MARKET FORCES AND AIRCRAFT SAFETY:
A DAILY STOCK MARKET RETURN ANALYSIS
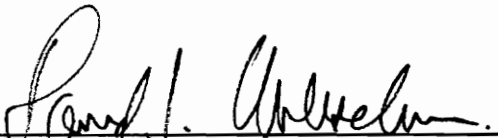
by

Brian Harold Rubenking

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

MASTER OF ARTS

in

Economics

APPROVED:

David I. Meiselman, Chairman

Robert J. Mackay   Alan N. Freiden

December, 1988

Blacksburg, Virginia

MARKET FORCES AND AIRCRAFT SAFETY:
A DAILY STOCK MARKET RETURN ANALYSIS

by

Brian Harold Rubenking

Committee Chairman: David I. Meiselman
Economics

(ABSTRACT)

The relationship between market forces and product safety in the context of the commercial passenger air travel market was investigated. The analysis was based on a detailed review of the events surrounding three airline accidents, each resulting in a substantial number of fatalities, and the subsequent investigations.

The presence or absence of statistically significant market impacts of the accidents on aircraft manufacturers and airlines was determined using a combination of event analysis and the market model of modern finance theory. For a period following each accident, daily and cumulative abnormal stock market returns (i.e., returns not explained by pre-accident market trends) were calculated for the three domestic commercial aircraft manufacturers, the airline involved, and the major airline carrier industry.

The results indicated that market forces exist that provide an incentive for manufacturers and airlines to devote resources to product safety, even though it is not possible for consumers to rationally evaluate the level of safety being provided, due to the inherent complexity of the products. The calculated market impacts generally conformed to expectations, in terms of sign and significance, and varied depending on the primary cause of a particular accident. However, the results with respect to the individual airlines involved in each accident did not support the hypotheses in several cases, indicating that other market, regulatory, or judicial factors may have had an impact on the calculated abnormal stock market returns.

A description of the background theory, the methodology used, and the detailed results is included.

TABLE OF CONTENTS

CHAPTER ONE

ECONOMIC THEORY OF MARKET FORCES

AND PRODUCT SAFETY

Economic theory indicates that market forces should provide an incentive for manufacturers and providers of goods and services to supply to consumers a high-quality, safe product. If consumers reevaluate downward their view of a product's safety and, hence, a firm's reputation, their demand for the firm's product will shift leftward, all other things equal. This demand shift could be expected to affect the firm's expected profitability. In an efficient capital market, this change will be reflected in a decrease in a firm's stock market returns, which reflect the long-term future value of a company's assets.

In practice, however, the various market forces that should act to ensure the provision of safe goods and services face barriers to successful operation. In the real world of imperfect information and highly complex products, consumers may not be able to quickly learn about and react to changes in product quality. In some situations, these factors can produce a "lemons" equilibrium, in which mainly bad goods are put on the market; this outcome is possible if the seller knows whether a given item is of good or bad quality and it

is impossible for buyers to make this differentiation.[1] In the study of product safety, a product is of "better" quality the higher is its level of safety.

This paper studies the relationship between market forces and product safety in the context of the commercial passenger air travel market. The analysis is based on a detailed review of the events surrounding three airline accidents resulting in substantial numbers of fatalities and the subsequent impact on the daily stock market returns of aircraft manufacturers and airlines.

Market Forces and Air Travel Safety

In a world of perfect information, consumers would be able to inspect every product prior to purchase and determine its safety characteristics. Prices would adjust to reflect varying levels of safety provided; consumers could opt for a safer product at a higher price, or pay less for a product involving a higher level of risk.[2]

---

[1]George A. Akerlof, "The Market For 'Lemons': Quality Uncertainty and the Market Mechanism," Quarterly Journal of Economics 84 (August 1970): 490.

[2]Andrew Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," Economic Inquiry XXIV (January 1986): 44.

In the absence of perfect information, the possibility exists for a "lemons" equilibrium, as described by Akerlof.[3] Akerlof used the example of the market for used cars to describe the situation in which the seller, based on personal experience, has information regarding the quality of a particular car; he or she knows whether it is a good car or a bad car. Buyers, on the other hand, cannot easily differentiate between a good car and a "lemon" prior to purchase. The theoretical result is that good cars and bad cars have the same market price and, therefore, primarily bad cars are put on the market.

Given the complex nature of the products involved in passenger air travel, i.e., the planes themselves and the provision of passenger airline services, it might seem that this would be a likely market for a "lemons" equilibrium. Since consumers cannot easily differentiate a "safe" from an "unsafe" product, aircraft manufacturers and airlines may lack an incentive to devote resources to the provision of safety.

However, other market forces theoretically exist that may give these firms an economic incentive to provide a safe product. Although the products involved in air trav-

---

[3]Akerlof, 490-92.

el are complex, at any given time consumers have developed perceptions of air travel safety based on the information available to them. These perceptions may relate to both the safety of air travel in general and the safety of particular aircraft or airlines.

Both aircraft manufacturers and airlines have strong "brand name" recognition that is reflected as a valued goodwill asset in their stock market prices. In an environment of costly information, firm reputation provides consumers with a relatively cheap source of pre-purchase information about product quality.[4] Companies expend significant amounts of firm-specific capital investment to promote their brand names; failure to provide a product as good (in this case, as safe) as promised will reduce the value of the firm's brand name capital.[5] Thus, any event that causes consumers to reevaluate the "brand name" reputation of a particular firm can be expected to have a positive or negative impact on the firm's stock returns, depending on the nature of the event.

---

[4]Mark L. Mitchell and Michael T. Maloney, "The Role of Market Forces in Promoting Air Travel Safety," (Clemson University, Center For Policy Studies, September 2, 1987), 2.

[5]Benjamin Klein and Keith B. Leffler, "The Role of Market Forces in Assuring Contractual Performance," Journal of Political Economy 89 (August 1981): 627.

In the case of passenger air travel, fatal accidents are events that could be expected to have a significant impact on manufacturers' and airlines' reputations for safety and, hence, on their stock market returns. If an accident does not cause consumers to reassess their evaluation of product safety, then no market impacts would be expected. If, on the other hand, a given accident causes consumers to perceive a particular manufacturer or airline as being less safe, then a negative impact on the firm's market returns should be expected.

In the case of airline accidents, logic indicates that the impact of any particular accident may vary based on the underlying cause or causes. Airline accidents can be caused by a variety of factors, including manufacturer's error, pilot error, improper airline maintenance procedures, air traffic controller error, and weather problems.

Accidents caused by a manufacturer's errors would be expected to have the largest negative impact on the returns of the manufacturer involved, while accidents caused by other factors would have a minimal impact. Furthermore, these accidents would be expected to have little or no market impact on the airlines. Conversely, accidents caused by pilot error or improper airline maintenance procedures would be expected to have a

significant adverse impact on the returns of the affected airline, while having little or no impact on the manufacturers. In each case, these hypotheses are based on the fact that the referenced factors are those that are under the direct control of the manufacturer or airline; therefore, an accident caused by one of these factors is more likely to affect consumers' perceptions of the adequacy of the safety resources being expended by the firm or firms involved.[6]

In general, one would also expect that the largest and most significant negative impacts would occur for the specific manufacturer and airline involved in an accident, and that other firms in these industries would show no, or at least smaller, impacts. In fact, other competing firms might actually benefit from a shift in public perception that a particular manufacturer or airline is "unsafe."

Accidents caused by factors beyond the control of either the manufacturer or the airline, such as weather and air traffic controller errors, might be expected to have little impact on either type of firm. However, it is possible that an accident caused by either of these factors might have a negative impact on public perceptions of

---

[6]Mitchell and Maloney, 3-4.

the ability of the airlines' flight crews or the manufac-
turers' aircraft to handle such problems. In this case,
firm-specific effects should be apparent. In addition, if
these types of accidents cause consumers to reevaluate
their overall perceptions of the safety of flying, a nega-
tive impact on the major airline carrier industry could be
expected.

Market Model of Modern Finance Theory

Economic research done in the areas of stock market
models and event studies provides the tools needed to
analyze the impact on individual firms and industries of
particular aircraft accidents. The current study is
essentially a multi-firm, multi-event study because it
looks at the impact on several firms of the same series of
related events.

The assumption that the stock market operates
efficiently implies that asset prices reflect all
currently available information. In such an environment,
it is not possible for any economic actors to make econom-
ic profits by buying or selling stocks whose prices do not
reflect their true value.[7] However, unexpected dis-

---

[7]G. William Schwert, "Using Financial Data to
Measure Effects of Regulation," The Journal of Law and
Economics 25 (April 1981): 124.

crete events (such as aircraft crashes) would be expected to have an impact on stock market returns as the market incorporates the new items of information.

The market model, originally developed by Markowitz and expounded upon in detail by Fama and others, is based on the assumption that there is a common "market" factor reflected in the returns of all assets.[8] This model is generally represented by the simple regression model:

$$\tilde{R}_{it} = a + B\tilde{R}_{mt} + \tilde{e}_{it}$$

where $\tilde{R}_{it}$ is the market return on the particular firm or asset being studied and $\tilde{R}_{mt}$ is some measure of the returns on a market portfolio.[9] For a given time, t, this model is conditional on the information available at time $t - 1$.[10] Other underlying assumptions are that $\tilde{e}$ has a mean of zero and a variance of d^2, $\tilde{e}$ is independent of $\tilde{R}_{mt}$ for all time periods, and the joint distribution of $\tilde{R}_{it}$ and $\tilde{R}_{mt}$ is stationary.[11]

---

[8]Ibid., 125.

[9]Ibid.

[10]Ibid.

[11]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 47.

Fama has presented evidence that the monthly returns to NYSE stocks are approximately normally distributed and that the market model is well-specified when monthly data are analyzed.[12] Chalk and others have utilized the identical model to conduct analyses based on daily stock market returns.

In recent years, the market model described above has been used to conduct numerous "event studies." These studies examine the impact of specific events on the stock market returns of an affected firm or firms. Although many studies have used this methodology to analyze the impact of various regulatory changes, it has also been used to study the effects of announcements relating to stock splits, accounting data, and takeovers.[13] Chalk applied the technique to an analysis of the impact on McDonnell Douglas of the 1979 crash in Chicago of an American Airlines-operated DC-10.

When applying this technique to the analysis of the impact of passenger aircraft crashes on the returns of manufacturers and of the airlines themselves, the potential impact of factors other than the market forces of

---

[12]Eugene F. Fama, Foundations of Finance, (New York: Basic Books, 1976), 26-35.

[13]Schwert, 125.

reduced brand name value must be considered. Like market forces, these factors could be expected to provide incentives for the provision of safety and to have an impact on the affected firms' stock market returns following an accident. These other factors can be broadly categorized as either regulatory or judicial.[14]

The relevant regulatory body for these industries is the Federal Aviation Administration (FAA). The FAA must certify all aircraft types before they can be used to provide passenger service. Once a plane is in service, the FAA can also issue airworthiness directives (AD) requiring changes in design to be implemented by the manufacturers or changes in maintenance procedures to be implemented by the airlines. The most stringent enforcement tool available to the FAA is the decertification of an already flying aircraft type, which was used for the only time following the 1979 DC-10 crash.

In the judicial arena, manufacturers and airlines may be liable for wrongful death and personal injury claims following an accident. The average award for such judg-

---

[14]Andrew Chalk, "Market Forces and Commercial Aircraft Safety," (Draft Ph.D. diss., Southern Methodist University, Edwin L. Cox School of Business, July 14, 1986), 2-3.

ments was approximately $500,000 in 1979[15]; following the 1987 Detroit crash, attorneys indicated they were expecting awards of from $1 million to $5 million per person.[16] Although insurance will generally cover such claims, manufacturers and airlines may be faced with increases in insurance premiums following any particular serious accidents.

Using the market model/event study methodology , it is not possible to differentiate the impacts of market, judicial, and regulatory impacts on the firms studied. Therefore, this study does not attempt to quantify the impact of market forces alone in dollar terms. Rather, the analysis will be couched in terms of whether the expected positive or negative impacts on particular firms' returns are evident and whether they are statistically significant. The presence of the expected impacts on stock market returns will provide evidence supporting the hypothesis that market forces provide an incentive for firms to provide product safety.

---

[15]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 45.

[16]"Northwest Courts Victims' Survivors," Washington Post, 27 August 1987, Sec. A, p. 8.

Prior Research in the Area of Market Forces and Aircraft Safety

As mentioned above, Chalk has conducted a detailed study of the impact of the 1979 DC-10 crash on the market returns of the three domestic commercial aircraft manufacturers. His results showed large and statistically significant negative impacts on the daily market returns of McDonnell Douglas following the accident and no impact on Boeing or Lockheed. This study did not attempt to analyze the impact on the airline involved. Some additional discussion of Chalk's results is provided in Chapter Three of this paper.

In a later study, Chalk applied a similar methodology to look at the evidence of market impacts on aircraft manufacturers across a pool of 76 U.S. passenger aircraft accidents involving fatalities. He found that statistically significant negative impacts on manufacturers' returns were only evident for accidents in which the manufacturer was implicated as being at least partly to blame and the aircraft involved was still being produced. Those crashes that were not caused by manufacturers' errors in any way or which involved aircraft no longer in production had no significant negative impacts. Chalk also found that the size of any negative effects on market returns was corre-

lated with the number of fatalities involved.[17]

Mitchell and Maloney employed a technique similar to that used in Chalk's second study referenced above to analyze the impact of aircraft accidents of different causes on the market returns of airlines, based on a pool of 56 crashes. Mitchell and Maloney attempted to break down the total negative impacts on airlines that were apparent for pilot-caused crashes into the market impact of lost consumer goodwill and increases in the cost of insurance. They found that, although insurance costs went up, they did not account for all of the stock market decreases, indicating the presence of a strong market effect.[18] Neither this study nor Chalk's second study employed the technique originally used by Chalk, that is, a daily analysis of market return impacts in conjunction with news reports of the crash and the subsequent investigation.

Various other aspects of airline safety and market forces have been the subject of a number of other studies. Golbe conducted an empirical study of the air-line industry and found that there was no statistical

---

[17]Chalk, "Market Forces and Commercial Aircraft Safety," 17-18.

[18]Mitchell and Maloney, 21-25.

linkage between airline profits and the provision of safety.[19]   He therefore argued that changes in regulations resulting in decreased profits for airlines should not be viewed as necessarily leading to less safe airlines.   Barnett and Lofaso, like Chalk, studied the 1979 DC-10 crash in Chicago, but from a different perspective.   They attempted to determine whether consumer fears following this crash had shifted passenger traffic to other types of aircraft; their results showed no statistically significant passenger resistance to flying on DC-10s less than a year after the crash.[20]

---

[19]Devra L. Golbe, "Safety and Profits in the Airline Industry," The Journal of Industrial Economics XXXIV, (March 1986): 305.

[20]Arnold Barnett and Anthony J. Lofaso, "After the Crash: The Passenger Response to the DC-10 Disaster," Management Science (November 1983): 1225.

CHAPTER TWO

METHODOLOGY

The basic methodology that was followed was based largely on the technique employed by Andrew Chalk to analyze the impact of market forces on domestic commercial aircraft manufacturers following the 1979 crash of an American Airlines-owned DC-10. The methodology is based on the market model of modern finance theory, which was used in this study to calculate daily abnormal stock market returns for selected firms for a period of time following three different commercial aircraft crashes. These abnormal returns were analyzed in conjunction with news reports concerning the accidents and the subsequent investigations to attempt to determine what market impact, if any, resulted from particular events and items of information. Although the methodology used was identical to that used by Chalk, it was applied to additional accidents and to both aircraft manufacturers and airlines.

Accidents Studied

The methodology was applied to the analysis of three recent commercial aircraft accidents, all of which resulted in substantial numbers of deaths. The crashes studied were:

- The May 25, 1979 crash of an American Airlines-operated McDonnell Douglas DC-10 in Chicago,

15

- The August 2, 1985 crash of a Delta Airlines-operated Lockheed L-1011 in Dallas-Ft. Worth, and

- The August 16, 1987 crash of a Northwest Airlines-operated McDonnell Douglas MD-80 in Detroit.

The 1979 crash was the same one studied in detail by Chalk; one of the goals of this analysis was to attempt to replicate his work.

The DC-10 crash occurred as the plane was taking off from Chicago's O'Hare Airport and resulted in 273 deaths. During the investigation, all DC-10's were legally grounded (i.e, decertified) by the FAA, the first and only time such action has been taken against a passenger jet aircraft. The 1979 DC-10 crash was originally thought to have been caused by a manufacturer's error, but additional investigation revealed that improper maintenance by the airline involved was the primary cause. McDonnell Douglas was not completely absolved of blame.

The other two crashes were selected for study to obtain representation of accidents having different causes. The L-1011 crash, which resulted in 137 deaths, occurred as the plane was landing in bad weather at the Dallas-Ft. Worth International Airport. Although some questions were raised regarding communications between the pilots and the air traffic controllers, this was a relatively clear case

of an accident caused by natural forces -- in this case, wind shear -- and, thus, largely not preventible by either the manufacturer or the airline.

A total of 156 people were killed in the 1987 crash of a McDonnell Douglas MD-80 taking off from Detroit Metropolitan Airport. The plane crashed on a local freeway, killing one driver, and the sole survivor from the plane was a four-year old girl. The investigation revealed that this accident was caused primarily by pilot error.

For the remainder of this paper, these three accidents will be identified based on the aircraft involved. Additional details surrounding the accidents themselves and the subsequent investigations are provided in Chapter Three of this study.

Data Sources

The source of all market and firm daily stock market return information used in this study was the data tapes developed and maintained by the Center for Research in Security Prices (CRSP) at the University of Chicago. From these files, data series were obtained for daily market returns for the three domestic manufacturers of commercial aircraft (Boeing, McDonnell Douglas and Lockheed) and for fourteen major domestic carriers (Delta, Continental, Eastern, Pan American, Piedmont, Republic, TWA, United,

USAir, Western, American, Northwest, Braniff, and National).[21] Data series for an index of daily market returns of all firms listed on the New York Stock Exchange and the American Stock Exchange were also obtained, on both an equally-weighted and value-weighted basis.

