefficients.

In addition to the estimation of the coefficients of the abnormal return, the coefficients of cumulative abnormal returns (CAR) have been estimated with different combinations of windows of the event-dates in both the single stage and 2SLS models. The coefficient estimate of the cumulative abnormal return may capture the information leakage about the NDAs before the event-date and it also may take into account of the information that how long the effect of the *event* sustained in the stock market.

The hypothesis of this event study i.e., the presence of non-zero abnormal return could be tested against the null hypothesis $H_0 : \gamma = 0$, where the alternative hypothesis is $H_1 : \gamma \neq 0$.

CHAPTER 4

DATA AND ITS SOURCES

The type of data is secondary panel data. Announcements of New Drug Approvals (NDAs) are ranged from January 1982 to December 2005 for the top eleven pharmaceutical companies (based on annual sales revenue and the R&D expenditures in 2005).

Table 4.1 Annual sales revenue and the R&D Expenditures in 2005

Company		Sales ($B)	% Change (2004)	R&D ($B)
1	Abbott Laboratories	13.99	16	1.82
2	AstraZeneca	23.95	12	5.36
3	Bristol-Myers Squibb	15.25	-1	2.75
4	GlaxoSmithKline	33.96	8	5.71
5	Lilly Eli	14.65	12	3.03
6	Merck	22.01	2	3.85
7	Novartis	24.96	16	4.48
8	Pfizer	44.28	-4	7.44
9	Sanofi-Aventis	32.34	-5	4.79
10	Schering-Plough	7.56	18	1.87
11	Wyeth	15.32	10	1.26

Source: http://www.pharmexec.com, 7th Annual Report, 2006.

Two major sources of data are Food and Drug Administration (FDA) and the Center for Research in Security Prices (CRSP)/COMPUSTAT databases. Some Data have been collected from different websites e.g. Pharmaceutical Executives, May 2006 (IMS Health data).

4.1 FDA data

The Event-dates which are the official dates of announcement of New Drug Approvals (NDAs) have been collected through a process of filtering from multiple databases of FDA websites. There are different ways of collection of data on NDAs from FDA databases. After examining all possible ways, the "Drugs@FDA" data files have been used to collect the dates of the NDAs. The "Drugs@FDA" is a zip folder which contains seven CSV files of all kinds of drug approvals which, in addition to NDAs, include Abbreviated New Drug approvals (ANDAs) and Biologic License Application (BLAs). After filtering the "Drugs@FDA" for the selected eleven firms, 526 NDAs were found for the time span mentioned above. There are some drugs which has multiple approvals for its different forms and dosages. In these cases there were multiple approvals of the same drug at a single date. Some of the drugs have the supplementary approvals which has no effect in the stock market. These supplementary approvals of the drugs were neither positive nor negative events in the stock market for the sponsoring company. So, the original dates of approval for drugs have been filtered using the detail information of the history of the drug approval for each drug.

Finally, these NDAs dates have been matched and merged with the CRSP data on the stock market for the mentioned eleven sponsoring firms which produced 400 exclusive event-dates (i.e., the announcements of the approval of New Drug Applications by the FDA) for this study.

4.2 CRSP Data

CRSP maintains the most comprehensive collection of security price, return, and volume data for the NYSE, AMEX and NASDAQ stock markets. The CRSP daily stock database have been used to collect the data on (holding period) Return, Value Weighted Return (market return), daily stock prices. CRSP data is available till Dec 2005 for the pharmaceutical industries:

Table 4.2 Companies, Data Range and Events

Permno	Company	Data Range	Events
20482	Abbott Laboratories	01/04/1982 --- 12/30/2005	45
79363	AstraZeneca	06/07/1993 --- 12/30/2005	21
19393	Bristol-Myers Squibb	01/04/1982 --- 12/30/2005	45
75064	GlaxoSmithKline	01/04/1982 --- 12/30/2005	104
50876	Lilly Eli	01/04/1982 --- 12/30/2005	27
22752	Merck	01/04/1982 --- 12/30/2005	43
88233	Novartis	05/11/2000 --- 12/30/2005	18
21936	Pfizer	01/04/1982 --- 12/30/2005	48
89475	Sanofi-Aventis	07/01/2002 --- 12/30/2005	8
25013	Schering-Plough	01/04/1982 --- 12/30/2005	18
15667	Wyeth	01/04/1982 --- 12/30/2005	23
			400

Source: CRSP database of daily stock and securities.