As used in this study and in the CRSP data base, the return for day t on a stock i is:[22]

$$R_{it} = (d_{it} + (p'_{it} - p_{i,t-1}))/(p_{i,t-1})$$

where:

d_{it} = dividend per share of the common stock of firm i from the end of day t-1 to the end of day t

$p_{i,t-1}$ = price per share of the common stock of firm i at the end of day t-1, and

p'_{it} = market value at the end of day t of one share of firm i purchased at the end of day t-1.

---

[21]The airlines selected for inclusion are those defined as "major airline carriers" by the Department of Transportation (DOT), which differentiates between these airlines and national, large regional, and medium regional carriers. Prior to 1981, the major carriers were called domestic trunk carriers and other airlines were categorized as either local service, regional, or other carriers.

[22]Fama, 12.

The return can be expressed as the dividend plus the capital gain, divided by the initial price, with all values adjusted as necessary to account for capital changes such as stock splits.[23]

All data were collected for a period of 150 trading days prior to, and 90 trading days following, each accident. Specifically, the cited data were collected for trading days covered by the following periods:

- Chicago crash: October 20, 1978 - October 3, 1979

- Dallas-Ft. Worth crash: December 28, 1984 - December 11, 1985

- Detroit crash: January 13, 1987 - December 22, 1987

Due to corporate mergers, it was not possible to obtain complete separate data series for all fourteen airlines for each accident. The airlines included in the analysis of each accident, which are indicated in the detailed Chapter Three discussions, are those for which data were available.

---

[23]Fama, 12-13.

Calculation Of Abnormal Daily Market Returns

For each of the three accidents studied, abnormal daily market returns were calculated for each of the three aircraft manufacturers, for the airline operating the aircraft that was involved in the accident, and for the major airline carrier industry (based on a simple average of the returns for the individual airlines for which data were available). The basic methodology involved estimating the market model for each firm (or industry) for a period preceding the crash as follows:

$$\tilde{R}_{it} = a + B\tilde{R}_{mt} + \tilde{e}_{it}$$

where:

$\tilde{R}_{it}$ = actual daily market returns for the individual firm, and

$\tilde{R}_{mt}$ = actual daily returns for the overall market index

Estimation of this equation provides values for the coefficients $\hat{a}$ and $\hat{B}$, which were then used to calculate:

$$\hat{R}_{it} = \hat{a} + \hat{B} R_{mt}$$

for a period following the accident. $\hat{R}_{it}$ represents the forecast return of the individual firm based on the market relationship prevailing in the pre-crash period. $\hat{B}$ can be interpreted as representing the systematic risk attributable to a particular firm because it indicates how the individual firm's return varies in relation to the overall

market return.[24]   Abnormal daily returns are then defined as:

$$e_{it} = R_{it} - \hat{R}_{it}$$

and represent the change in the daily return of the individual firm that is not explained by the overall market trends of the pre-crash period.[25]

In order to allow for tests of the statistical significance of events for a particular day, it was necessary to standardize e based on $\hat{\sigma}_{it}$, the estimated standard error of forecast. This factor was calculated as follows:[26]

$$\hat{\sigma} = \sqrt{s^2 \left[1 + (1/N) + ((R_{mt} - \overline{R}_m)^2 / \Sigma(R_{mt} - \overline{R}_m)^2) \right]}$$

where:

   s^2 = estimation period residual variance

   N   = number of estimation period observations

   $\overline{R}_m$ = estimation period sample mean of the market
               return

   R_{mt} = daily market return

---

[24]Chalk, "Market Forces and Commercial Aircraft Safety," 7.

[25]Chalk's convention of expressing all calculated abnormal returns in percentage terms was followed. For example, a calculated abnormal return of -0.0546 would be presented as -5.46 percent.

[26]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 47.

The standardized test statistic, Z, was then calculated:

$$Z = e/\sigma$$

Assuming e is normally distributed, then Z has a t-distribution with N-2 degrees of freedom.

In order to account for the possible sensitivity of the analysis on the estimated coefficients $\hat{a}$ and $\hat{B}$,[27] a number of different market models were estimated for each dependent variable for each accident. The market models were estimated based on three different pre-crash periods:

- 150 trading days before the crash
- 100 trading days before the crash
- 100 trading day period ending 50 trading days before the crash

In addition, each model was estimated using both the value-weighted and the equally-weighted measures of daily market returns as the independent variable.

Thus, for a given dependent variable for a particular accident, six possible models were estimated. The six models used are summarized in Table 1.

Since there were five dependent variables of interest for each accident (daily market returns of the three manu-

---

[27] Ibid., 48.

Table 1

Alternative Estimated Models of Stock
Return Behavior Used for All Accidents

Model No. 1:
    Independent variable: Value-weighted index of NYSE and AMEX market returns

    Estimation period: 150 trading days before accident

Model No. 2:
    Independent variable: Equally-weighted index of NYSE and AMEX market returns

    Estimation period: 150 trading days before accident

Model No. 3:
    Independent variable: Value-weighted index of NYSE and AMEX market returns

    Estimation period: 100 trading days before accident

Model No. 4:
    Independent variable: Equally-weighted index of NYSE and AMEX market returns

    Estimation period: 100 trading days before accident

Model No. 5:
    Independent variable: Value-weighted index of NYSE and AMEX market returns

    Estimation period: 100 trading day period ending 50 trading days before accident

Model No. 6:
    Independent variable: Equally-weighted index of NYSE and AMEX market returns

    Estimation period: 100 trading day period ending 50 trading days before accident

facturers and of the airline involved and an equally-weighted average of the market returns for the major airline carrier industry) and six models being tested, a total of 30 models of abnormal daily market returns in the post-accident period (90 trading days) were estimated for each of the three accidents -- a total of 90 models for the entire study. Appendix A provides the estimated coefficients, with the associated t-statistics, and the R^2 for each model calculated. The identical methodology described above was used to calculate abnormal daily market returns and Z-statistics for each model.

Newspaper Reports On Crashes

The initial source of newspaper report information used was the National Newspaper Index produced by the Information Access Company, which provides listings by topic area from the New York Times, the Wall Street Journal, the Christian Science Monitor, the Los Angeles Times and the Washington Post. For the relevant time periods, listings were reviewed that were included under both the aircraft manufacturer and the airline involved in each accident.

Based on the headline entries, key newspaper items were identified, obtained, and reviewed for the 90 trading-day period following the L-1011 and MD-80 accidents.

Chalk had already performed this step for the DC-10 crash
and this effort was not repeated. No attempt was made to
obtain articles relating to the manufacturers and airlines
that were <u>not</u> involved in each accident in this study.

The goal of this research was to identify the sequence
of events in the post-crash periods relating to the inves-
tigation of the causes of the crash. News stories were
also reviewed relating to other events in the post-crash
period that could be expected to have a market impact on
the aircraft manufacturer and the airline involved, such
as major orders, passenger traffic reports, and financial
data. Based on this research a chronology of key events
was constructed for each post-crash period.

<u>Analysis Of Abnormal Daily Market Return And News Report
Data</u>

In order to test for the presence of market impacts of
the airline crashes on the manufacturers and airlines
involved, it was necessary to analyze the abnormal daily
return data in conjunction with the news report research.
Abnormal daily market returns for the manufacturers, the
affected airline, and the major airline carrier industry
were examined for each day in which key events occurred,
as identified in the prepared chronologies.

A given event often has an expected impact on the market returns of a given firm. For example, the winning of a large aircraft order by Boeing, if unexpected, should have a positive impact on the firm's daily market returns, all other things equal. In the case of an accident, a negative impact on the returns of the affected manufacturer or airline, or both, might be expected, depending on the cause of the accident. Overall industry impacts could be possible, as well.

For each event, the expected market impact for the manufacturers and the airlines was compared to the calculated abnormal daily market returns. The comparisons were made in terms of both expected sign and statistical significance (as indicated by the calculated Z-statistics). Key events studied included both those concerning to the accidents and the subsequent investigations and other major news reports relating to company performance.

Extensions On Prior Work

Although this study uses the same methodology employed by Andrew Chalk in his 1986 study of the DC-10 crash in Chicago, it incorporates significant additional analytical elements. Chalk analyzed a single accident and only looked at the impact on the three manufacturers. This study looks at two additional airline crashes, each having

different causes, and attempts to identify any differential impacts based on the cause. Furthermore, this study also looks at the market impact on the airline involved in each crash and on the major airline carrier industry as a whole.

Chalk himself, as well as other economists, have conducted additional studies related to this general research question, but none of these studies have employed the same methodology, i.e., daily abnormal returns analysis in conjunction with news report research, applied to individual airline accidents.

CHAPTER THREE

STOCK MARKET RETURN AND EVENT ANALYSIS

The following discussion provides an analysis of the abnormal market returns calculated for the three domestic commercial aircraft manufacturers, the airline involved, and the major airline carrier industry for each of the three accidents being studied. The abnormal returns and the Z-statistics for evaluating statistical significance were calculated as described in detail in Chapter Two.

The results that are the basis for the detailed discussions that follow are those using model number 2, as referenced in Table 1; this model uses the equally-weighted index of market returns as the independent variable and an estimation period of 150 trading days prior to the accident. This was the model focused on by Chalk in his January 1986 study of the DC-10 crash. However, as indicated in Chapter Two, results were calculated for each accident using five other alternative models, in order to assess the sensitivity of the analytical technique. All of the calculated abnormal market returns and Z-statistics for the key "event" days in the post-accident periods using these other models are provided in Appendix B.

In general, the results based on these other models are comparable to those discussed in this chapter for

model number 2. The abnormal returns associated with a given firm and event are generally of the same sign and same approximate level of significance, regardless of which model is examined. In the discussions that follow, the results based on these other models are only mentioned in instances where they differ substantially in magnitude, sign, or significance from the model 2 results, or if they confirm some seemingly unusual or unexpected model 2 results.

News items that are not related to the accidents, but which contain information specific to the manufacturer or airline involved may also have an impact on abnormal returns. The impact of such news items that occurred on the same days as events relating to the accidents is incorporated into the analyses. Appendix C provides a listing for the L-1011 and MD-80 accidents of news items that appeared on days in the 90-day post-accident period for which there was no news relating to the crash. Chalk performed this step for the DC-10 crash in his 1986 study.

For most of the events surrounding each accident and the subsequent investigations, there is a hypothesis regarding the expected impact on the manufacturer and airline involved. Because of these priors, it is appropriate to evaluate the statistical significance of a given event based on a one-sided test. Therefore, based on 148

degrees of freedom (150 days in the estimation period - 2) and the t-distribution, an event can be considered to have a statistically significant impact on market returns (i.e., e > 0 or e < 0) at the 5 percent level if the absolute value of the Z-statistic is greater than approximately 1.656.[28] In any case where there is no prior hypothesis regarding the expected sign of the abnormal return, it is appropriate to use a two-sided test, in which case the relevant "Z-values" are 1.976 for 148 degrees of freedom and 1.984 for 98 degrees of freedom, for purposes of evaluating statistical significance at the 5 percent level.

1979 DC-10 Accident -- Background

Appendix D provides a table indicating the major events relating to the 1979 crash of a DC-10, along with the associated abnormal stock market returns for McDonnell Douglas, Lockheed, Boeing, American Airlines, and the

---

[28]This value was calculated based on interpolation from the standard table of student's t critical values. The corresponding value for those models based on a 100 day estimation period and, hence, 98 degrees of freedom, is 1.661.

major airline carrier industry.[29] The chronology of events presented in this table is taken from Chalk's January 1986 article,[30] but the empirical results presented are based entirely on the present research. Table 2 provides a summary of the model 2 regression equation results on which the calculated abnormal returns are based.

The results calculated for McDonnell Douglas, Boeing, and Lockheed based on model number 2 were in many cases identical and in all cases very close to the values calculated and presented by Chalk. For each key event day, the signs of the calculated abnormal returns were the same; any differences related to variations in the magnitude of either the calculated abnormal return or Z-statistic for a given firm and event. Given that both these results and Chalk's were based on the same data base and model, the slight differences in the results cannot be explained.

---

[29]The following fourteen airlines are included: American, Delta, Continental, Eastern, Pan Am, Piedmont, Republic, TWA, United, USAir, Western, Northwest, Braniff, and National. These were the "major airline carriers" between 1979 and 1987, based on DOT's definitions, which distinguish between these largest airlines and national, large regional, and medium regional carriers.

[30]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 50-53.

Table 2

Summary of Model Number 2 Regression
Results For 1979 DC-10 Accident

Dependent Variable	a	B	R^2
McDonnell Douglas	-0.0011 (-0.680)	1.1643 (6.985)	0.2479
Boeing	-0.0009 (-0.568)	1.2386 (7.247)	0.2619
Lockheed	-0.0015 (-0.528)	1.7658 (6.324)	0.2127
American	-0.0017 (-0.885)	1.6304 (8.371)	0.3214
Major Airline Carrier Industry	-0.0012 (-1.274)	1.7092 (17.557)	0.6801

1979 DC-10 Accident -- Daily Return Analysis

The crash itself occurred on Friday, May 25, 1979 at 4:04 pm, Eastern Daylight Time. The McDonnell Douglas DC-10 owned by American Airlines crashed shortly after taking off from Chicago's O'Hare Airport. Since the crash occurred after the markets closed, no impact on the returns of McDonnell Douglas or American Airlines on the 25th was expected.

This is indeed the case for McDonnell Douglas, which shows a statistically insignificant abnormal return of -0.40 percent. As would be expected, no impact is apparent on Boeing or Lockheed. American Airlines shows a relatively large abnormal return of -4.02 percent and the major airline carrier industry shows an abnormal return of -1.37 percent. Although the return for the airline industry has an insignificant Z-statistic of -1.15, American shows a Z-statistic of -1.69, which is significant at the 5 percent level based on a one-sided test. Since this effect could not have been due to the crash, another event must have been involved.

As the investigation began over the weekend, attention turned initially to the possibility of loose engine mounting bolts as the cause of the crash. During the morning of Monday, May 28, the FAA issued an airworthiness direc-

tive instructing all U.S. operators of DC-10s to ground their airplanes to inspect their engine mounting bolts. The markets were closed on the 28th for Memorial Day, so the full impact of the crash itself and of the FAA's AD regarding the DC-10 would be expected to be apparent on Tuesday, May 29, the first trading day since the accident.

During this initial stage of the investigation, tentative blame for the accident was being focused on the plane itself, manufactured by McDonnell Douglas. Therefore, on the 29th we expected to see a strong negative impact on McDonnell Douglas' returns, no impact on the returns of the other two manufacturers, and no impact or a slight negative impact on the airlines' returns.

The results support these hypotheses. McDonnell Douglas shows a highly significant negative abnormal return of -9.72 percent. Similar results were calculated based on the other five models, which show abnormal returns for McDonnell Douglas on this day ranging from -9.33 percent to -9.83 percent. Boeing and Lockheed show relatively small positive returns that, though statistically not significant, may reflect the presence of some benefit at the expense of McDonnell Douglas. Both American Airlines and the major airline carrier industry show negative abnormal returns for this day, but, as had been hypothesized, these values are not statistically significant.

On the evening of the 29th, following the close of stock market trading, the FAA issued a second airworthiness directive grounding all DC-10s for additional inspections. These inspections were to be focused on the pylon mountings, which some airlines had discovered problems with during the inspections following the issuance of the first AD. The expected impact on market returns of this news is the same as for the issuing of the first AD -- a strong negative impact on McDonnell Douglas and no other statistically significant effects.

On Wednesday, May 30, the impact of the May 29 evening announcement is apparent. McDonnell Douglas shows a negative abnormal return of -3.35 percent which, with a Z-statistic of -1.64 is not quite significant at the 5 percent level based on a one-sided test. The negative impact of the second airworthiness directive may have been somewhat tempered by the fact that some DC-10s returned to service on Wednesday after being inspected. Boeing and Lockheed show very small and statistically insignificant abnormal returns on the 30th. American Airlines and the major airline carrier industry evidence small, statistically insignificant positive and negative returns, respectively.

No major "bad" news relating to the accident became available to the market on Thursday, May 31. The FAA announced that it had dismissed the original theory that the crash had been caused by loose engine mounting bolts on the DC-10. In addition, it was announced that McDonnell Douglas had won two contracts with the government of Canada and the U.S. Army. This information apparently contributed to a statistically significant positive abnormal return for McDonnell Douglas of 6.18 percent. Chalk speculates that this positive return may have resulted in part from the failure of bad news that had been anticipated by the market to occur.[31] Again, no significant positive or negative abnormal returns were expected for the other manufacturers or the airlines. The results supported this hypothesis.

Following the close of the market on Thursday, May 31, the FAA announced that the inspection of DC-10s following the second airworthiness directive had uncovered safety problems in 37 of 138 DC-10s registered in the United States. In addition, on Friday, June 1, the Airline Passengers Association, a consumers' group, announced that it would file a Federal lawsuit requesting that all DC-10s be

---

[31]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 49.

grounded until the cause or causes of the crash were found and corrected. The combination of these two events could be expected to have a negative impact on McDonnell Douglas, which had a statistically significant (Z-statistic of -3.41) negative return of -6.93 percent on June 1. As the investigation continued to focus attention on the DC-10 and McDonnell Douglas, no impact was expected, or apparent, for the other manufacturers or the airlines on this trading day.

On Monday, June 4, the National Transportation Safety Board publicly issued its recommendations relating to the appropriate procedures for inspection of the DC-10's pylon mountings. These procedures were more extensive than those ordered in the FAA's second airworthiness directive and seemed to indicate that the NTSB felt that inspection efforts to date had been inadequate. McDonnell Douglas' abnormal returns for June 4 show the expected negative abnormal return of -8.90 percent, with a significant Z-statistic of -4.37. No significant positive or negative abnormal returns are apparent, or expected, for the other manufacturers or for the airlines.

On the evening of June 4, the FAA issued a third airworthiness directive that incorporated some of the NTSB recommendations and resulted in the third temporary grounding of the DC-10. We would expect McDonnell Douglas to

show significant negative abnormal returns for the following trading day, Tuesday, June 5, and no significant effects for any of the other firms. However, the results show a strong positive abnormal return of 5.80 percent for McDonnell Douglas, with a Z-statistic of 2.84. The other five models estimated show similar results for this day, with positive abnormal returns ranging from 4.43 percent to 5.66 percent and Z-statistics ranging from 2.16 to 3.21.

The unexpected strong positive result for McDonnell Douglas for this day, which was consistent across all six models, is difficult to explain. Chalk, who had a similar result, indicated that his research revealed no other news items unrelated to the accident that might have accounted for this effect.[32] Interestingly, Lockheed also shows a strong positive return of 5.46 percent on this day, with a relatively high Z-statistic of 1.60. It is possible that there was some positive news relating to the aircraft manufacturing industry in general on this day that was overlooked by Chalk.

After the markets had closed on Tuesday, June 5, Federal Judge Aubrey Robinson issued an injunction grounding

---

[32]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 54.

all DC-10s until the cause or causes of the Chicago crash were found and corrected. This injunction was issued (at 4:45 pm Eastern Daylight Time) in response to the suit filed by the Airline Passengers Association on June 1. At 9:30 that evening, the FAA won a stay of the order in order to contest it in court on Wednesday. However, still later in the evening, the FAA learned of the discovery of cracks in additional DC-10s and, because of the seriousness of the news, decided to decertify the aircraft type and ground all DC-10s immediately. It began notifying operators at 3:00 am on Wednesday. The FAA announced at 9:00 am on Wednesday that it did not object to Judge Robinson's injunction and held a press conference at 2:00 pm the same day to explain the most recent sequence of events.

This was the first, and only, time that a commercial aircraft type already in service has been decertified by the FAA. Therefore, a large negative impact on McDonnell Douglas' market returns was expected. Furthermore, given the magnitude of the FAA's action, Boeing's and Lockheed's returns might be expected to show a positive impact following the action against McDonnell Douglas. However, given the continued, and increased, focus on the plane itself, no significant negative impacts on American Airlines or the major airline carrier industry as a whole were expected.

As expected, McDonnell Douglas shows an abnormal market return for Wednesday, June 6 of -10.79 percent, with a highly significant Z-statistic of -5.29. In terms of magnitude, this represents the largest negative abnormal return evident for McDonnell Douglas for the period including both the crash itself and the subsequent investigation. There also appears to be some accrual of benefits to the two other domestic manufacturers of commercial aircraft. Boeing shows a positive abnormal return for June 6 of 3.71 percent with a Z-statistic of 1.78, which is significant at the 5 percent level based on a one-sided test; Lockheed shows a positive abnormal return of 1.43 percent, but it is not statistically significant at the 5 percent level.

Contrary to expectations, American Airlines shows a strong negative abnormal return for this day of -5.31 percent, with a significant Z-statistic of -2.23. For the other models estimated, American's abnormal returns ranged from -5.25 to -5.92 percent. This seems to indicate that the public associated the decertification of the DC-10 with both the manufacturer and the airline involved in the accident, even though the investigation to date had focused on problems apparently inherent in the design of the aircraft. No negative impact was evident for the major airline carrier industry, which indicates that the public

did not reevaluate its overall perceptions of the safety of commercial flight; rather, its fears were directed towards McDonnell Douglas and American Airlines.

On Thursday, June 7, rumors circulated that two DC-10 customers, Alitalia and Egyptair, might cancel DC-10 orders worth $400 million in sales. Although McDonnell Douglas also won a $110 million contract for the Air Force on this day, the negative impact of the possible cancelled sales apparently dominated, as McDonnell Douglas showed a negative abnormal return of -4.09 percent on this day, with a significant Z-statistic of -2.01. As would be expected, no significant positive or negative effects were apparent for the other two manufacturers or for the airlines.

On Friday, June 8, evidence began to emerge implicating improper maintenance by American Airlines as the principle cause of the May 25 crash. The NTSB revealed that all of the planes in which cracks had been discovered during the FAA-ordered inspections had been maintained by their airlines using the same improper technique, which was not in accord with McDonnell Douglas procedures. It was discovered that use of this technique had been started by a mechanic employed by American Airlines, who later moved to Continental Airlines and taught the improper technique to his co-workers there.

The expected market impacts of this shift in focus from McDonnell Douglas to American Airlines personnel as the cause of the crash were a strong positive effect on the returns of McDonnell Douglas and a strong negative effect on American Airlines. There was no reason to expect any impact on the other two manufacturers or the major airline carrier industry.

Abnormal market returns calculated for Friday, June 8 show a strong positive response for McDonnell Douglas, as expected, of 4.07 percent, with a significant Z-statistic of 2.00. Comparable results were obtained using the other five models, as well.

Unexpectedly, American Airlines does not show evidence of any negative impact of this new development in the investigation; abnormal returns for this trading day are only -0.33 percent, with a Z-statistic of -0.14. Three of the other models estimated actually show a positive, though statistically insignificant, abnormal return for American Airlines on this day.

These findings would seem to indicate that the news of a probable role for airline maintenance in causing the crash either did not cause consumers to reevaluate their perceptions of the level of safety provided by American Airlines or that any possible negative impact on the airline had already been incorporated into the firm's market

returns following the decertification of the DC-10. Given that the DC-10 aircraft type was still grounded, it is possible that public perception was largely focusing on the plane as the problem, rather than the maintenance procedures, despite the latest news.

Over the course of the next several weeks, several other milestones relating to the accident investigation occurred. On Monday, June 18, NTSB representatives testified at Congressional hearings on air travel safety that the American Airlines DC-10 that crashed was probably damaged during maintenance conducted in March. Since the likely role of maintenance in the accident had already been revealed several weeks earlier, no statistically significant market impacts were expected, and none were apparent.

However, it is important to note that McDonnell Douglas had not been completely exonerated by this point in the investigation. On Tuesday, July 10, the FAA issued a report indicating that the design of the DC-10's pylon assembly incorporated structural problems that should be corrected; specific design changes were recommended. As would be expected, McDonnell Douglas shows a negative abnormal return for this day of -3.03 percent, which, with a Z-statistic of -1.49, is not statistically significant at the 5 percent level based on a one-sided test, but is

significant at a level between 5 and 10 percent. Boeing and Lockheed also show negative abnormal returns for this day, but the Z-statistics are only -0.97 and -0.36, respectively.

Good news for McDonnell Douglas occurred on Friday, July 13 when the FAA lifted the grounding of DC-10s and the planes started flying again. As expected, McDonnell Douglas shows a strong positive abnormal return for this day of 3.36 percent, which is statistically significant with a Z-statistic of 1.65. However, on Tuesday, July 17, the FAA issued a report on the May 25 accident that was highly critical of both McDonnell Douglas, for alleged manufacturing and design mistakes and breakdowns in quality control, and American Airlines, for its maintenance procedures. McDonnell Douglas' returns show the expected negative impact of this announcement, with an abnormal return for the day of -4.71 percent and a Z-statistic of -2.31, Again, American Airlines seems to have been insulated from this unfavorable announcement, showing a relatively small, and statistically insignificant, abnormal return of -0.67 percent.

1979 DC-10 Accident -- Cumulative Return Analysis

In order to assess the cumulative impact of the accident, the cumulative abnormal returns were calculated

for McDonnell Douglas, Boeing, Lockheed, American Airlines, and the major airline carrier industry for several periods, using model number 2.[33] As Chalk points out, the end-date one uses to calculate cumulative abnormal returns is crucial because if the end-date is too soon, relevant events are omitted from the analysis, while if the end-date is too late, extraneous information may "contaminate" the abnormal returns series.[34] Therefore, as Chalk did, solely for McDonnell Douglas, abnormal returns were calculated based on several different post-crash periods.

The cumulative data indicated that McDonnell Douglas' stock return position improved somewhat following the revelation of the role of improper maintenance in the crash, possibly enough to make up for the losses sustained earlier. Table 3 shows cumulative abnormal returns for

---

[33]Cumulative abnormal returns for a given period equal the sum the abnormal returns, e, calculated for each day in the period. Statistical significance is determined by calculating the cumulative Z-statistic, which equals the sum of the Z-statistics calculated for each day in the trading period divided by the square root of the number of days in the period being studied.

[34]Chalk, "Market Forces and Aircraft Safety," 55.

Table 3

Cumulative Return Analysis For

1979 DC-10 Accident

Period	Boeing	Lockheed	McDonnell Douglas	American	Major Airline Industry
05/25/79 to 06/07/79	6.97 (1.11)	5.06 (0.49)	-32.21 (-5.27)	-11.09 (-1.55)	-2.30 (-0.64)
06/08/79 to 06/13/79	0.86 (0.20)	-4.45 (-0.65)	14.91 (3.66)	2.79 (0.59)	-0.22 (-0.09)
05/25/79 to 07/13/79	1.67 (0.14)	3.10 (0.16)	-7.46 (-0.63)	-9.25 (-0.67)	-1.82 (-0.27)
05/25/79 to 07/17/79	-0.55 (-0.04)	-2.73 (-0.13)	-13.40 (-1.10)	-10.28 (-0.72)	-3.12 (-0.44)
05/25/79 to 07/30/79	6.72 (0.48)	6.85 (0.30)	-14.25 (-1.04)	-3.46 (-0.22)	5.78 (0.73)

Note: Results presented here are based on model number 2.

McDonnell Douglas, Boeing, Lockheed, American Airlines, and the major airline carrier industry, based on three different post-accident end-dates: 1) July 13, the day the decertification of DC-10s was lifted; 2) July 17, the day the FAA issued its interim report that was critical of both McDonnell Douglas and American; and 3) July 30, the day the NTSB hearings began.

As shown in Table 3, McDonnell Douglas had cumulative abnormal returns of -7.46 percent, -13.40 percent, and -14.25 percent for the three periods cited above. However, in none of these cases is the cumulative abnormal return statistically significant, with Z-statistics of -0.63, -1.10, and -1.04, respectively. The lack of a statistically significant negative impact indicates that McDonnell Douglas substantially recovered from the negative effects of the accident by mid- to end-July.

American Airlines also shows negative cumulative abnormal returns for each of the three post-crash periods, but none of the values are statistically significant. No statistically significant cumulative impacts are apparent for Boeing, Lockheed, or the major airline carrier industry either.

A more interesting picture of the cumulative impact on McDonnell Douglas is shown by looking at the cumulative returns for some smaller subperiods within the

post-accident period. For the period from the accident on May 25 to June 7, the trading day prior to the revelation of the role of improper maintenance in the accident, McDonnell Douglas shows cumulative abnormal returns of -32.21 percent, with a Z-statistic of -5.27. The negative impact of the accident, the initial stages of the investigation, and the decertification are clear. For the same period, American Airlines shows cumulative abnormal returns of -11.09 percent. The Z-statistic for this value is -1.55, which though not indicative of statistical significance at the 5 percent level based on a one-sided test, is relatively high.

For the four-day trading period from June 8, the day that the role of American's maintenance procedures was revealed, to June 13, there is a strong positive impact on McDonnell Douglas. Cumulative abnormal returns for this period are 14.91 percent, with a statistically significant Z-statistic of 3.66. Clearly, McDonnell Douglas benefited from the discovery of the role of American Airlines in contributing to the accident.

However, as discussed above, McDonnell Douglas continued to show statistically significant negative abnormal returns on particular days when its possible role in the crash was the focus of the investigation. Although the magnitude of the cumulative negative returns was large for

the longer post-accident periods, the lack of statistical significance indicates that the firm had at least partially recovered from the negative impacts of the accident. The cumulative impacts calculated may have been influenced by the awarding of a fairly large number of military contracts to McDonnell Douglas during this period. As Chalk points out, unless these awards were "systematically smaller" than had been expected, they may be viewed as being "positive" information for McDonnell Douglas.[35]

This information may, therefore, actually be "hiding" a statistically significant negative impact of the crash on McDonnell Douglas. In fact, Chalk's calculations showed cumulative abnormal returns for McDonnell Douglas that were somewhat larger than those calculated in this study for the same three post-accident periods.[36] In addition, his results did indicate statistical significance at the 5 percent level for two of the periods, with Z-statistics of -1.65 for the periods ending on July 17 and July 30. However, his Z-statistic for the period through July 13 is insignificant, with a Z-statistic of only -1.14.

It is difficult to account for the difference between

---

[35]Chalk, "Market Forces and Aircraft Safety: The Case of the DC-10," 56.

[36]Ibid.

our calculated results for McDonnell Douglas' cumulative abnormal returns and those of Chalk, given that both sets of results were developed from the same database. His results indicate a somewhat larger, and more significant, cumulative negative impact of the accident on McDonnell Douglas' returns. The perceived presence of some continuing negative effects of the accident is also evidenced by the extensive advertising campaign mounted by McDonnell Douglas beginning in August 1980 to promote the DC-10. It seems likely that such a cumulative negative impact does exist, though it is also clear that the original strong negative effect was tempered substantially by the subsequent stages of the investigation that revealed American's role in causing the accident.

1979 DC-10 Accident -- Summary

In summary, for most of the major events relating to the 1979 crash of the American Airlines-operated DC-10, the expected positive or negative impact was clearly evident in the abnormal returns of McDonnell Douglas. Of equal importance, no effects were observed for Boeing or Lockheed, either cumulatively or for any specific accident-related event.

As had been initially hypothesized, there was no initial impact on American Airlines or the major airline carrier industry following this crash, in which a manufacturer's error was originally the prime "suspect." Consumers reevaluated their perceptions of the safety of the DC-10, which had a negative impact on McDonnell Douglas' returns, but these fears generally did not extend to American or other airlines. Although American evidenced a fairly large negative cumulative return over the early stages of the investigation, this effect, due largely to the decertification, was not statistically significant. In fact, American Airlines appeared to remain unaffected even after its maintenance procedures on the DC-10 were called into question. Apparently, the public still placed the blame primarily on McDonnell Douglas. However, McDonnell Douglas' returns did turn upward after the role of American's maintenance procedures was introduced, largely counteracting the initial negative impacts of the accident.

1985 L-1011 Accident -- Background

Table 4 provides a summary of the regression results based on model 2, which formed the basis for the calculation of the abnormal returns and the Z-statistics that are the subject of the following discussion. Appendix E indicates the major events surrounding the 1985 crash of the

Table 4

Summary of Model Number 2 Regression Results
For 1985 L-1011 Accident

Dependent Variable	a	B	R^2
McDonnell Douglas	-0.0013 (-1.210)	1.7778 (7.458)	0.2731
Boeing	-0.0011 (-0.894)	2.2761 (8.947)	0.3510
Lockheed	-0.0009 (-0.700)	1.8253 (6.798)	0.2380
Delta	-0.0008 (-0.639)	1.5099 (5.542)	0.1719
Major Airline Carrier Industry	0.0007 (0.684)	1.5981 (7.772)	0.2898

Lockheed L-1011 and the subsequent investigation, along with the associated abnormal stock market returns and Z-statistics calculated for McDonnell Douglas, Boeing, Lockheed, Delta Airlines, and the major airline carrier industry.[37]

The initial general hypothesis was that significant positive or negative impacts on either the manufacturer or the airline should not be apparent because the cause of the accident appeared to be weather-related throughout the investigation. Since this factor is not controllable by the firms involved, the crash is not likely to cause the public to reassess its perceptions of the safety of the particular aircraft or airline. However, the possibility of negative impacts on either Lockheed or Delta existed if the circumstances of the accident were such that they caused the public to reevaluate their perceptions of the ability of the manufacturer or the airline to handle bad weather problems.

1985 L-1011 Accident -- Daily Return Analysis

The crash occurred on Friday, August 2, 1985 at 6:05

---

[37]The following twelve airlines are included: American, Delta, Continental, Eastern, Pan Am, Piedmont, Republic, TWA, United, USAir, Western, and Northwest.

pm, Central Daylight Time, as a Lockheed L-1011 owned by Delta Airlines was trying to land during a thunderstorm at Dallas-Fort Worth Airport. Initial news reports cited several witnesses who said the plane appeared to have been struck by lightning. In addition, speculation centered on the possible role of wind shear as a major factor in the accident.

Since the accident occurred after the markets had closed, no impacts on the manufacturers' or airlines' abnormal returns on Friday would have been expected, regardless of the cause of the accident. In fact, no statistically significant impacts are apparent on August 2.

While the markets were closed over the weekend, the NTSB investigation into the causes of the accident began in earnest. On Saturday, August 3, NTSB investigators were unable to confirm reports of some witnesses that the plane had been struck by lightning just before the crash. The NTSB also indicated that wind shear appeared to be the most probable cause of the crash, although the airport's computerized ground sensors for wind shear conditions had not given a warning and the air traffic controllers had not warned the pilots of the crashed plane or of any others of possible wind shear conditions. Investigators also pointed out that a highly concentrated wind shear "microburst" might not be picked up by the airport's sen-

sors.   Initial reviews of the flight recorders showed no evidence of alarm among the plane's flight crew prior to the crash.

On Sunday, August 4, the NTSB released several items of information relating to the crash investigation. Information that the airport's wind shear sensors had sounded an alarm indicating the presence of wind shear conditions about twelve to fourteen minutes after the crash lent credence to the wind shear theory, although it still had not been determined if wind shear was occurring at the time of the accident. In a separate report, experts from the National Center for Atmospheric Research in Boulder, Colorado said that the weather conditions at the airport at the time of the crash appeared to be typical of the conditions associated with wind shear.