PERMNO is the permanent identification number for each company in the CRSP database. This is used to identify the companies since permanent number of the company is the only unique identifying code according to the CRSP database. The other identifier such as CUSIP or NCUSIP etc. may not return the information about the intended company in all the cases.

CHAPTER 5

EMPIRICAL RESULTS AND THE ANALYSIS

According to the methodology described in the chapter 3, two models have been used to run the regressions to conduct this event study. In case of the simple OLS the Holding Period Return (RET) is regressed on the market return (VWR), dummy variable of the event day and on the dummy variables for the previous 5 days and for the forward 5 days both for the pooled data of eleven firms for the ninety day before and after the event date and similarly for the OLS by individual pharmaceutical companies. Constant term was included in all the regressions. In case of the OLS on the pooled data the coefficient estimate for the dummy of the next day of the event became significant at 5 % level (Table 5.1). Which implies that the abnormal return on the next day of the announcement of the NDAs is significantly different from zero ie, positive abnormal return exists on the next day of the public announcement of the new drug e approval. So, for the next day of the event the null hypothesis could be rejected i.e., $H_0 : \gamma = 0$ and alternate hypothesis can be accepted i.e., $H_1 : \gamma \neq 0$ since the abnormal return is positive**.** The coefficients estimates of the other days ie, five days prior to and five days forward to the event dates are not significantly different from zero.

In case of the OLS by individual firms only Novartis showed the existence of the abnormal return on the event day at the 1 % level of significance (Table 5.1). In case of Glaxo, next day of the event day shows the significant abnormal return at 10% level.

Most of the other firms did not show the existence of the positive abnormal return on either event day or prior or after (Table 5.1).

Table 5.1 NDAs and Performances of the Pharmaceutical Companies

	Pooled	Pfizer	Merck	Lilly	Wyeth	Bristol
Market Return	0.799*	0.890*	0.849*	0.894*	0.655*	0.809*
	(0.009)	(0.025)	(0.021)	(0.030)	(0.036)	(0.026)
Day-5	0.000	-0.001	0.002	0.008**	0.002	0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day-4	0.000	0.004***	0.000	-0.004	-0.005	0.002
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day-3	0.000	0.005**	0.001	0.000	0.004	0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day-2	0.001	-0.001	0.000	-0.002	0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day-1	-0.001	0.001	0.001	0.004	0.000	-0.000
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Event Day	-0.000	0.000	0.003	-0.001	-0.003	-0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day+1	0.002**	0.001	0.001	-0.001	0.005	-0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day+2	0.000	0.002	-0.002	0.004	0.001	-0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day+3	-0.000	0.004	-0.003	-0.000	0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day+4	0.000	-0.003	0.000	-0.002	0.003	0.000
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)
Day+5	0.000	-0.001	0.002	0.002	-0.002	0.002
	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)
Constant	0.000*	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	35049	4427	4465	2963	2867	4069
R-squared	0.194	0.225	0.274	0.228	0.109	0.194
Events	400	48	43	27	23	45
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

Table 5.1 - Continued

	Glaxo	Novartis	Astrazeni	Abbott	Sanofi	Schering
Market Return	0.876* (0.024)	0.417* (0.032)	0.502* (0.033)	0.829* (0.024)	0.986* (0.056)	0.834* (0.039)
Day-5	-0.001 (0.002)	0.001 (0.003)	0.001 (0.004)	0.001 (0.002)	-0.001 (0.005)	-0.010** (0.004)
Day-4	0.000 (0.002)	0.001 (0.003)	-0.001 (0.004)	-0.002 (0.002)	-0.000 (0.005)	0.003 (0.004)
Day-3	-0.001 (0.002)	-0.003 (0.003)	0.005 (0.004)	-0.001 (0.002)	0.002 (0.005)	-0.010** (0.004)
Day-2	0.002 (0.002)	0.006*** (0.003)	0.003 (0.004)	0.001 (0.002)	-0.002 (0.005)	0.001 (0.004)
Day-1	-0.004** (0.002)	0.002 (0.003)	0.002 (0.004)	-0.002 (0.002)	-0.006 (0.006)	-0.001 (0.004)
Event Day	-0.002 (0.002)	0.012* (0.003)	-0.002 (0.004)	-0.003 (0.002)	0.009 (0.006)	0.006 (0.004)
Day+1	0.003*** (0.002)	0.004 (0.003)	-0.000 (0.004)	0.003 (0.002)	-0.003 (0.006)	0.006 (0.004)
Day+2	0.002 (0.002)	0.006*** (0.003)	-0.000 (0.004)	-0.004 (0.002)	-0.006 (0.006)	0.003 (0.004)
Day+3	-0.001 (0.002)	-0.005 (0.003)	0.005 (0.004)	-0.001 (0.002)	-0.003 (0.006)	-0.001 (0.004)
Day+4	-0.001 (0.002)	0.003 (0.003)	0.002 (0.004)	0.002 (0.002)	-0.001 (0.006)	0.007*** (0.004)
Day+5	-0.002 (0.002)	-0.002 (0.003)	0.005 (0.004)	0.002 (0.002)	-0.001 (0.006)	0.007*** (0.004)
Constant	0.001** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000*** (0.000)	0.000 (0.001)	0.000 (0.000)
Observations	5287	1170	2319	4601	831	2050
R-squared	0.203	0.146	0.096	0.214	0.280	0.190
Events	104	18	21	45	8	18
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