The NTSB also revealed that in the minutes before the crash, air traffic controllers had instructed the Delta flight crew to drop their speed from 210 knots to 150 knots, in a series of progressive steps, in order to maintain the proper distance from the business Lear jet landing ahead of them on the same runway. Had wind shear been encountered, this slower speed would have made it much more difficult for the flight crew to pull the plane out.

NTSB investigators stated on Monday, August 5, that although other causes had not been ruled out, the primary theory was that the plane had been hit by wind shear and that the pilots had been hampered in their efforts to pull out by the slower speed that had been ordered by the air traffic controllers. To date, no evidence had been uncovered of any problems with the plane itself; there was no evidence of engine or electrical failure and all flaps and rudders were in the correct positions for landing at the time of the crash. Information provided by the flight recorder indicated that the airmass through which the plane was flying immediately before the crash was showing rapid changes in velocity and direction that were indicative of wind shear.

Although no suggestions of error on the part of the flight crew or the air traffic controllers had been made, the NTSB indicated that the investigation was now focusing on how much the Delta crew knew about the possibility of encountering a dangerous storm in the area of the airport. Numerous witnessess reported the presence of heavy electrical storms and rain about the time of the crash.

Monday, August 5 was the first trading day following the accident, so any market effects of the accident and the initial investigation findings should be apparent on that day. The hypothesis was that no statistically signif-

icant negative abnormal market returns would be apparent for either Lockheed or Delta, the manufacturer and airline involved, because the evidence accumulated to date indicated strongly that the accident was caused by unexpected, severe weather, a factor not under either firms' control. We also expected Boeing, McDonnell Douglas, and the major airline carrier industry to be unaffected by the accident.

These expectations were largely borne out by the calculated abnormal returns. McDonnell Douglas, Boeing, and the major airline carrier industry all show small, positive, statistically insignificant abnormal market returns for this date. Although Lockheed and Delta show negative abnormal returns of -1.13 percent and -0.73 percent, respectively, these values have statistically insignificant Z-statistics of -0.77 and -0.49, respectively.

The results obtained based on the other five models estimated were generally similar to these. However, for Lockheed, several of these other models generated somewhat more significant results; notably, model number 3 generated an abnormal return for Lockheed on August 5 of -1.69 percent, with a Z-statistic of -1.28. Although not statistically significant at the 5 percent level, this result is indicative of a somewhat stronger negative effect on Lockheed than that calculated using model number 2.

No significant impacts are evident for the next day, August 6, either, when it is possible that some of the information cited above regarding the progress of the accident investigation might still be filtering through to the market. Also on this day, Lockheed received a $63.7 million contract award from the Navy.

On Wednesday, August 7, 1985, the NTSB investigating team confirmed that, although the cause of the crash had not yet been definitely determined, the main "suspect" was still wind shear. However, the NTSB also indicated that it was turning its attention to Delta's pilot training programs, especially with regard to flying in bad weather. This implication of some possible fault of Delta's in causing the accident, i.e., through poor pilot performance, could conceivably have resulted in a significant negative impact on that firm's market returns on this day. However, Delta's calculated abnormal returns for August 7 are actually a positive 1.15 percent, with a Z-statistic of 0.77, seemingly indicating that public concern was still focusing on wind shear as the cause of the crash. The other five models also consistently show statistically insignificant positive abnormal returns for Delta on this trading day.

The NTSB disclosed on Thursday, August 8, that the Delta flight crew had not been provided with the latest National Weather Service report prior to the crash. This report indicated the presence of cumulonimbus clouds, which usually develop into thunderstorms, in the area of the airport. However, the NTSB also said that it was entirely speculative whether this information would have affected the crew's decision to attempt a landing.

This news, which casts some doubt on the performance of the air traffic controllers at Dallas-Fort Worth Airport, rather than the manufacturer or the airline, would not be expected to produce any significant market impacts on these firms. The calculated abnormal returns support this hypothesis; the only firm to show an impact of any magnitude on August 8 is Lockheed, with an abnormal return of -1.93 percent. With a Z-statistic of -1.32, however, this value is not statistically significant at the 5 percent level. In fact, on the next day, Friday, August 9, with no "new" news of the crash available, Lockheed shows a positive abnormal return of 1.32 percent, also not statistically significant.

On Wednesday, September 4, although no news relating to the accident investigation appeared, it was revealed that in court papers filed on August 29, Delta named the FAA as a third party in several lawsuits filed against

Delta by passengers' relatives. Delta's suit alleged that the negligence of the air traffic controllers at Dallas-Fort Worth was partly to blame for the accident. In the suit, Delta sought contributions from the FAA for any liabilities issued against Delta as a result of the relatives' lawsuits.

The expected impact of this news is not clear. The negative publicity for Delta is indicative of a possible negative impact, although the report of the lawsuits really contains no new information pointing to Delta as the party at fault. In addition, the news that Delta is seeking to at least partially shelter itself against any potential negative financial determinations could be expected to have a positive impact on Delta's stock market returns.

In fact, Delta shows a negative abnormal return of -1.28 percent for this trading day, although the Z-statistic is only -0.86. No statistically significant impacts are evident for the aircraft manufacturers or for the major airline carrier industry either.

The NTSB released a large number of documents relating to the August 2 crash on Monday, September 30. This report included several key pieces of information relating to the cause of the crash, as follows:

- The crew of another Delta plane that landed four minutes before the crash spoke, while taxiing, of seeing very severe weather in the area of the crash, but they did not report this observation to the controllers.

- The business jet that landed immediately ahead of the Delta plane had experienced a loss of speed and altitude similar to that associated with wind shear, but the pilot had not reported it to anyone at the time.

- Transcripts of the crew conversations on the crashed flight indicated that: 1) the pilots were aware of storms in the area and had requested route changes twice en route to Dallas to avoid bad weather, 2) the pilots had complained of the air traffic controllers' inexperience at the Dallas-Fort Worth airport, and 3) the pilots had realized they were in trouble immediately before the crash, but by the time they acted it was too late.

- The FAA indicated that the thunderstorm report that was available from the National Weather Service 14 minutes before the crash was not of such severity that it would normally be forwarded to flight crews.

Although these reports indicated some possible poor response on the part of the Delta pilots, the news primarily continued to indicate that severe weather was the likely cause of the crash. It appeared that some share of the blame might lie with the air traffic controllers and on other pilots who appeared to have been aware of the presence of hazardous weather conditions prior to the crash, but had not formally reported this information.

Because of the circumstances dsecribed above, we hypothesized that no negative abnormal returns should be evident for either Lockheed or Delta following the release of the above news. However, there was a possibility that the major airline carrier industry might show a negative impact, if the information about the air traffic controllers' handling of the weather reports caused the traveling public to reassess their perceptions of the overall safety of flying. Again, no impact from this investigation news was expected for either Boeing or McDonnell Douglas.

Calculated abnormal returns for September 30 generally support these hypotheses. Boeing and McDonnell Douglas show small, statistically insignificant impacts for all models estimated. Lockheed shows a negative abnormal return of -1.45 percent, but it is statistically insignificant at the 5 percent level with a Z-statistic of only -0.99. Lockheed shows a larger negative abnormal

return for this day based on some of the other models calculated, but none of these returns are significant at the 5 percent level; the largest Z-statistic is -1.52.

Delta shows a negative abnormal return for this day of -1.11 percent, but it is also not significant. The major airline carrier industry shows a small, statistically insignificant positive return on this day for all models calculated, indicating that no consumer fears resulting in reduced demand are being directed at flying as a whole.

There are also no statistically significant impacts on Tuesday, October 1, the following trading day, when it is possible that the market could still have been reacting to this latest news of the NTSB investigation.

On Thursday, October 3, the FAA defended the Dallas-Fort Worth air traffic controllers criticized by the pilots of the crashed jet, stating its belief that the comments published from the crew conversation transcripts were either incorrect or had been taken out of context. No significant positive or negative effects resulting from this news were expected for any of the market returns being studied, and none were apparent.

On Thursday, October 24, the NTSB released its preliminary report on the accident. The report, which concluded that the Dallas plane had encountered severe microburst wind shear, was the first official statement definitively

identifying wind shear as the cause of the crash. Any role of lightning in causing the crash was completely ruled out. When the shear struck, it took the crew several seconds to decide to go full throttle, and it was then too late to save the plane. The NTSB hearings were to begin the following week, at which it was expected that Lockheed representatives would argue that the shear was flyable and that Delta and pilots' groups would argue the opposite.

Although this report largely exonerated the manufacturer and the airline of any blame in causing the accident, it really just provided official confirmation of the long-suspected cause. Therefore, no statistically significant negative market effects were anticipated.

Delta shows a negative abnormal return for this day for all models estimated, but it is relatively small and is not consistently significant. Lockheed, however, shows a negative abnormal return of -2.55 percent, with a Z-statistic of -1.75, which is significant at the 5 percent level based on a one-sided test. Lockheed shows a negative abnormal return on this day for the five other models estimated as well, three of which are significant at the 5 percent level, and two of which are not. Thus, the impact on Lockheed is inconsistent with the hypothesis

and may be due in part to other news items pertaining to Lockheed on this day that are not related to the crash, although none were discovered during the newspaper review. The major airline carrier industry also shows a negative abnormal return for this day, but it is insignificant. On the trading day following the release of this report, Friday, October 25, Delta shows a statistically significant negative abnormal return (for all six models estimated), but no other impacts are evident. The apparent negative impact on Delta may reflect some perception, based on the October 24 news reports, that the plane could somehow have been saved if the Delta pilots had reacted more quickly.

The remaining news items pertaining to the crash involve the NTSB hearings conducted the following week. No "surprise" testimony came out of these hearings. Thirty-two witnesses were called and there was general agreement that particularly violent wind shear was the primary cause of the accident and that no one in a position to do anything about it saw the accident coming.

1985 L-1011 Accident -- Cumulative Return Analysis

Based on the analysis of daily market returns following the accident itself and the subsequent investigation, we did not anticipate finding evidence of any

statistically significant cumulative effects in the post-accident period. In order to accurately evaluate the presence or absence of any cumulative impacts, cumulative abnormal market returns were calculated for McDonnell Douglas, Lockheed, Boeing, Delta Airlines, and the major airline carrier industry. The cumulative returns were determined based on three different end-dates: 1) September 30, the day the NTSB released numerous accident-related documents implying a strong role for wind shear in causing the accident; 2) October 24, the day the NTSB released its preliminary report pinpointing the role of wind shear in causing the accident; and 3) November 1, the final day of the NTSB hearings. Table 5 provides the calculated cumulative abnormal return data for the three post-accident periods cited above.

For the first period, from August 2 to September 30, Lockheed shows a small positive cumulative abnormal return of 1.43 percent, which is statistically insignificant with a Z-statistic of 0.16. A much larger impact is apparent for Delta Airlines, with cumulative abnormal returns of -9.76 percent, though this is also statistically insignificant with a Z-statistic of -1.04. These findings conform to our expectations. No significant impacts are apparent for Boeing, McDonnell Douglas, or the major airline carrier industry either.

Table 5

Cumulative Return Analysis For

1985 L-1011 Accident

Period	Boeing	Lockheed	McDonnell Douglas	Delta	Major Airline Industry
08/02/85 to 09/30/85	8.41 (0.96)	1.43 (0.16)	0.75 (0.09)	-9.76 (-1.04)	-8.44 (-1.18)
08/02/85 to 10/24/85	6.82 (0.65)	-6.75 (-0.60)	-4.49 (-0.46)	-15.98 (-1.42)	-8.41 (-0.98)
08/02/85 to 11/01/85	4.05 (0.36)	-4.67 (-0.40)	-8.47 (-0.82)	-18.51 (-1.56)	-10.46 (-1.16)

Note: Results presented here are based on model number 2.

For the next period analyzed, from August 2 to October 24, Lockheed shows a larger impact, with a cumulative abnormal return of -6.75 percent. Though this appears to be indicative of a possible negative impact from the investigation findings, this value has a statistically insignificant Z-statistic of -0.60. Delta evidences an even larger negative impact with cumulative abnormal returns of -15.98 percent. Although this value is not significant at the 5 percent level based on a one-sided test, its Z-statistic is much larger at -1.42. Note that it was during this period that the NTSB report was released that indicated that it took several seconds for the Delta crew to respond when the wind shear hit.

The impact on Delta is even larger when the third post-accident period, running through November 1, is analyzed. For this period, Delta shows negative cumulative abnormal returns of -18.51 percent. The Z-statistic of -1.56 is also larger, though still not statistically significant at the 5 percent level. These results indicate the possibility that, over the course of the investigation, consumers began to doubt somewhat the performance of the Delta crew in responding to the wind shear.

Lockheed has cumulative returns of -4.67 percent for this period, but they are not statistically significant. Neither Boeing, McDonnell Douglas, nor the major airline

carrier industry show any statistically significant cumulative impacts for either of the latter two post-accident periods studied.

1985 L-1011 Accident -- Summary

The analysis of this accident began with expectations of minimal, if any, negative impacts on either the manufacturer or the airline involved because it was determined with some degree of certainty early on in the investigation that wind shear, a factor not controllable by the firms, was the major cause. Generally, the results supported this hypothesis. For the accident itself and the key events of the subsequent investigation, there were no statistically significant impacts apparent in the calculated daily abnormal returns of Lockheed and Delta, with the exception of one statistically significant abnormal return for Lockheed. As would be expected, no impacts were apparent for the other two commercial aircraft manufacturers on any of the key "event" days. The major airline carrier industry, for which the expected impact was ambiguous, showed no statistically significant effects for these events either. This indicated the absence of any downward reassessment by consumers of the overall safety of commercial flying.

The only important cumulative effects are apparent for Delta, as discussed above. Although the negative cumulative returns calculated for Delta are not statistically significant at the 5 percent level, they are relatively large. In addition, the absolute value of these cumulative negative returns, and of the Z-statistics, grows steadily larger as longer post-accident periods are examined. The review of non-accident-related news reports for this period (see Appendix C) did not turn up any items that could account for this apparent negative impact. In fact, during the post-accident period, Delta announced plans for a $45 million expansion of its Dallas-Fort Worth terminal and placed a $105 million order for new Rolls-Royce engines to increase the range of part of its fleet. News reports also indicated an increase in Delta's traffic and a decrease in net income during this period. With the exception of the income report, these other news items appear to be "positive" for Delta's market returns. Therefore, it appears possible that consumers may have attributed some degree of blame to Delta, associated with a perceived inability of its pilots to handle the wind shear. As measured by these results, however, such an effect, if present, is relatively weak, although it may be partially counterbalanced by the "good" news relating to Delta during the post-accident period.

1987 MD-80 Accident -- Background

Appendix F indicates the major events relating to the well-publicized 1987 crash of a McDonnell Douglas MD-80 and the NTSB investigation that followed. This accident is unique amoung the three studied in that the investigation determined definitively that pilot error played the key role in causing the accident. The table provided in the appendix also contains information on the abnormal stock market returns and Z-statistics associated with each key news event, which were calculated for McDonnell Douglas, Boeing, Lockheed, Northwest Airlines, and the major airline carrier industry.[38] Table 6 summarizes the model number 2 regression equation results on which the abnormal return figures are based.

1987 MD-80 Accident -- Daily Return Analysis

This accident occurred on Sunday, August 16, 1987 when a McDonnell Douglas MD-80 owned by Northwest Airlines crashed at 8:46 pm, Eastern Standard Time, shortly after taking off from Detroit Metropolitan Airport. The plane

---

[38]The following seven airlines are included: American, United, Northwest, USAir, Delta, Pan Am, and Piedmont.

Table 6

Summary of Model Number 2 Regression Results
For 1987 MD-80 Accident

Dependent Variable	a	B	R^2
McDonnell Douglas	-0.0013 (-1.412)	1.1161 (7.125)	0.2554
Boeing	-0.0009 (-0.582)	0.8495 (3.169)	0.0635
Lockheed	-0.0005 (-0.295)	0.8750 (2.784)	0.0498
Northwest	-0.0006 (-0.391)	1.3888 (5.307)	0.1599
Major Airline Carrier Industry	-0.0001 (-0.094)	1.3359 (7.614)	0.2814

hit a parking lot light pole and the corner of a rental car office building before crashing on a local highway. Early news reports cited claims of some witnessess that they had seen fires in the engines and that the plane appeared to be having trouble gaining altitude. News reports also cited the labor and service problems experienced by Northwest since its merger with Republic in the Fall of 1986. This was the first major passenger aircraft accident in the United States in 1987 and the first crash in the United States involving the MD-80, which had had an excellent safety record prior to this time.

Given the severity of the crash, and the initial "mystery" regarding the apparent cause, we believed that both McDonnell Douglas and Northwest Airlines would experience a significant negative market impact, that there might also be a negative impact on the major airline carrier industry, and that the other two aircraft manufacturers would be unaffected. Abnormal returns calculated for Monday, August 17, indicate that these suppositions regarding Boeing and Lockheed were fairly accurate, but that the other hypotheses were not supported by the calculations.

Boeing and Lockheed have statistically insignificant abnormal market returns for this trading day of 0.92 percent and -0.06 percent, respectively. McDonnell Douglas, however, shows an unexpectedly small negative abnormal

return of only -0.05 percent, with a Z-statistic of only -0.05. Similar values were calculated using the five other models estimated, with the largest abnormal return being -0.31 percent, with a Z-statistic of -0.27. McDonnell Douglas won a $10.9 million Navy contract on Monday as well, which may have had some offsetting positive effect.

A somewhat larger negative effect was evident for Northwest, which had a negative abnormal return of -1.99 percent on August 17, with a Z-statistic of -1.10. This figure was as large as -2.32 percent, with a Z-statistic of -1.38 for the other models calculated, but the impact was not statistically significant at the 5 percent for any of the models. The passenger airline industry also showed a consistently negative, but statistically insignificant, effect across all models.

The lack of a statistically significant negative impact on McDonnell Douglas and Northwest on the first trading day following this major accident indicates that, contrary to expectations, the public had not reassessed their perceptions of the levels of safety being provided by these two firms. Several factors in the news reports could have produced this effect.

The lack of an immediate and clear cause of the crash may have actually caused the public to forego passing immediate judgment. Alternatively, it is possible that the initial unconfirmed reports of engine fires may have focused public attention on Pratt & Whitney, the manufacturer of the crashed plane's engines, rather than on the plane manufacturer or the airline. Additional credence is lent to this theory by the fact that the safety of Pratt & Whitney engines had been called into question in several other recent incidents. This is an instance where it would be interesting to look at the abnormal return data for the engine manufacturer as well, to see if any negative impact is evident, but this was outside the scope of this study.

On the evening of Monday, August 17, the NTSB team gave a briefing at which it presented its preliminary findings. The cause of the accident was still unknown. The plane had given a stall warning prior to the crash, but there was no evidence yet of an engine fire or explosion. Although other possible factors, such as wind shear, were still being studied, the focus of the investigation was currently on the Pratt & Whitney engines. The plane that crashed had had engine problems before, but those engines had been replaced.

This NTSB statement indicating that the investigation was going to focus initially on the engines should have served to insulate McDonnell Douglas and Northwest from any negative market impacts. On Tuesday, August 18, the trading day after the NTSB evening briefing, McDonnell Douglas shows a positive abnormal return of 0.59 percent, with a Z-statistic of 0.54, while Northwest shows a statistically insignificant negative return of -0.14 percent, both as expected. Lockheed shows a large and strongly significant positive abnormal return on this day, presumably related to some event not concerned with the accident investigation.

During its evening briefing of Tuesday, August 18, the NTSB stated that the plane had taken off at an unusually steep angle. It was also revealed that the airport's wind shear sensors had sounded a warning earlier in the evening, so a possible role for weather in the accident was still being examined. Possible impacts of the gross weight and weight distribution of the plane were also being studied. Although an engine fire or explosion had been ruled out at this point, the possibility of other engine problems was still being studied. However, Northwest had inspected the engines on all of its MD-80s earlier in the summer in response to a Pratt & Whitney service bulletin.

The lack of any new information implicating either McDonnell Douglas or Northwest as being to blame for the accident, and a continued emphasis on possible engine problems, led to expectations of no negative impacts on McDonnell Douglas or Northwest resulting from the latest briefing. The abnormal stock market returns for Wednesday, August 19 confirm this hypothesis, with no statistically significant negative impact apparent for either firm.

The investigation took a surprising twist on Wednesday, however, when the NTSB revealed at its evening briefing that "black box" evidence from the crashed plane indicated that the wing's flaps and slats were not properly set for takeoff and that the flight crew may have omitted these items from a routine preflight checklist. However, contradictory evidence was supplied by the fact that an alarm on the plane that should have sounded if the flaps and slats were not properly set had not gone off. Also on this day, McDonnell Douglas won a $26 million Navy contract for Harpoon cruise missiles.

The news indicating that improper performance by the Northwest flight crew could have played a major role in the crash should have produced a strong negative impact on the airline's market returns. On Thursday, August 20, the first trading day after this news was revealed by the NTSB, Northwest, as expected, shows a negative abnormal

return of -1.79 percent. However, contrary to expectations, the Z-statistic for this figure is only -0.98, indicating a lack of significance at the 5 percent level, based on a one-sided test. The five other models estimated showed similar abnormal returns for Northwest for this day, with values ranging from -1.66 percent to -2.11 percent, and Z-statistics ranging from -0.94 to -1.16, none indicative of statistical significance.

The lack of a stronger, more significant negative impact on Northwest of the news implicating their pilots' performances in causing the crash is difficult to explain. The newspaper search uncovered no evidence of "good news" for Northwest Airlines on this day that might have counteracted the accident-related bad news. One possible explanation is that the evidence of this particular Northwest crew's failure to follow correct procedures was viewed solely as an isolated incident that did not reflect poorly on the airline as a whole, but this seems unlikely.

In its briefing delivered on the evening of Thursday, August 20, the NTSB again stated that evidence from the flight recorder and transcripts of the pilots' conversations indicated that the flaps and slats had been neither set nor checked, but emphasized that this fact had not yet been confirmed with physical evidence from the wreckage. In addition, one witness (another Northwest pilot) insist-

ed positively that the flaps and slats were positively set. The Air Line Pilots Association cautioned against assuming that human error was the sole cause of the crash, and cited the fact that an alarm had not sounded as possible evidence that the flaps were indeed properly set. However, the chairman of the FAA cited the possibility that "cockpit complacency" may have played a role in the crash. Aviation experts indicated that the behavior of the plane was consistent with an attempted takeoff with improperly positioned flaps.

Again, the continued attention on possible improper performance by Northwest's flight crew led to expectations of a significant negative impact on Northwest's market returns for Friday, August 21, particularly if the initial news regarding the flaps had not been entirely absorbed by the market on the previous day. No evidence was expected of significant impacts on the returns of McDonnell Douglas or the other manufacturers. Although these expectations regarding the manufacturers were borne out by the findings, Northwest actually showed a positive, though statistically insignificant, abnormal market return of 1.12 percent on Friday, August 21. Northwest showed a positive abnormal return on the following trading day, Monday, August 24, as well. The other five models estimated produced similar insignificant abnormal returns for Northwest for these two trading days.

On Tuesday, August 25, the NTSB stated that physical evidence from the wreckage of the crash confirmed that the flaps were improperly positioned during takeoff. The one witness's account that the flaps were properly set had been discounted, and the focus of the investigation had now turned to why the alarms had not sounded while the plane was taxiing to indicate that the flaps were not set properly for takeoff.

Northwest continued to be unaffected by this additional confirmation of its pilots' role in the crash, showing statistically insignificant negative abnormal returns on Tuesday, August 25 and Wednesday, August 26, of -0.93 percent and -0.89 percent, respectively.

On Friday, October 16, the NTSB released its interim report on the accident. Although this report included no comments or conclusions from the NTSB, it disclosed additional evidence that the pilots' failure to deploy the flaps may have caused the crash. Northwest actually had a positive abnormal return for this day of 2.04 percent, with a Z-statistic of 0.97. Inexplicably, all three airplane manufacturers show negative abnormal returns for this day, which are statistically significant based on a one-sided test at the 5 percent level for some of the six models, but not for others. These impacts are likely due to some industry development not related to the accident.

The NTSB hearings began on Monday, November 16. The NTSB vice chairperson had indicated that the hearings would focus on the pilots' performance and on the failure of the alarms to sound indicating that the flaps and slats were not properly set. No significant impacts were expected to result from the initiation of the hearings because no new findings were anticipated. No impacts were apparent on November 16 for Boeing, Lockheed, Northwest, or the major airline carrier industry.

McDonnell Douglas, however, had abnormal returns of -3.58 percent, with a significant Z-statistic of -3.31. This market impact is likely a reaction to the Sunday, November 15 crash of a Continental Airlines DC-9 while trying to take off from Denver in a snowstorm, rather than any effect of the hearings. Also note that McDonnell Douglas showed a positive abnormal return on Tuesday, November 17, the following trading day, apparently in response to the news that the Denver investigation was focusing on snow and ice build-up on the plane's wings, rather than on a plane design problem.

The unusual feature of the results of the analysis of this accident is the lack of a statistically significant daily negative impact on the stock market returns of North-west Airlines when the role of its pilots in causing the crash was discovered. It is interesting to note North-

west's apparent "immunity" from bad news as evidenced by several other events occuring in the post-accident period, which are cited in Appendix C. On Friday, September 4, it was announced that Northwest had surpassed Continental as "the most complained about airline," based on the Department of Transportation's August report. Northwest showed negative abnormal returns for this day of -2.54 percent (as high as -2.69 percent for one model), but a Z-statistic of only -1.40, not significant at the 5 percent level. Similarly, on Monday, November 16, DOT announced that Northwest would have to pay a civil fine of $325,000 for allegedly mishandling customer refund claims in 1986 and 1987. Northwest showed a small negative abnormal return of -0.31 percent, with a Z-statistic of -0.17.

These two other items of bad news for Northwest, in conjunction with other on-going stories relating to its service problems and labor disputes, would have increased my expectations of negative abnormal returns during the post-accident period.

1987 MD-80 Accident -- Cumulative Return Analysis

In addition to the daily analysis, the cumulative impacts of the accident on McDonnell Douglas, Boeing, Lockheed, Northwest Airlines, and the major airline carrier market were examined. Table 7 shows the cumulative abnormal returns and Z-statistics

Table 7

Cumulative Return Analysis For

1987 MD-80 Accident

Period	Boeing	Lockheed	McDonnell Douglas	Northwest	Major Airline Industry
08/17/87 to 08/19/87	1.53 (0.48)	4.43 (1.16)	0.92 (0.49)	-3.26 (-1.04)	-0.65 (-0.32)
08/20/87 to 08/25/87	1.26 (0.34)	0.04 (0.01)	-0.36 (-0.17)	-0.23 (-0.06)	-1.73 (-0.71)
08/17/87 to 10/16/87	-3.43 (-0.24)	-1.92 (-0.10)	3.71 (0.54)	-15.18 (-1.29)	-4.80 (-0.62)
08/17/87 to 11/16/87	-3.10 (-0.25)	-1.81 (0.11)	13.73 (1.61)	-20.77 (-1.40)	-3.92 (-0.34)

Note: Results presented here are based on model number 2.

calculated for four different post-accident periods and suberiods. The specific periods studied were: 1) August 17 through August 19, the trading day prior to the initial revelation of the pilot's errors; 2) August 20, the trading day that the information on the pilot's errors was available to impact the markets, through August 25, the day the NTSB indicated that physical evidence from the wreckage confirmed earlier evidence of pilot errors; 3) August 17 through October 16, the release date of the NTSB's interim report; and 4) August 17 through November 16, the first day of the NTSB hearings.

During the first period studied, the cause of the accident was primarily speculative, but suspicions were focusing on the engine manufacturer. As a result, no impacts on McDonnell Douglas or Northwest were expected. The data confirm these hypotheses, with no statistically significant positive or negative cumulative impacts apparent for the four individual firms being studied or for the major airline carrier industry.

For the second period studied, during which the possible role of Northwest pilot error was revealed and confirmed, initial expectations were for a strong negative impact on Northwest's returns. However, these cumulative results confirmed the daily analyses for this period, with Northwest showing cumulative abnormal returns for the four

trading day period of only -0.23 percent, with an insignif-
icant cumulative Z-statistic of -0.06. No positive impact
is apparent for McDonnell Douglas, which might have been
expected given the nature of the news, virtually absolving
the manufacturer of any possible blame. These results
also confirm the daily return analysis for this period.
As expected, no statistically significant impacts are
apparent for Boeing, Lockheed, or the major airline carri-
er industry.

For both of the two longer periods that were examined,
Northwest shows a fairly large, though statistically insig-
nificant, negative impact. For the period from August 17
to October 16, the date of release of the NTSB's interim
report, Northwest shows cumulative abnormal returns of
-15.18 percent, with a Z-statistic of -1.29. The corre-
sponding figures for the period through November 16 are
-20.77 percent and -1.40. These results may indicate that
the accident itself and the other bad news for Northwest
during this period did have a weak negative cumulative
effect on the firm's market returns, but the impact is
much less significant than expected.

For the same two periods, McDonnell Douglas has cumula-
tive abnormal returns of 3.71 percent and 13.73 percent.
Although neither of these values is statistically signifi-
cant, the second does have a relatively high Z-statistic

of 1.61. Boeing, Lockheed, and the major airline carrier industry all show relatively small negative cumulative abnormal returns for these two periods, but none of the values are statistically significant.

1987 MD-80 Accident -- Summary

As with the simple daily return analysis, the most difficult aspect of the cumulative results to explain is the apparent absence of a statistically significant negative impact on Northwest Airlines of the news identifying improper performance by their pilot and co-pilot as the primary cause of the accident. Although Northwest shows evidence of growing negative impacts for the two longer periods examined, these effects are not statistically significant at the 5 percent level based on a one-sided test. In addition, these negative impacts are apparently not based on the news regarding the pilots' performance, because no effects of the release of this news are apparent for the subperiod covering its release and confirmation.

Although the other results for this accident relating to abnormal returns for the manufacturers and the airline industry confirmed the original hypotheses, an adequate explanation for the unexpected lack of an impact on Northwest is not available. It is possible that other

events affecting Northwest prior to and during the post-accident period, such as service problems and labor disputes, may have been the dominant factors affecting Northwest's stock market returns. If this was the case, the additional impact of news relating to the accident investigation may have been reduced. It is also possible that the initial strong focus of the investigation on the engines may have diluted the impact of the later revelations regarding Northwest's role.

Some indirect evidence that such a factor may have played a role is provided by the results relating to the 1979 DC-10 accident. In this case, attention had initially been concentrated on manufacturing errors as the main cause of the accident. When the investigation later implicated American Airlines as well, no significant negative daily or cumulative market return impacts were apparent for the airline.

CHAPTER FOUR

SUMMARY OF FINDINGS

The use of the market model in association with event analysis appears to be a useful tool for assessing the presence of market impacts of accidents on aircraft manufacturers and airlines. There appear to be differential impacts based on the cause of the accident. For the three accidents studied, our hypotheses regarding expected positive or negative impacts were generally confirmed by the results calculated on both a daily and a cumulative basis. However, there were several notable exceptions, involving the specific airline whose plane crashed, in which expectations were not borne out by the data.

For all three accidents studied, no statistically significant positive or negative impacts were anticipated for the two commercial aircraft manufacturers whose planes were <u>not</u> involved in the particular accident being studied. The data consistently supported this hypothesis. There was no evidence of a significant impact on the two manufacturers not involved in each crash, either on the basis of cumulative returns or for the specific daily news events associated with each accident and the subsequent investigations.

With regard to the major airline carrier industry, prior expectations were not as strong. In general, it did not seem likely that the overall industry would be affected negatively by a particular accident. For this to happen, the events surrounding the accident would have to cause the traveling public to reassess their perceptions of the safety of flying per se, rather than the safety of a particular manufacturer or airline. Although it did not seem likely that a single accident could have such an impact, it was possibile that an accident having wider implications for air travel safety could conceivably have industry-wide effects. This might be the case if the competence of air traffic controllers were called into question, for example.

In fact, the results showed no statistically signifi-cant impacts on the major airline carrier industry for any of the three accidents studied. We were fairly confident that we would obtain these results for the MD-80 and DC-10 crashes, which were caused by pilot errors and by a combination of manufacturer's and maintenance errors, respectively. The L-1011 accident, though caused by wind shear, did call into question some of the procedures followed by the Dallas-Fort Worth air traffic controllers regarding the monitoring of weather data and the provision of this information to the pilots; therefore, this raised

the possibility of an airline industry impact, depending on the shifts in public perceptions that occurred. However, the results indicated no statistically significant impacts for this accident.

With regard to the commercial aircraft manufacturer whose plane was involved in each accident, the hypothesis was that the impact would vary depending on the role, if any, of manufacturing and design problems in contributing to the accident. The calculated results strongly supported these hypotheses.

For the 1979 DC-10 crash, the initial stages of the investigation focused almost exclusively on apparent design problems with the DC-10. Although the maintenance procedures followed by American Airlines were also called into question at a later stage in the investigation, McDonnell Douglas was not completely absolved of blame. Therefore, the presence of a strong negative impact on McDonnell Douglas' stock market returns was expected. As detailed in the previous chapter, the anticipated large, significant impact on McDonnell Douglas was evident, particularly in the early stages of the investigation. An analysis of cumulative abnormal returns, however, indicated that McDonnell Douglas had largely recovered from the impact of the accident within several months, following the revelation of the role of American's maintenance procedures.

The other two accidents studied were caused by wind shear and pilot error, respectively, so little or no significant negative impacts on the manufacturers involved were anticipated. The results supported this hypothesis strongly. No statistically significant negative impacts were apparent on a daily or cumulative basis for either Lockheed (1985 crash) or McDonnell Douglas (1987 crash).

The results with regard to the individual airlines involved in each crash are less definitive. As with the manufacturers, it was expected that the impact on the specific airlines' returns would depend on the cause of the accident, with a negative impact associated only with crashes caused by factors controllable by the airlines, such as pilot error and maintenance procedures. However, the results showed that, at least for the accidents that were studied, the airlines involved seemed to be largely unaffected, even when events indicated that the airlines were at least partially to blame.

The results for the 1985 crash generally supported my hypotheses. No impact on Delta was anticipated because the crash was caused by an unusually severe, and entirely unexpected, incidence of wind shear. An indirect negative impact on Delta could have been possible if the circumstances of the accident created a perception that the weather was "flyable", and that the Delta pilots had

simply responded incorrectly, but the investigation did not indicate that this was the case.

In fact, the results show no statistically significant negative impacts on Delta for any of the specific days associated with the accident investigation. Although some cumulative negative impacts are apparent, they are not statistically significant.

The results for the other two accidents studied do not support the general hypotheses. In both cases, the investigations identified a role for the airline involved in causing the accidents within several weeks of their occurrence. In the case of the DC-10, it was learned that American had followed improper maintenance procedures. In the case of the MD-80, it was learned that Northwest's pilots had failed to set the flaps and slats prior to takeoff and had omitted these items from a routine pre-flight checklist.

Contrary to expectations, however, neither of these revelations had any statistically significant negative impacts on the airlines involved. Thus, it appears that these items did not cause the market to reassess the perceptions of the relative safety of the particular airlines involved. In the case of the DC-10, it may have been that the early emphasis on the manufacturer and the actual grounding of the aircraft type on this basis reduced the

later impact on the airline. This may also be possible in the case of the MD-80 crash, where the investigation initially focused on the engines, rather than the manufacturer or airline. Furthermore, effects on Northwest's returns during the 1987 post-accident period may have been dominated by the company's ongoing labor and service problems.