In case of the cumulative abnormal return (CAR) also, the pharmaceutical company Novartis showed the existence of positive abnormal return for different combinations of the windows around the event date (output attached). The

pharmaceutical company Schering Plough and Glaxo showed existence of the abnormal returns for couple of combinations of windows around the event day (Table 5.2).

Table 5.2 NDAs and Performances of the Pharmaceutical Companies (CAR)

	Pooled	Pfizer	Merck	Lilly	Wyeth	Bristol
3-Day Window (t-1, t+1)	0.001 (0.001)	0.002 (0.004)	0.005 (0.004)	0.001 (0.006)	0.002 (0.006)	- 0.002 (0.004)
3-Day Window (t, t+2)	0.002 (0.001)	0.003 (0.004)	0.002 (0.004)	0.002 (0.006)	0.003 (0.006)	- 0.003 (0.004)
3-Day Window (t+1, t+3)	0.002 (0.001)	0.007 (0.004)	- 0.004 (0.004)	0.003 (0.006)	0.007 (0.007)	- 0.001 (0.004)
6-Day Window (t, t+5)	0.002 (0.002)	0.003 (0.005)	0.001 (0.005)	0.002 (0.008)	0.004 (0.009)	- 0.000 (0.006)
2-Day Window (t, t+1)	0.002 (0.001)	0.001 (0.003)	0.005 (0.003)	- 0.002 (0.005)	0.001 (0.005)	- 0.002 (0.003)
2-Day Window (t-1, t)	- 0.001 (0.001)	0.001 (0.003)	0.004 (0.003)	0.002 (0.005)	- 0.003 (0.005)	- 0.001 (0.003)
3-Day Window (t-2, t)	0.000 (0.001)	0.000 (0.004)	0.004 (0.004)	- 0.000 (0.006)	- 0.002 (0.006)	- 0.000 (0.004)
6-Day Window (t-5, t)	0.001 (0.002)	0.009 (0.004)	0.008 (0.005)	0.004 (0.008)	- 0.001 (0.008)	0.003 (0.005)
Events	400	48	43	27	23	45
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

Table 5.2 - Continued

	Glaxo	Novartis	Astrazeni	Abbott	Sanofi	Schering
3-Day Window (t-1,t+1)	- 0.003 (0.003)	0.018** (0.005)	- 0.001 (0.006)	- 0.002 (0.004)	0.001 (0.010)	0.011*** (0.007)
3-Day Window (t, t+2)	0.004 (0.003)	0.022* (0.005)	- 0.003 (0.006)	- 0.004 (0.004)	0.001 (0.010)	0.015** (0.007)
3-Day Window (t+1,t+3)	0.004 (0.003)	0.004 (0.005)	0.004 (0.006)	- 0.001 (0.004)	- 0.011 (0.010)	0.008 (0.007)
6-Day Window (t, t+5)	- 0.000 (0.004)	0.017** (0.008)	0.009 (0.009)	- 0.000 (0.005)	- 0.003 (0.014)	0.029* (0.009)
2-Day Window (t, t+1)	0.001 (0.002)	0.016* (0.004)	- 0.003 (0.005)	- 0.000 (0.003)	0.007 (0.008)	0.012** (0.006)
2-Day Window (t-1, t)	- 0.006 (0.002)	0.014* (0.004)	- 0.000 (0.005)	- 0.005 (0.003)	0.003 (0.008)	0.005 (0.006)
3-Day Window (t-2, t)	- 0.004 (0.003)	0.020* (0.005)	0.003 (0.006)	- 0.004 (0.004)	0.002 (0.010)	0.006 (0.007)
6-Day Window (t-5, t)	- 0.006 (0.004)	0.018** (0.008)	0.008 (0.009)	- 0.005 (0.005)	0.002 (0.011)	-0.010 (0.009)
Events	104	18	21	45	8	18
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