It is interesting to note, however, that Mitchell and Maloney's results, which were based on a pooled aggregate of many accidents, indicated the presence of a clear, statistically significant negative impact on airlines in those cases in which pilot error was to blame. Thus, although the results may vary depending on the particular circumstances surrounding a particular case, it appears that the expected effects do exist in the aggregate.

Daily stock market return analysis, in conjunction with daily event analysis appears to be a useful tool for measuring the impact of airline crashes on the manufacturers and airlines involved. The results of this study based on this methodology indicate the presence of significant market forces that provide firms with incentives to devote resources to safety. The impact will vary, with the largest negative effects on the manufacturer and airline involved expected for those accidents caused by factors directly under their control. My results, however, uncovered several examples where the

airline involved in an accident appeared to be unaffected by investigative findings indicating they were part of the cause. We were unable to determine the reason for these findings, which indicate that, at least for airlines, the actual results for a specific accident may vary from the expected results. In the cases studied, it appears to be possible that other elements of the investigations and other non-accident-related news may have reduced the impact of the "bad" news regarding airline responsibility for the accidents.

It is important to remember that the abnormal returns calculated using this methodology represent the impact of all market, judicial, and regulatory forces acting on the firm being examined during the post-accident period. Thus, the failure of an expected impact resulting from accident-related news to occur may be due to the presence of simultaneous counteracting effects from another source. Although an attempt was made to identify the presence of such other impacts through my newspaper search, no effort was made to break down the measured stock market effects into their various components. Thus, in the case of the instances cited above, where the airlines did not appear to be affected by the news that they were at least partially implicated in causing the crash, it is possible that a significant negative market impact exists, but is being "hidden" by the effects of other forces.

Appendix A

Estimated Models of Stock Return Behavior

Estimated Models Of McDonnell Douglas
Stock Return Behavior -- May 25, 1979 DC-10 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	−0.0010	−0.0011	−0.0027	−0.0045	−.0.0003	−0.0001
	(−0.699)	(−0.680)	(−1.622)	(−2.618)	(−0.166)	(−0.025)
B	1.7733	1.1643	1.8378	1.8708	1.9794	1.1917
	(9.800)	(6.985)	(6.836)	(6.823)	(8.935)	(5.872)
R^2	0.3935	0.2479	0.3229	0.3221	0.4490	0.2603

Estimated Models Of Boeing Stock
Return Behavior -- May 25, 1979 DC-10 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0010 (-0.728)	-0.0009 (-0.568)	-0.0037 (-2.627)	-0.0053 (-3.069)	0.0002 (0.099)	0.0005 (0.229)
B	2.1477 (13.152)	1.2386 (7.247)	2.3384 (10.330)	1.9298 (7.132)	2.1202 (11.216)	1.1663 (6.052)
R^2	0.5389	0.2619	0.5213	0.3417	0.5621	0.2721

Estimated Models Of Lockheed Stock Return
Behavior -- May 25, 1979 DC-10 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0015	-0.0015	-0.0015	-0.0040	-0.0020	-0.0015
	(-0.605)	(-0.528)	(-0.689)	(-1.787)	(-0.620)	(-0.395)
B	2.9761	1.7658	2.7029	2.6627	3.0721	1.6743
	(10.215)	(6.324)	(8.004)	(7.574)	(8.638)	(5.033)
R^2	0.4135	0.2127	0.3953	0.3692	0.4323	0.2054

Estimated Models Of American Airlines Stock Return
Behavior -- May 25, 1979 DC-10 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0016 (-0.905)	-0.0017 (-0.885)	-0.0029 (-1.341)	-0.0052 (-2.303)	-0.0021 (-0.993)	-0.0018 (-0.735)
B	2.3797 (11.422)	1.6304 (8.371)	2.5014 (7.302)	2.4552 (6.897)	2.3945 (10.254)	1.5481 (7.201)
R^2	0.4685	0.3214	0.3254	0.3268	0.5176	0.3460

Estimated Models Of Major Airline Carrier Industry
Stock Return Behavior -- May 25, 1979 DC-10 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0009 (-1.056)	-0.0012 (-1.274)	-0.0010 (-0.918)	-0.0029 (-2.715)	-0.0015 (-1.455)	-0.0014 (-1.074)
B	2.2004 (21.971)	1.7092 (17.557)	1.8943 (11.333)	1.9500 (11.626)	2.3012 (20.752)	1.6988 (15.525)
R^2	0.7690	0.6801	0.5722	0.5487	0.8162	0.7130

Estimated Models Of McDonnell Douglas Stock
Return Behavior -- August 2, 1985 L-1011 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0005	-0.0013	-0.0006	-0.0007	-0.0019	-0.0027
	(-0.494)	(-1.210)	(-0.408)	(-0.490)	(-1.414)	(-1.899)
B	1.4227	1.7778	1.1394	1.6774	1.6929	2.0164
	(7.700)	(7.458)	(4.280)	(4.864)	(7.628)	(7.013)
R^2	0.2860	0.2731	0.1575	0.1945	0.3725	0.3342

Estimated Models Of Boeing Stock
Return Behavior -- August 2, 1985 L-1011 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0000 (-0.006)	-0.0011 (-0.894)	0.0002 (0.128)	0.0000 (0.016)	-0.0015 (-1.142)	-0.0024 (-1.745)
B	1.8123 (9.201)	2.2761 (8.947)	1.8769 (6.662)	2.7654 (7.842)	1.9203 (8.969)	2.3001 (8.233)
R^2	0.3639	0.3510	0.3117	0.3856	0.4508	0.4089

Estimated Models Of Lockheed Stock
Return Behavior -- August 2, 1985 L-1011 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0001	-0.0009	-0.0001	-0.0001	-0.0007	-0.0016
	(-0.053)	(-0.700)	(-0.069)	(-0.066)	(-0.458)	(-1.001)
B	1.4811	1.8253	1.3726	1.8283	1.5589	1.9341
	(7.139)	(6.798)	(5.387)	(5.425)	(6.255)	(6.137)
R^2	0.2562	0.2380	0.2285	0.2310	0.2853	0.2776

Estimated Models Of Delta Airlines Stock
Return Behavior -- August 2, 1985 L-1011 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0003	-0.0008	-0.0003	-0.0002	-0.0014	-0.0018
	(-0.272)	(-0.639)	(-0.198)	(-0.121)	(-0.963)	(-1.124)
B	1.3812	1.5099	1.6939	2.0997	1.3897	1.4785
	(6.746)	(5.542)	(6.312)	(5.761)	(5.815)	(4.694)
R^2	0.2352	0.1719	0.2890	0.2530	0.2566	0.1836

Estimated Models Of Major Airline Carrier Industry
Stock Return Behavior -- August 2, 1985 L-1011 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	0.0012	0.0007	0.0016	0.0017	0.0007	0.0002
	(1.402)	(0.684)	(1.747)	(1.762)	(0.600)	(0.174)
B	1.4098	1.5981	1.6453	2.0584	1.3253	1.4795
	(9.300)	(7.772)	(9.166)	(8.281)	(7.149)	(6.021)
R^2	0.3688	0.2898	0.4616	0.4117	0.3428	0.2700

Estimated Models Of McDonnell Douglas Stock
Return Behavior -- August 16, 1987 MD-80 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0009 (-1.015)	-0.0013 (-1.412)	-0.0008 (-0.646)	-0.0009 (-0.756)	-0.0018 (-1.525)	-0.0022 (-1.880)
B	0.7293 (7.043)	1.1161 (7.125)	0.7532 (5.848)	1.2007 (6.088)	0.7250 (5.981)	1.1073 (6.238)
R^2	0.2510	0.2554	0.2587	0.2744	0.2674	0.2842

Estimated Models Of Boeing Stock
Return Behavior -- August 16, 1987 MD-80 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0006	-0.0009	-0.0005	-0.0006	-0.0014	-0.0017
	(-0.408)	(-0.582)	(-0.269)	(-0.284)	(-0.972)	(-1.146)
B	0.5559	0.8495	0.6891	0.9986	0.5032	0.7553
	(3.144)	(3.169)	(3.086)	(2.872)	(3.303)	(3.351)
R^2	0.0626	0.0635	0.0886	0.0777	0.1002	0.1028

Estimated Models Of Lockheed Stock
Return Behavior -- August 16, 1987 MD-80 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0004 (-0.198)	-0.0005 (-0.295)	0.0005 (0.216)	0.0005 (0.217)	-0.0007 (-0.287)	-0.0009 (-0.391)
B	0.6359 (3.087)	0.8750 (2.784)	0.5475 (2.162)	0.7471 (1.896)	0.6254 (2.578)	0.8725 (2.418)
R^2	0.0605	0.0498	0.0455	0.0354	0.0635	0.0563

Estimated Models Of Northwest Airlines Stock
Return Behavior -- August 16, 1987 MD-80 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	-0.0005 (-0.357)	-0.0006 (-0.391)	0.0001 (0.034)	0.0001 (0.074)	-0.0005 (-0.267)	-0.0007 (-0.343)
B	1.1352 (6.947)	1.3888 (5.307)	0.9472 (5.093)	1.2080 (4.029)	1.2387 (6.700)	1.4581 (4.924)
R^2	0.2459	0.1599	0.2093	0.1421	0.3142	0.1983

Estimated Models Of Major Airline Carrier Industry
Stock Return Behavior -- August 16, 1987 MD-80 Accident

	Model No. 1	Model No. 2	Model No. 3	Model No. 4	Model No. 5	Model No. 6
a	0.0001	-0.0001	0.0007	0.0007	0.0004	0.0001
	(0.125)	(-0.094)	(0.694)	(0.665)	(0.312)	(0.091)
B	1.0122	1.3359	0.9316	1.2487	1.0457	1.3144
	(9.362)	(7.614)	(8.124)	(6.509)	(8.277)	(6.421)
R^2	0.3719	0.2814	0.4025	0.3018	0.4115	0.2962

Appendix B

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident

Date

05/25/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-0.30	-0.34	-0.91	-3.85	-1.10
	(-0.17)	(-0.21)	(-0.31)	(-1.83)	(-1.09)
3	-0.16	-0.13	-0.81	-3.76	-0.99
	(-0.09)	(-0.09)	(-0.39)	(-1.76)	(-0.95)
4	-0.51	-0.37	-1.29	-4.19	-1.36
	(-0.30)	(-0.22)	(-0.60)	(-1.92)	(-1.32)
5	-0.45	-0.44	-0.89	-3.80	-1.21
	(-0.22)	(-0.26)	(-0.27)	(-1.77)	(-1.20)
6	-0.53	-0.46	-0.91	-3.96	-1.35
	(-0.22)	(-0.21)	(-0.24)	(-1.59)	(-1.06)

Date

05/29/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-9.51	1.60	0.43	-1.79	-0.78
	(-5.20)	(0.97)	(0.15)	(-0.85)	(-0.77)
3	-9.33	1.89	0.40	-1.65	-0.80
	(-5.57)	(1.34)	(0.19)	(-0.77)	(-0.77)
4	-9.42	1.73	0.26	-1.78	-0.89
	(-5.62)	(1.04)	(0.12)	(-0.82)	(-0.87)
5	-9.56	1.48	0.49	-1.74	-0.85
	(-4.71)	(0.86)	(0.15)	(-0.81)	(-0.83)
6	-9.83	1.19	0.07	-2.07	-1.03
	(-4.18)	(0.53)	(0.02)	(-0.83)	(-0.81)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

05/30/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-2.71 (-1.47)	0.14 (0.08)	0.37 (0.12)	1.22 (0.58)	0.53 (0.52)
3	-2.48 (-1.46)	0.59 (0.41)	0.12 (0.06)	1.46 (0.68)	0.26 (0.25)
4	-2.42 (-1.42)	0.21 (0.13)	0.12 (0.05)	1.46 (0.66)	0.34 (0.33)
5	-2.59 (-1.27)	-0.00 (-0.00)	0.51 (0.16)	1.29 (0.60)	0.55 (0.54)
6	-3.43 (-1.46)	-1.00 (-0.45)	-0.95 (-0.25)	0.36 (0.15)	-0.02 (-0.01)

Date

05/31/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	6.20 (3.39)	0.64 (0.39)	0.64 (0.21)	2.28 (1.08)	1.25 (1.24)
3	6.36 (3.80)	0.90 (0.64)	0.64 (0.31)	2.40 (1.13)	1.27 (1.23)
4	6.44 (3.84)	0.98 (0.59)	0.76 (0.35)	2.51 (1.15)	1.36 (1.33)
5	6.11 (3.02)	0.52 (0.30)	0.68 (0.21)	2.33 (1.09)	1.17 (1.16)
6	6.07 (2.58)	0.48 (0.22)	0.62 (0.16)	2.27 (0.91)	1.24 (0.98)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/01/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-6.91	0.15	-0.86	-1.24	-0.38
	(-3.78)	(0.09)	(-0.29)	(-0.59)	(-0.38)
3	-6.75	0.40	-0.83	-1.13	-0.34
	(-4.03)	(0.29)	(-0.39)	(-0.53)	(-0.33)
4	-6.75	0.43	-0.81	-1.11	-0.33
	(-4.02)	(0.26)	(-0.38)	(-0.51)	(-0.32)
5	-7.01	0.04	-0.82	-1.19	-0.47
	(-3.46)	(0.02)	(-0.25)	(-0.56)	(-0.46)
6	-7.05	0.02	-0.85	-1.25	-0.43
	(-3.00)	(0.01)	(-0.22)	(-0.50)	(-0.34)

Date

06/04/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-9.18	0.23	-1.22	-0.42	-0.39
	(-5.02)	(0.14)	(-0.41)	(-0.20)	(-0.38)
3	-9.03	0.45	-1.15	-0.32	-0.30
	(-5.39)	(0.32)	(-0.55)	(-0.15)	(-0.29)
4	-8.65	0.91	-0.60	0.19	0.08
	(-5.16)	(0.55)	(-0.28)	(0.09)	(0.08)
5	-9.30	0.12	-1.18	-0.37	-0.48
	(-4.58)	(0.07)	(-0.36)	(-0.17)	(-0.48)
6	-9.01	0.44	-0.72	-0.03	-0.04
	(-3.83)	(0.20)	(-0.19)	(-0.01)	(-0.03)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/05/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	4.76 (2.58)	-0.32 (-0.19)	3.54 (1.19)	-2.81 (-1.32)	-0.82 (-0.81)
3	4.84 (2.84)	-0.29 (-0.20)	3.88 (1.81)	-2.82 (-1.30)	-0.43 (-0.41)
4	5.42 (3.21)	0.83 (0.50)	4.81 (2.22)	-1.96 (-0.89)	0.15 (0.15)
5	4.43 (2.16)	-0.40 (-0.23)	3.48 (1.06)	-2.77 (-1.28)	-1.02 (-1.00)
6	5.66 (2.40)	1.02 (0.46)	5.56 (1.44)	-1.38 (-0.55)	0.25 (0.20)

Date

06/06/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-11.30 (-6.17)	2.99 (1.81)	0.46 (0.16)	-5.96 (-2.83)	-1.10 (-1.09)
3	-11.18 (-6.64)	3.13 (2.21)	0.65 (0.31)	-5.92 (-2.76)	-0.88 (-0.85)
4	-10.90 (-6.48)	3.70 (2.23)	1.11 (0.52)	-5.49 (-2.51)	-0.60 (-0.58)
5	-11.52 (-5.66)	2.89 (1.67)	0.45 (0.14)	-5.92 (-2.76)	-1.25 (-1.23)
6	-10.91 (-4.64)	3.61 (1.62)	1.50 (0.39)	-5.25 (-2.11)	-0.59 (-0.47)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/07/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-4.53	0.01	0.12	-0.11	-0.65
	(-2.48)	(0.01)	(0.04)	(-0.05)	(-0.65)
3	-4.40	0.17	0.29	-0.05	-0.46
	(-2.62)	(0.12)	(0.14)	(-0.02)	(-0.44)
4	-4.13	0.68	0.72	0.35	-0.19
	(-2.46)	(0.41)	(0.33)	(0.16)	(-0.18)
5	-4.73	-0.09	0.12	-0.06	-0.79
	(-2.33)	(-0.05)	(0.04)	(-0.03)	(-0.77)
6	-4.21	0.52	1.01	0.50	-0.20
	(-1.79)	(0.23)	(0.26)	(0.20)	(-0.16)

Date

06/08/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	4.77	0.52	1.88	0.62	0.07
	(2.61)	(0.31)	(0.64)	(0.29)	(0.07)
3	4.95	0.83	1.83	0.77	0.02
	(2.95)	(0.59)	(0.87)	(0.36)	(0.02)
4	4.20	-0.07	0.73	-0.24	-0.76
	(2.50)	(-0.04)	(0.34)	(-0.11)	(-0.74)
5	4.74	0.40	1.96	0.68	0.02
	(2.34)	(0.23)	(0.60)	(0.32)	(0.02)
6	3.96	-0.41	0.79	-0.30	-0.83
	(1.68)	(-0.18)	(0.20)	(-0.12)	(-0.66)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/11/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	2.46 (1.34)	-0.63 (-0.38)	-2.01 (-0.68)	-2.95 (-1.40)	-1.19 (-1.18)
3	2.61 (1.55)	-0.42 (-0.30)	-1.92 (-0.91)	-2.86 (-1.34)	-1.08 (-1.04)
4	3.07 (1.83)	0.17 (0.10)	-1.24 (-0.58)	-2.24 (-1.03)	-0.60 (-0.59)
5	2.32 (1.14)	-0.74 (-0.43)	-1.99 (-0.61)	-2.90 (-1.36)	-1.30 (-1.28)
6	2.74 (1.17)	-0.27 (-0.12)	-1.30 (-0.34)	-2.40 (-0.97)	-0.71 (-0.56)

Date

06/15/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-0.60 (-0.33)	-0.11 (-0.07)	-1.34 (-0.46)	-2.30 (-1.09)	-0.12 (-0.12)
3	-0.44 (-0.26)	0.14 (0.10)	-1.31 (-0.62)	-2.18 (-1.02)	-0.08 (-0.08)
4	-0.52 (-0.31)	0.07 (0.04)	-1.43 (-0.66)	-2.28 (-1.05)	-0.16 (-0.16)
5	-0.69 (-0.34)	-0.22 (-0.13)	-1.29 (-0.40)	-2.24 (-1.05)	-0.20 (-0.20)
6	-0.81 (-0.34)	-0.32 (-0.15)	-1.44 (-0.37)	-2.40 (-0.97)	-0.26 (-0.20)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/18/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-1.03 (-0.56)	1.31 (0.79)	3.64 (1.24)	0.36 (0.17)	0.24 (0.24)
3	-0.83 (-0.49)	1.69 (1.19)	3.49 (1.65)	0.56 (0.26)	0.08 (0.08)
4	-1.30 (-0.77)	0.93 (0.56)	2.77 (1.29)	-0.11 (-0.05)	-0.39 (-0.38)
5	-0.99 (-0.49)	1.18 (0.68)	3.75 (1.15)	0.43 (0.20)	0.23 (0.22)
6	-1.89 (-0.80)	0.19 (0.09)	2.32 (0.60)	-0.63 (-0.25)	-0.60 (-0.47)

Date

06/19/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	3.30 (1.80)	-0.88 (-0.53)	-1.19 (-0.40)	-1.11 (-0.53)	1.03 (1.02)
3	3.46 (2.07)	-0.61 (-0.43)	-1.18 (-0.56)	-0.98 (-0.46)	1.05 (1.01)
4	3.57 (2.13)	-0.52 (-0.31)	-1.03 (-0.48)	-0.85 (-0.39)	1.16 (1.14)
5	3.22 (1.59)	-0.99 (-0.57)	-1.14 (-0.35)	-1.05 (-0.49)	0.95 (0.94)
6	3.18 (1.35)	-1.03 (-0.46)	-1.19 (-0.31)	-1.11 (-0.44)	1.03 (0.81)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

06/25/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-1.51 (-0.83)	-0.33 (-0.20)	0.47 (0.16)	-2.01 (-0.95)	-1.16 (-1.15)
3	-1.32 (-0.78)	0.04 (0.03)	0.34 (0.16)	-1.82 (-0.85)	-1.30 (-1.25)
4	-1.21 (-0.72)	-0.10 (-0.06)	0.45 (0.21)	-1.73 (-0.79)	-1.17 (-1.14)
5	-1.48 (-0.73)	-0.45 (-0.26)	0.58 (0.18)	-1.95 (-0.91)	-1.18 (-1.17)
6	-1.95 (-0.83)	-1.01 (-0.45)	-0.24 (-0.06)	-2.47 (-0.99)	-1.44 (-1.13)

Date

07/05/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	1.42 (0.78)	0.19 (0.12)	-1.00 (-0.34)	0.37 (0.18)	0.29 (0.29)
3	1.56 (0.93)	0.39 (0.28)	-0.90 (-0.43)	0.46 (0.21)	0.42 (0.40)
4	1.56 (0.93)	0.53 (0.32)	-0.87 (-0.40)	0.49 (0.22)	0.42 (0.41)
5	1.27 (0.63)	0.09 (0.05)	-0.99 (-0.30)	0.42 (0.20)	0.18 (0.18)
6	1.44 (0.61)	0.32 (0.14)	-0.64 (-0.17)	0.58 (0.23)	0.38 (0.30)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

07/06/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-0.86	0.79	-1.95	-2.45	-1.43
	(-0.47)	(0.48)	(-0.66)	(-1.16)	(-1.41)
3	-0.76	0.86	-1.65	-2.45	-1.09
	(-0.45)	(0.60)	(-0.77)	(-1.13)	(-1.04)
4	-0.14	1.95	-0.68	-1.55	-0.46
	(-0.08)	(1.17)	(-0.31)	(-0.71)	(-0.45)
5	-1.15	0.71	-2.00	-2.41	-1.62
	(-0.57)	(0.41)	(-0.61)	(-1.12)	(-1.58)
6	-0.02	2.02	-0.09	-1.12	-0.41
	(-0.01)	(0.90)	(-0.02)	(-0.45)	(-0.32)

Date

07/10/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-2.70	-1.60	-0.63	0.86	--
	(-1.48)	(-0.97)	(-0.21)	(0.41)	--
3	-2.52	-1.27	-0.71	1.03	--
	(-1.50)	(-0.90)	(-0.34)	(0.48)	--
4	-2.57	-1.49	-0.82	0.93	--
	(-1.53)	(-0.90)	(-0.38)	(0.43)	--
5	-2.71	-1.72	-0.55	0.92	--
	(-1.34)	(-0.99)	(-0.17)	(0.43)	--
6	-3.13	-2.19	-1.23	0.44	--
	(-1.33)	(-0.98)	(-0.32)	(0.18)	--

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

07/13/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	3.65	-0.72	-0.03	0.93	0.75
	(2.00)	(-0.44)	(-0.01)	(0.44)	(0.74)
3	3.84	-0.39	-0.12	1.11	0.66
	(2.29)	(-0.27)	(-0.06)	(0.52)	(0.63)
4	3.87	-0.54	-0.12	1.10	0.69
	(2.30)	(-0.33)	(-0.06)	(0.50)	(0.67)
5	3.65	-0.85	0.06	1.00	0.71
	(1.80)	(-0.49)	(0.02)	(0.47)	(0.70)
6	3.26	-1.30	-0.06	0.55	0.48
	(1.39)	(-0.58)	(-0.16)	(0.22)	(0.38)

Date

07/17/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-4.09	-1.62	-2.44	0.10	-0.30
	(-2.23)	(-0.98)	(-0.83)	(0.04)	(-0.29)
3	-3.86	-1.17	-2.69	0.34	-0.57
	(-2.28)	(-0.82)	(-1.26)	(0.16)	(-0.54)
4	-3.76	-1.50	-2.63	0.39	-0.44
	(-2.21)	(-0.89)	(-1.21)	(0.18)	(-0.42)
5	-3.97	-1.76	-2.30	0.17	-0.28
	(-1.95)	(-1.01)	(-0.70)	(0.08)	(-0.27)
6	-4.79	-2.74	-3.73	-0.73	-0.81
	(-2.03)	(-1.22)	(-0.97)	(-0.29)	(-0.63)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1979 DC-10 Accident
(Continued)

Date

07/30/79

Model	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Industry
1	-1.64 (-0.90)	1.60 (0.97)	0.88 (0.30)	-0.15 (-0.07)	0.24 (0.23)
3	-1.48 (-0.88)	1.85 (1.31)	0.92 (0.44)	-0.04 (-0.02)	0.28 (0.27)
4	-1.54 (-0.92)	1.82 (1.10)	0.85 (0.39)	-0.10 (-0.05)	0.23 (0.22)
5	-1.74 (-0.86)	1.49 (0.86)	0.93 (0.28)	-0.10 (-0.05)	0.15 (0.15)
6	-1.81 (-0.77)	1.44 (0.66)	0.85 (0.22)	-0.21 (-0.08)	0.14 (0.11)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident

Date

08/02/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.13 (0.10)	0.24 (0.18)	-0.06 (-0.04)	-0.09 (-0.06)	-0.23 (-0.22)
3	0.06 (0.04)	0.24 (0.16)	-0.08 (-0.06)	-0.01 (-0.01)	-0.21 (-0.23)
4	-0.07 (-0.05)	0.03 (0.02)	-0.27 (-0.20)	-0.26 (-0.18)	-0.45 (-0.47)
5	0.34 (0.26)	0.42 (0.33)	0.03 (0.02)	0.02 (0.02)	-0.20 (-0.18)
6	0.17 (0.13)	0.23 (0.18)	-0.11 (-0.07)	-0.17 (-0.11)	-0.36 (-0.31)

Date

08/05/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.06 (-0.05)	0.09 (0.07)	-1.64 (-1.14)	-1.06 (-0.75)	-0.13 (-0.12)
3	-0.19 (-0.14)	0.10 (0.07)	-1.69 (-1.28)	-0.92 (-0.66)	-0.06 (-0.06)
4	0.32 (0.24)	0.94 (0.68)	-1.20 (-0.91)	-0.43 (-0.30)	0.43 (0.44)
5	0.20 (0.16)	0.29 (0.23)	-1.54 (-1.05)	-0.95 (-0.67)	-0.11 (-0.10)
6	0.74 (0.54)	0.90 (0.68)	-0.99 (-0.67)	-0.65 (-0.44)	0.23 (0.20)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

08/06/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.43 (0.33)	0.54 (0.38)	1.62 (1.10)	-0.26 (-0.18)	0.28 (0.26)
3	0.08 (0.06)	0.60 (0.40)	1.49 (1.10)	0.13 (0.09)	0.54 (0.56)
4	0.30 (0.22)	0.96 (0.68)	1.55 (1.14)	0.04 (0.03)	0.48 (0.48)
5	0.91 (0.68)	0.82 (0.63)	1.78 (1.18)	-0.14 (-0.10)	0.23 (0.21)
6	0.83 (0.60)	0.75 (0.56)	1.80 (1.19)	-0.41 (-0.27)	0.06 (0.05)

Date

08/07/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.92 (-0.72)	2.19 (1.60)	-0.41 (-0.28)	0.83 (0.58)	0.65 (0.61)
3	-0.97 (-0.70)	2.18 (1.50)	-0.43 (-0.33)	0.89 (0.64)	0.65 (0.71)
4	-0.58 (-0.43)	2.82 (2.05)	-0.04 (-0.03)	1.30 (0.91)	1.06 (1.09)
5	-0.73 (-0.56)	2.36 (1.87)	-0.33 (-0.23)	0.94 (0.67)	0.68 (0.63)
6	-0.26 (-0.19)	2.90 (2.21)	0.14 (0.10)	1.23 (0.83)	1.00 (0.86)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

08/08/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.03 (0.02)	0.07 (0.05)	-1.91 (-1.32)	-0.06 (-0.04)	0.25 (0.23)
3	0.26 (0.19)	-0.01 (-0.01)	-1.82 (-1.38)	-0.31 (-0.22)	0.02 (0.02)
4	-0.00 (-0.00)	-0.44 (-0.32)	-2.01 (-1.52)	-0.45 (-0.31)	-0.12 (-0.13)
5	-0.06 (-0.04)	0.13 (0.10)	-1.91 (-1.30)	0.04 (0.03)	0.37 (0.34)
6	-0.04 (-0.03)	0.14 (0.10)	-1.94 (-1.31)	0.15 (0.10)	0.44 (0.38)

Date

08/09/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.41 (-0.32)	0.42 (0.31)	1.56 (1.09)	0.60 (0.43)	0.51 (0.49)
3	-0.47 (-0.34)	0.41 (0.29)	1.54 (1.17)	0.67 (0.49)	0.53 (0.57)
4	-0.71 (-0.53)	0.02 (0.02)	1.24 (0.95)	0.29 (0.21)	0.16 (0.16)
5	-0.21 (-0.16)	0.59 (0.47)	1.65 (1.12)	0.71 (0.51)	0.55 (0.50)
6	-0.50 (-0.37)	0.26 (0.20)	1.39 (0.94)	0.44 (0.30)	0.30 (0.26)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

09/04/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.33 (0.25)	-1.55 (-1.13)	-2.12 (-1.47)	-1.48 (-1.04)	-0.90 (-0.85)
3	0.24 (0.18)	-1.55 (-1.07)	-2.15 (-1.63)	-1.39 (-1.00)	-0.87 (-0.93)
4	0.55 (0.41)	-1.05 (-0.76)	-1.87 (-1.42)	-1.11 (-0.78)	-0.59 (-0.61)
5	0.55 (0.42)	-1.37 (-1.09)	-2.03 (-1.38)	-1.37 (-0.97)	-0.87 (-0.79)
6	0.88 (0.65)	-0.98 (-0.75)	-1.68 (-1.13)	-1.19 (-0.81)	-0.66 (-0.57)

Date

09/05/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.42 (-0.33)	3.51 (2.57)	0.98 (0.68)	-0.80 (-0.57)	-0.52 (-0.50)
3	-0.42 (-0.31)	3.49 (2.41)	0.98 (0.75)	-0.81 (-0.58)	-0.56 (-0.61)
4	-0.28 (-0.21)	3.71 (2.71)	1.12 (0.85)	-0.66 (-0.47)	-0.42 (-0.43)
5	-0.28 (-0.22)	3.66 (2.91)	1.04 (0.71)	-0.69 (-0.50)	-0.47 (-0.43)
6	-0.05 (-0.04)	3.92 (3.00)	1.27 (0.86)	-0.55 (-0.38)	-0.31 (-0.27)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

09/30/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.58 (-0.45)	-0.57 (-0.42)	-2.03 (-1.41)	-1.62 (-1.14)	0.13 (0.13)
3	-0.48 (-0.35)	-0.61 (-0.42)	-1.99 (-1.52)	-1.72 (-1.25)	0.02 (0.02)
4	-0.09 (-0.07)	0.04 (0.03)	-1.53 (-1.17)	-1.16 (-0.82)	0.56 (0.58)
5	-0.53 (-0.40)	-0.46 (-0.37)	-1.99 (-1.36)	-1.51 (-1.08)	0.22 (0.20)
6	0.12 (0.09)	0.28 (0.21)	-1.38 (-0.94)	-1.01 (-0.69)	0.70 (0.61)

Date

10/01/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.77 (0.59)	0.01 (0.01)	-1.18 (-0.80)	-1.14 (-0.79)	0.15 (0.14)
3	1.20 (0.85)	-0.11 (-0.07)	-1.01 (-0.74)	-1.62 (-1.13)	-0.25 (-0.26)
4	1.47 (1.07)	0.33 (0.23)	-0.54 (-0.40)	-0.90 (-0.63)	0.43 (0.44)
5	0.50 (0.37)	-0.00 (-0.00)	-1.23 (-0.82)	-1.04 (-0.73)	0.33 (0.30)
6	1.37 (1.01)	0.98 (0.74)	-0.48 (-0.32)	-0.20 (-0.14)	1.09 (0.94)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

10/03/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.92	-0.78	0.07	0.16	0.42
	(0.71)	(-0.57)	(0.05)	(0.11)	(0.39)
3	0.96	-0.81	0.08	0.11	0.34
	(0.70)	(-0.56)	(0.06)	(0.08)	(0.37)
4	1.03	-0.69	0.17	0.22	0.45
	(0.77)	(-0.50)	(0.13)	(0.16)	(0.46)
5	1.02	-0.65	0.12	0.27	0.48
	(0.78)	(-0.52)	(0.08)	(0.19)	(0.44)
6	1.22	-0.42	0.32	0.41	0.63
	(0.91)	(-0.32)	(0.21)	(0.28)	(0.55)

Date

10/04/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.25	-2.01	-0.80	-1.14	-0.54
	(-0.19)	(-1.46)	(-0.55)	(-0.80)	(-0.51)
3	-0.39	-1.99	-0.85	-0.98	-0.46
	(-0.28)	(-1.36)	(-0.64)	(-0.70)	(-0.49)
4	-0.52	-2.20	-1.07	-1.30	-0.77
	(-0.39)	(-1.60)	(-0.81)	(-0.91)	(-0.79)
5	0.03	-1.80	-0.69	-1.02	-0.53
	(0.02)	(-1.42)	(-0.47)	(-0.73)	(-0.49)
6	-0.22	-2.08	-0.89	-1.31	-0.78
	(-0.17)	(-1.59)	(-0.60)	(-0.89)	(-0.67)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

10/24/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-5.16	-0.58	-2.30	-0.55	-0.92
	(-4.02)	(-0.42)	(-1.60)	(-0.38)	(-0.88)
3	-5.23	-0.58	-2.33	-0.47	-0.90
	(-3.81)	(-0.40)	(-1.77)	(-0.34)	(-0.97)
4	-5.47	-0.97	-2.63	-0.85	-1.27
	(-4.08)	(-0.71)	(-2.01)	(-0.60)	(-1.32)
5	-4.95	-0.40	-2.22	-0.44	-0.89
	(-3.79)	(-0.32)	(-1.51)	(-0.31)	(-0.82)
6	-5.25	-0.74	-2.48	-0.72	-1.15
	(-3.91)	(-0.57)	(-1.68)	(-0.49)	(-1.00)

Date

10/25/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-1.27	-0.97	0.19	-2.46	-1.29
	(-0.99)	(-0.71)	(0.13)	(-1.72)	(-1.22)
3	-1.41	-0.96	0.14	-2.31	-1.21
	(-1.02)	(-0.66)	(0.11)	(-1.66)	(-1.30)
4	-1.53	-1.15	-0.06	-2.61	-1.50
	(-1.14)	(-0.84)	(-0.05)	(-1.84)	(-1.55)
5	-1.00	-0.77	0.30	-2.35	-1.28
	(-0.76)	(-0.61)	(0.20)	(-1.66)	(-1.17)
6	-1.23	-1.03	0.11	-2.62	-1.51
	(-0.92)	(-0.79)	(0.08)	(-1.77)	(-1.31)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

10/29/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-2.33 (-1.81)	-0.22 (-0.16)	0.03 (0.02)	0.02 (0.01)	-0.11 (-0.11)
3	-2.12 (-1.53)	-0.29 (-0.20)	0.11 (0.09)	-0.22 (-0.16)	-0.33 (-0.35)
4	-1.89 (-1.41)	0.09 (0.06)	0.45 (0.34)	0.25 (0.17)	0.12 (0.12)
5	-2.39 (-1.83)	-0.16 (-0.12)	0.04 (0.03)	0.12 (0.08)	0.00 (0.00)
6	-1.81 (-1.35)	0.50 (0.39)	0.56 (0.38)	0.63 (0.43)	0.48 (0.42)