The two stage least square regressions showed the similar types of positive abnormal returns on the next day of the event at 5 % level of significance in case of the pooled data (Table 5.3). Novartis showed the existence of the positive abnormal return on the event day at 1 % level of significance and Glaxo showed the evidence of positive abnormal return on the next day of the event at 5% level of significance. Pharmaceutical company Abbott showed the existence of the positive abnormal return on the next day of event at 1 % level of significance (Table 5.3).

Table 5.3 NDAs and Performances of the Pharmaceutical Companies (2SLS)

	Pooled	Pfizer	Merck	Lilly	Wyeth	Bristol
Day-5	-0.001 (0.002)	-0.008 (0.006)	0.001 (0.005)	0.006 (0.007)	-0.011 (0.009)	0.006 (0.006)
Day-4	-0.002 (0.002)	0.009 (0.006)	-0.000 (0.006)	-0.005 (0.007)	-0.017*** (0.009)	0.008 (0.007)
Day-3	-0.002 (0.002)	-0.001 (0.006)	0.004 (0.006)	-0.004 (0.008)	-0.010 (0.009)	-0.005 (0.007)
Day-2	0.002 (0.002)	-0.004 (0.006)	-0.001 (0.006)	-0.017** (0.008)	0.001 (0.009)	-0.003 (0.007)
Day-1	-0.001 (0.002)	0.006 (0.007)	0.002 (0.006)	-0.006 (0.008)	0.012 (0.009)	-0.006 (0.007)
Event Day	-0.001 (0.002)	0.004 (0.007)	-0.002 (0.006)	-0.008 (0.008)	0.003 (0.009)	-0.010 (0.007)
Day+1	0.005** (0.002)	-0.004 (0.008)	0.000 (0.005)	-0.004 (0.008)	0.014 (0.009)	-0.004 (0.007)
Day+2	0.000 (0.002)	0.001 (0.008)	-0.003 (0.005)	-0.001 (0.008)	0.006 (0.012)	-0.004 (0.007)
Day+3	-0.003 (0.002)	-0.003 (0.009)	-0.008 (0.005)	0.004 (0.007)	-0.008 (0.012)	-0.005 (0.008)
Day+4	0.004*** (0.002)	-0.010 (0.011)	0.005 (0.005)	0.008 (0.007)	-0.004 (0.012)	0.011 (0.011)
Day+5	0.003 (0.002)	-0.002 (0.011)	0.014** (0.006)	0.009 (0.008)	-0.011 (0.016)	0.001 (0.010)
Constant	0.001* (0.000)	-0.000 (0.001)	0.000 (0.000)	0.000 (0.001)	0.001 (0.001)	0.001*** (0.001)
Obs.	7696	992	845	563	459	893
R-squared	0.002	0.006	0.012	0.022	0.024	0.008
Events	400	48	43	27	23	45
Standard errors in parentheses *** significant at 10%; ** significant at 5%; * significant at 1%						

Table 5.3 – continued

	Glaxo	Novartis	Astrazeni	Abbott	Sanofi	Schering
Day-5	-0.003	0.010***	-0.001	-0.002	-0.019	-0.019
	(0.003)	(0.006)	(0.011)	(0.008)	(0.013)	(0.012)
Day-4	-0.002	0.005	-0.006	-0.017**	-0.014	-0.014
	(0.003)	(0.006)	(0.009)	(0.008)	(0.013)	(0.012)
Day-3	-0.004	-0.002	0.003	0.001	0.005	0.006
	(0.003)	(0.006)	(0.009)	(0.008)	(0.013)	(0.012)
Day-2	0.001	0.018*	0.013	0.006	-0.015	-0.016
	(0.003)	(0.005)	(0.009)	(0.008)	(0.013)	(0.012)
Day-1	-0.005	0.002	-0.001	-0.008	-0.007	-0.008
	(0.003)	(0.005)	(0.009)	(0.008)	(0.013)	(0.012)
Event Day	-0.003	0.017*	-0.011	0.012	0.019	0.019
	(0.003)	(0.005)	(0.009)	(0.009)	(0.013)	(0.012)
Day+1	0.008**	0.004	-0.015***	0.041*	0.015	0.016
	(0.003)	(0.005)	(0.009)	(0.009)	(0.018)	(0.018)
Day+2	0.003	0.009***	-0.007	0.003	-0.005	-0.007
	(0.004)	(0.005)	(0.009)	(0.009)	(0.018)	(0.018)
Day+3	0.000	-0.007	0.001	-0.003	0.002	0.002
	(0.004)	(0.005)	(0.011)	(0.008)	(0.018)	(0.018)
Day+4	0.003	0.000	0.006	0.013	0.021	0.021
	(0.004)	(0.005)	(0.011)	(0.011)	(0.018)	(0.018)
Day+5	-0.003	0.003	0.010	0.009	-0.003	-0.002
	(0.004)	(0.005)	(0.011)	(0.011)	(0.018)	(0.018)
Constant	0.001**	0.001	0.001	0.001	0.001	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Obs.	1783	346	409	907	151	151
R-squared	0.007	0.082	0.022	0.033	0.066	0.071
Events	104	18	21	45	8	18
Standard errors in parentheses *** significant at 10%; ** significant at 5%; * significant at 1%						

Similarly in case of the cumulative abnormal return, the two stage least squares results showed the similar type of existence of the positive abnormal return for different

combinations of the windows around the event day for the pharmaceutical companies Novartis, Abbott, Glaxo (Table 5.4).

Table 5.4 NDAs and Performances of the Pharmaceutical Companies (CAR, 2SLS)

	Pooled	Pfizer	Merck	Lilly	Wyeth	Bristol
3-Day Window (t-1, t+1)	0.003 (0.003)	0.006 (0.013)	- 0.001 (0.009)	- 0.018 (0.013)	0.030*** (0.017)	- 0.020 (0.012)
3-Day Window (t, t+2)	0.005 (0.004)	0.000 (0.013)	- 0.005 (0.009)	- 0.013 (0.013)	0.024 (0.018)	- 0.018 (0.012)
3-Day Window (t+1, t+3)	0.002 (0.004)	- 0.006 (0.015)	- 0.011 (0.008)	- 0.001 (0.012)	0.012 (0.019)	- 0.013 (0.013)
6-Day Window (t, t+5)	0.008 (0.005)	- 0.014 (0.023)	0.006 (0.012)	0.008 (0.018)	0.001 (0.030)	- 0.011 (0.021)
2-Day Window (t, t+1)	0.004 (0.003)	- 0.000 (0.011)	- 0.002 (0.007)	- 0.012 (0.011)	0.018 (0.013)	- 0.014 (0.010)
2-Day Window (t-1, t)	- 0.002 (0.003)	0.010 (0.010)	- 0.001 (0.007)	- 0.014 (0.011)	0.016 (0.013)	- 0.016 (0.010)
3-Day Window (t-2, t)	-0.000 (0.003)	0.007 (0.012)	- 0.002 (0.009)	- 0.031** (0.013)	0.017 (0.017)	- 0.018 (0.013)
6-Day Window (t-5, t)	- 0.005 (0.005)	0.006 (0.016)	0.003 (0.012)	- 0.034*** (0.018)	- 0.020 (0.024)	- 0.010 (0.017)
Events	400	48	43	27	23	45
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

Table 5.4 - Continued

	Glaxo	Novartis	Astrazeni	Abbott	Sanofi	Schering
3-Day Window (t-1, t+1)	0.000 (0.006)	0.022** (0.009)	- 0.027 (0.016)	0.045* (0.015)	0.028 (0.025)	0.027 (0.025)
3-Day Window (t, t+2)	0.007 (0.006)	0.030* (0.009)	- 0.033** (0.016)	0.056* (0.016)	0.029 (0.028)	0.028 (0.028)
3-Day Window (t+1, t+3)	0.011 (0.006)	0.006 (0.009)	- 0.021 (0.017)	0.041* (0.015)	0.012 (0.031)	0.011 (0.030)
6-Day Window (t, t+5)	0.008 (0.008)	0.025*** (0.013)	- 0.016 (0.025)	0.075* (0.024)	0.048 (0.042)	0.049 (0.042)
2-Day Window (t, t+1)	0.005 (0.005)	0.021* (0.007)	- 0.026*** (0.013)	0.053* (0.013)	0.034 (0.022)	0.035 (0.021)
2-Day Window (t-1, t)	- 0.008 (0.005)	0.018** (0.007)	- 0.011 (0.013)	0.004 (0.012)	0.012 (0.018)	0.011 (0.017)
3-Day Window (t-2, t)	- 0.007 (0.006)	0.036* (0.009)	0.002 (0.016)	0.011 (0.015)	- 0.003 (0.022)	- 0.004 (0.021)
6-Day Window (t-5, t)	- 0.016 (0.008)	0.049* (0.014)	- 0.002 (0.024)	- 0.008 (0.020)	- 0.030 (0.032)	- 0.031 (0.031)
Events	104	18	21	45	8	18
Standard errors in parentheses ***significant at 10%; ** significant at 5%; * significant at 1%						

There are few evidences of negative returns (Table: 5.1, 5.2, 5.3 and 5.4) which are mostly associated with the statistically insignificance ie, not significantly different from zero.

One of the main reasons to observe the significant positive abnormal returns on the next day of the event is, mostly, the announcements of NDAs happens at the later part of the trading day. So, the stock market shows the reaction on the next day of the event (Chaney et al., 1991).

The reasons of absence of the abnormal returns, in most of the cases, because of either the market anticipated the approval for the sponsoring company and adjusted

already in the stock prices or market simply ignored that event (Woolridge, and Snow, 1990, Sharma & Lacey, 2004).

One of the reasons behind the prior knowledge received by the market about any drug's probable approval is that the New Molecular Entity (NME) or the New Chemical Entity (NCE) gets patented, sometimes, long before the actual drug receives approval by FDA which will be marketed for the end-user. This patenting of the NME/NCE of any specific drug may happen during the Investigational New Drug (IND) approval process initiated by the sponsoring pharmaceutical company. So, in these cases, market already had the *indirect* information about the drug to be approved and about its sponsoring pharmaceutical company. If the *Efficient Market Hypothesis (EMH)* is in effect, the market internalizes the available information of these forthcoming drug approvals and the securities and stock market prices of the sponsoring companies become adjusted smoothly before the actual event-date, i.e., the announcement of approval of a specific drug by the FDA.

Another probable reason of zero abnormal return around and on the event day, mainly for the leading pharmaceutical company that there probability of getting approval for the new drug is high enough comparing to the relatively smaller company. So, the smaller company's getting approval creates more abnormal return comparing to the larger company who often enjoys the higher probability of receiving NDA approval form FDA.

One of the reasons of experiencing negative return around the event day is receiving approval for the smaller of diseases than the sponsoring firm originally

applied for. If the negative return is significant around the event day that, almost surely, implies that the sponsoring firm had relatively bigger bad news in the market then the positive / good news of approval e.g. getting a drug recall order from FDA etc. Sometime the drug recall for the bad side-effect of the drug of a substitute drug of other competitor induces suspicions for the substitute drug and thereby stock price of the company who did not receive the drug recall experiences negative return in the stock market.

CHAPTER 6

CONCLUDING REMARKS

The summary of the findings, according to the regression results, of the present research using event study methodology are as follows:

- Existence of statistically significant positive abnormal returns (AR) for the day following the events.
- The cumulative abnormal return (CAR) is statistically insignificant for the estimates of the pooled regressions and for some of the individual pharmaceutical companies.
- No sign of information leakage ahead of the events.
- Some individual pharmaceutical companies show the existence of statistically significant positive abnormal returns (AR) and the cumulative abnormal return (CAR) for event day and the day after (e.g. Novartis, Abbott).

The regression results suggest that the effect of the NDAs are essentially mixed which have the similarities with the findings the previous researchers found in their studies of events for the pharmaceutical and for the other industries as well according to the literature review (chapter 2). The results of this study can not be compared directly (one-to-one) with the results of the previous study conducted by Sharma & Lacey, (2004) because the information of the list of the firms, new drugs (brands and NMEs) is

absent in that report for the proprietary nature of the data as authors mentioned in the article. But obviously the results of some other previous researchers showed the zero or negative (abnormal) return and some of them found the positive abnormal return around the event day like I found in the present study.

In future research on this context, the existence of abnormal returns for the announcement of approval of the blockbuster drugs could be estimated. As the pharmaceutical company Novartis showed the significant positive abnormal return around the event day with only 18 events comparing to the 104 events for Glaxo, the future researchers may try to estimate the abnormal return after NDA for relatively smaller firms who receives the NDA approval infrequently and gets more attention in the stock market.

APPENDIX A

A BRIEF DESCRIPTION OF VARIABLES IN THE CRSP DATABASE

METHODOLOGY AND COMPUTATION OF VARIABLES IN THE CRSP DATABASE

The basic model of regression for the analysis of the event date studies in the present study is as follows:

$$RET_{it} = \alpha + \beta_1 D_i + \beta_2 VWR_{it} + \varepsilon_{it}$$

Where RET_{it} is the (holding period) Return which is the dependent variable of the model used in the present study and the independent variable of this model is VWR which is the Value Weighted Return (market return).

The data on the dependent variable RET_{it} have been collected from the Center for Research in Security Prices (CRSP)/COMPUSTAT databases. The CRSP used the following methodologies to compute the Holding Period Return i.e., the CRSP's name of the variable is RET in their database. This RET is the holding period return in the securities' market which is the dependent variable RET_{it} the present study:

Holding Period Return or RET[1]: A return is the change in the total value of an investment in a common stock over some period of time per dollar of initial investment. RET(I) is the return for a sale on day I. It is based on a purchase on the most recent time previous to I when the security had a valid price. Usually, this time is I - 1. Returns are calculated as follows:

For time t (a holding period), let:

t' = time of last available price < t

r(t) = return on purchase at t', sale at t

p(t) = last sale price or closing bid/ask average at time t

d(t) = cash adjustment for t

f(t) = price adjustment factor for t

p(t') = last sale price or closing bid/ask average at time of last available price < t.

then r(t) = [(p(t)f(t)+d(t))/p(t')]-1

t' is usually one period before t, but t' can be up to ten periods before t if there are no valid prices2 in the interval.

Here the p(t) and the p(t') are the Closing Price or Bid/Ask Average (CRSP Variable Name = PRC). This variable PRC has not been used in the present study explicitly. But the dependent variable RET_{it} of the present study includes the effects of PRC since CRSP used the PRC to compute the RET. According to CRSP database the PRC[2] is the closing price or the negative bid/ask average for a trading day. If the closing price is not available on any given trading day, the number in the price field has a

[1] http://continuum.uta.edu:3206/ds/crsp/dsf/ and http://continuum.uta.edu:3206/ds/crsp/description/ret.html
[2] http://continuum.uta.edu:3206/ds/crsp/dsf/ and http://continuum.uta.edu:3206/ds/crsp/description/prc.html

negative sign to indicate that it is a bid/ask average and not an actual closing price. In this field the negative sign is a symbol and that the value of the bid/ask average is not negative. All prices are raw prices as they were reported at the time of trading.

The independent variable of the present study is *VWR* which is the Value-Weighted Return or the Market Return of the securities. The data on this independent variable have, also, been collected from the CRSP database. The CRSP Variable Name = VWRETD which is the *VWR* in the present study.

According to the definition of the CRSP[3] database, "the VWRETD indices contain either the daily or monthly returns, including all distributions, on a value-weighted market portfolio (excluding American Depository Receipts (ADRs))". In the present study the data on daily returns have been collected from the CRSP database.

[3] http://continuum.uta.edu:3206/ds/crsp/dsf/ and http://continuum.uta.edu:3206/ds/crsp/description/vwretd.html

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BIOGRAPHICAL INFORMATION

Imtiaz Ahmed acquired strong academic foundation in his country of origin, Bangladesh. After earning the Bachelor of Social Sciences (B.S.S.) and the Master's of Social Sciences (M.S.S.) in Economics from the Department of Economics of the University of Dhaka, Dhaka, Bangladesh, Imtiaz subsequently received the AusAID Scholarship of the Federal Government of Australia, to carry-out the Master of Arts in the Economics of Development from the Australian National University (ANU), Canberra, Australia. This present thesis is a partial requirement of the program of the Master of Arts in Economics from the University of Texas at Arlington to be awarded in May 2007. The research interest includes the Health Economics, Pharmaceutical Economics, the issues in Microeconomics and in the Economics of Development, among others. The horizon of future plan includes the possibility of accomplishing Ph.D. Degree in Economics and pursuing the career in teaching and research or consultancies in the fields of Economics and/or Econometrics.