Date

10/30/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.77 (-0.60)	1.13 (0.82)	-0.92 (-0.64)	0.42 (0.29)	-0.26 (-0.25)
3	-0.64 (-0.47)	1.08 (0.74)	-0.87 (-0.66)	0.28 (0.20)	-0.40 (-0.44)
4	-0.46 (-0.34)	1.37 (1.00)	-0.63 (-0.48)	0.59 (0.42)	-0.10 (-0.10)
5	-0.75 (-0.57)	1.23 (0.97)	-0.89 (-0.61)	0.52 (0.37)	-0.17 (-0.15)
6	-0.32 (-0.24)	1.71 (1.31)	-0.50 (-0.34)	0.88 (0.60)	0.17 (0.15)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

10/31/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.28	-1.03	1.15	-1.90	-0.82
	(0.22)	(-0.75)	(0.80)	(-1.34)	(-0.78)
3	0.28	-1.05	1.15	-1.90	-0.86
	(0.20)	(-0.72)	(0.88)	(-1.37)	(-0.93)
4	0.11	-1.33	0.95	-2.14	-1.10
	(0.08)	(-0.97)	(0.73)	(-1.51)	(-1.14)
5	0.43	-0.88	1.22	-1.79	-0.77
	(0.33)	(-0.70)	(0.83)	(-1.28)	(-0.71)
6	0.28	-1.05	1.09	-1.93	-0.89
	(0.21)	(-0.80)	(0.74)	(-1.31)	(-0.78)

Date

11/01/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	-0.10	-1.70	0.48	1.95	0.96
	(-0.08)	(-1.24)	(0.33)	(1.37)	(0.91)
3	0.12	-1.77	0.57	1.70	0.73
	(0.09)	(-1.21)	(0.43)	(1.22)	(0.78)
4	0.18	-1.69	0.72	1.96	0.97
	(0.13)	(-1.22)	(0.55)	(1.37)	(1.00)
5	-0.18	-1.64	0.48	2.05	1.08
	(-0.14)	(-1.30)	(0.33)	(1.45)	(0.99)
6	0.21	-1.21	0.81	2.43	1.42
	(0.15)	(-0.92)	(0.55)	(1.65)	(1.23)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1985 L-1011 Accident
(Continued)

Date

11/04/85

Model	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Industry
1	0.27	0.62	-1.05	0.38	-0.88
	(0.21)	(0.46)	(-0.73)	(0.27)	(-0.84)
3	0.27	0.60	-1.05	0.38	-0.92
	(0.20)	(0.42)	(-0.80)	(0.28)	(-0.99)
4	0.36	0.76	-0.96	0.47	-0.83
	(0.27)	(0.55)	(-0.73)	(0.33)	(-0.86)
5	0.41	0.77	-0.98	0.49	-0.83
	(0.32)	(0.61)	(-0.67)	(0.35)	(-0.76)
6	0.58	0.97	-0.81	0.59	-0.71
	(0.43)	(0.74)	(-0.55)	(0.40)	(-0.62)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident

Date

08/17/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-0.29 (-0.27)	0.74 (0.40)	-0.25 (-0.12)	-2.28 (-1.33)	-1.48 (-1.31)
3	-0.31 (-0.27)	0.72 (0.36)	-0.32 (-0.14)	-2.32 (-1.38)	-1.53 (-1.48)
4	-0.08 (-0.07)	0.91 (0.45)	-0.18 (-0.08)	-2.09 (-1.19)	-1.29 (-1.15)
5	-0.20 (-0.17)	0.82 (0.56)	-0.21 (-0.09)	-2.29 (-1.28)	-1.51 (-1.23)
6	0.04 (0.04)	0.99 (0.67)	-0.24 (-0.01)	-1.98 (-1.02)	-1.22 (-0.91)

Date

08/18/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.49 (0.44)	-0.35 (-0.19)	6.15 (2.82)	0.08 (0.05)	0.31 (0.27)
3	0.50 (0.43)	-0.17 (-0.08)	5.94 (2.56)	-0.24 (-0.14)	0.13 (0.13)
4	0.64 (0.54)	-0.15 (-0.07)	5.90 (2.53)	-0.39 (-0.22)	0.05 (0.04)
5	0.57 (0.48)	-0.34 (-0.23)	6.17 (2.59)	0.23 (0.12)	0.33 (0.26)
6	0.68 (0.57)	-0.28 (-0.19)	6.17 (2.57)	-0.07 (-0.03)	0.17 (0.13)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident
(Continued)

Date

08/19/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.49 (0.46)	0.97 (0.53)	-1.54 (-0.72)	-0.96 (-0.56)	0.48 (0.42)
3	0.48 (0.41)	0.95 (0.47)	-1.62 (-0.71)	-1.00 (-0.59)	0.43 (0.41)
4	0.32 (0.27)	0.82 (0.40)	-1.72 (-0.75)	-1.16 (-0.66)	0.26 (0.23)
5	0.58 (0.50)	1.06 (0.72)	-1.51 (-0.64)	-0.98 (-0.54)	0.45 (0.37)
6	0.47 (0.40)	0.98 (0.67)	-1.60 (-0.68)	-1.13 (-0.58)	0.31 (0.23)

Date

08/20/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-0.01 (-0.01)	-0.74 (-0.40)	-1.98 (-0.91)	-1.95 (-1.13)	-1.85 (-1.62)
3	-0.06 (-0.05)	-0.94 (-0.46)	-1.94 (-0.84)	-1.74 (-1.02)	-1.79 (-1.71)
4	-0.24 (-0.20)	-1.01 (-0.49)	-1.94 (-0.83)	-1.66 (-0.94)	-1.78 (-1.57)
5	0.09 (0.07)	-0.59 (-0.39)	-1.93 (-0.81)	-2.11 (-1.16)	-1.92 (-1.55)
6	-0.00 (-0.00)	-0.64 (-0.43)	-1.93 (-0.81)	-1.85 (-0.94)	-1.79 (-1.32)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident
(Continued)

Date

08/21/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.06	-0.33	2.74	1.19	-0.02
	(0.05)	(-0.18)	(1.27)	(0.70)	(-0.02)
3	0.03	-0.37	2.68	1.18	-0.06
	(0.03)	(-0.18)	(1.17)	(0.70)	(-0.06)
4	-0.08	-0.45	2.62	1.10	-0.15
	(-0.07)	(-0.22)	(1.14)	(0.63)	(-0.14)
5	0.15	-0.23	2.78	1.16	-0.06
	(0.12)	(-0.16)	(1.18)	(0.65)	(-0.05)
6	0.08	-0.27	2.73	1.11	-0.11
	(0.07)	(-0.19)	(1.16)	(0.57)	(-0.08)

Date

08/24/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.22	3.05	-0.22	1.63	0.84
	(0.20)	(1.65)	(-0.10)	(0.95)	(0.74)
3	0.22	3.13	-0.36	1.46	0.73
	(0.19)	(1.54)	(-0.16)	(0.87)	(0.71)
4	0.13	3.01	-0.47	1.24	0.54
	(0.11)	(1.48)	(-0.20)	(0.71)	(0.48)
5	0.31	3.10	-0.20	1.69	0.84
	(0.26)	(2.09)	(-0.08)	(0.94)	(0.68)
6	0.24	3.05	-0.29	1.39	0.62
	(0.20)	(2.06)	(-0.12)	(0.72)	(0.46)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident
(Continued)

Date

08/25/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-0.57 (-0.53)	-0.68 (-0.37)	-0.54 (-0.25)	-1.33 (-0.78)	-0.83 (-0.73)
3	-0.61 (-0.52)	-0.81 (-0.40)	-0.55 (-0.24)	-1.22 (-0.72)	-0.82 (-0.79)
4	-0.46 (-0.40)	-0.64 (-0.31)	-0.39 (-0.17)	-0.92 (-0.52)	-0.55 (-0.49)
5	-0.48 (-0.41)	-0.55 (-0.37)	-0.50 (-0.21)	-1.43 (-0.79)	-0.89 (-0.72)
6	-0.29 (-0.25)	-0.41 (-0.28)	-0.31 (-0.13)	-0.95 (-0.49)	-0.51 (-0.38)

Date

08/26/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.47 (0.43)	0.11 (0.06)	0.15 (0.07)	-0.43 (-0.25)	0.08 (0.07)
3	0.46 (0.40)	0.17 (0.09)	0.02 (0.01)	-0.58 (-0.34)	-0.02 (-0.02)
4	0.19 (0.16)	-0.09 (-0.05)	-0.20 (-0.09)	-0.97 (-0.56)	-0.40 (-0.36)
5	0.55 (0.47)	0.17 (0.11)	0.17 (0.07)	-0.37 (-0.21)	0.07 (0.06)
6	0.31 (0.27)	-0.00 (-0.00)	-0.05 (-0.02)	-0.87 (-0.45)	-0.33 (-0.25)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident
(Continued)

Date

10/16/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-2.77 (-2.30)	-4.16 (-2.03)	-3.48 (-1.46)	2.10 (1.11)	0.74 (0.59)
3	-2.67 (-2.01)	-3.52 (-1.53)	-4.00 (-1.53)	1.13 (0.59)	0.29 (0.24)
4	-1.61 (-1.15)	-2.95 (-1.20)	-3.73 (-1.34)	1.25 (0.59)	0.65 (0.48)
5	-2.70 (-2.04)	-4.34 (-2.61)	-3.50 (-1.32)	2.61 (1.29)	0.87 (0.63)
6	-1.84 (-1.35)	-3.79 (-2.19)	-3.10 (-1.11)	2.32 (1.02)	0.97 (0.61)

Date

10/19/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-2.86 (-1.32)	-1.66 (-0.45)	-13.43 (-3.10)	6.11 (1.78)	1.61 (0.71)
3	-2.45 (-0.94)	0.74 (0.16)	-15.11 (-2.94)	2.66 (0.71)	0.10 (0.04)
4	1.01 (0.33)	2.48 (0.46)	-14.39 (-2.37)	2.70 (0.58)	1.00 (0.34)
5	-2.85 (-1.15)	-2.52 (-0.80)	-13.58 (-2.72)	7.97 (2.09)	2.19 (0.84)
6	-0.18 (-0.06)	-0.86 (-0.24)	-12.46 (-2.19)	6.33 (1.36)	2.00 (0.62)

Calculated Abnormal Returns and Z-Statistics
For Models 1, 3, 4, 5, and 6 For Key Days
Relating to The 1987 MD-80 Accident
(Continued)

Date

11/16/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	-3.82 (-3.52)	0.92 (0.50)	0.83 (0.39)	-0.65 (-0.38)	2.18 (1.93)
3	-3.84 (-3.30)	0.87 (0.43)	0.78 (0.34)	-0.64 (-0.38)	2.14 (2.07)
4	-3.62 (-3.15)	1.07 (0.53)	0.93 (0.40)	-0.38 (-0.22)	2.40 (2.15)
5	-3.73 (-3.17)	1.02 (0.69)	0.87 (0.37)	-0.68 (-0.38)	2.14 (1.74)
6	-3.49 (-3.00)	1.19 (0.81)	1.07 (0.45)	-0.31 (-0.16)	2.46 (1.84)

Date

11/17/87

Model	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Industry
1	0.90 (0.82)	0.15 (0.08)	0.26 (0.12)	1.97 (1.14)	0.42 (0.36)
3	0.92 (0.78)	0.33 (0.16)	0.05 (0.02)	1.65 (0.97)	0.24 (0.23)
4	1.37 (1.16)	0.62 (0.30)	0.22 (0.09)	1.82 (1.02)	0.49 (0.43)
5	0.98 (0.83)	0.16 (0.11)	0.28 (0.12)	2.11 (1.16)	0.44 (0.35)
6	1.39 (1.17)	0.43 (0.28)	0.52 (0.21)	2.22 (1.12)	0.64 (0.46)

Appendix C

Other News Items On Days Without
News Regarding The L-1011 And MD-80 Accidents

Other News Items Relating To Lockheed And
Delta Airlines During The Prediction Period
On Days Without News Regarding The Accident

Date   Event

08/06/85   Lockheed wins Navy contract totaling $63.7
                    million.

08/11/85   Lockheed joins McDonnell Douglas team
                    competing to build framework of U.S. manned
                    space station; this team won a 21-month, $27
                    million contract from NASA in April to do
                    preliminary design studies.

08/29/85   Lockheed wins Air Force contracts totaling
                    $32 million for C-141 technical manuals and
                    aircraft repairs.

09/02/85   Lockheed wins a $16.6 million Air Force
                    contract for laser-optics research.

09/07/85   Minor fire breaks out on British AirTours
                    L-1011 about to take off from Gatwick
                    Airport, but was automatically extinguished;
                    no injuries; fuel had collected in tailpipe.

09/20/85   Lockheed must replace as many as 25,000 nuts
                    on each of 5 new C-5Bs (largest plane in
                    world) before Air Force will accept planes;
                    Lockheed spokesman says costs of replacing
                    not known.

09/22/85   Delta announces plans to build $45 million
                    expansion of its Dallas-Ft. Worth terminal.

10/02/85   Delta places $105 million order with
                    Rolls-Royce for 18 RB211 engines, to be used
                    to increase range of six L-1011s.

                    Delta to begin service to Munich and
                    Stuttgart, West Germany on April 27 and to
                    Ireland on May 7.

10/07/85   Delta's traffic rises.

                    Lockheed names Kitchen chairman and CEO; he
                    has been firm's primary spokesman answering
                    public and Congressional criticism of
                    procurement process and the role of
                    contractors.

Date	Event
10/09/85	Air Force is seeking proposals for new fighter plane to enter nation's arsenal in mid-1990s; bidding is open, but RFPs have been sent to seven major aerospace companies, including Lockheed.
10/10/85	Lockheed wins Air Force contract totaling $72.5 million.
10/17/85	Lockheed net income rose 14.6% in third quarter to $102 million, or $1.54 per share, up from $1.36 per share in same quarter of 1984; higher earnings, which were in line with analysts' expectations, were attributable to increased sales, that led to increased program profits.
10/23/85	Units of Lockheed win $12.7 million contract to support testing at Dugway Proving Grounds, Utah
10/25/85	Delta's net income dropped 51% for first fiscal quarter due to drop in average revenue per passenger mile caused by deep-discount fares initiated by other carriers in some of Delta's major markets; this quarter included gain of $0.19/share from proceeds of insurance payment on crashed Dallas jet.
	Delta L-1011 with 226 people aboard aborted take-off from Grapevine, Texas after fuel caught fire in an engine; no injuries.
	NTSB recommends that all L-1011 jets be inspected immediately to check electrical and other systems involved in a brief fire aboard Jordanian airliner last week; if recommendation is adopted by FAA, it will be binding on all U.S. airlines; FAA and Lockheed spokesmen indicated that they are studying the problem and will take appropriate action; there are 246 L-1011s operating worldwide, including 83 in the United States.

Date	Event
11/07/85	Army and SDI Organization make tentative award to Lockheed to design part of system that would destroy incoming warheads before they enter atmosphere; five year contract, terms to be negotiated, value unknown but expected to exceed $200 million, one of largest SDI contract awarded thus far; two other unnamed firms had also competed.
11/11/85	Thanksgiving and Christmas discounts planned by Delta for round-trip domestic flights.
11/13/85	Lockheed weighing possible purchase in electronics field, maybe as early as next year; currently searching for major candidate or, possibly, several smaller ones.
11/18/85	Lockheed Corp. wins Navy contracts totaling $331.6 million to develop and produce Trident ballistic missiles and to produce naval ID systems.
11/20/85	Lockheed wins $69.8 million Navy contract to support the fleet ballistic missile program.
11/26/85	Lockheed defends $544 price on toilet seat cover, due to small quantities, stringent specifications; invited outside bids since complaints, but received none.
12/01/85	$662.7 million added to Lockheed Air Force contract for C-5B aircraft production.
12/03/85	Lockheed wins $19.6 million contract for engineering and support services at White Sands Missile Range in New Mexico.

Other News Items Relating To McDonnell Douglas
And Northwest Airlines During The Prediction Period
On Days Without News Regarding The Accident

Date   Event

08/26/87   Units of McDonnell Douglas Corp. win Air
                  Force contracts totaling $14.6 million for
                  test equipment

08/30/87   Northwest revising discount fair structure
                  effective September 8, raising ticket prices
                  and increasing advance purchase
                  requirements; representative of industry
                  trend.

08/31/87   Units of McDonnell Douglas Corp. win Army
                  and Air Force contracts totaling $124.7
                  million for parts and equipment.

                  Data show McDonnell Douglas is third largest
                  military electronics contractor for 1986
                  fiscal year; Hughes is first.

09/02/87   McDonnell Douglas Corp. to build 118,000
                  square foot assembly plant in Pueblo,
                  Colorado for its Delta rocket.

09/04/87   Northwest passes Continental as "most
                  complained about" airline, based on DOT's
                  August report to be released today.

09/07/87   Units of McDonnell Douglas Corp. win Navy
                  contracts totaling $43.3 million for FA-18
                  test equipment.

09/09/87   Northwest announced it will give free
                  tickets for continental U.S. and Canada to
                  passengers who fly first class or executive
                  across the Pacific this fall.

9/14/87   McDonnell Douglas Corp. likely to be
                  supplier of design for Japan's new fighter
                  jet.

                  McDonnell Douglas Corp. wins $14 million
                  contract for Harpoon missile support
                  equipment.

Date	Event
09/15/87	McDonnell Douglas Corp. wins $60 million Navy contract for FA-18 aircraft training equipment
	Boeing and McDonnell Douglas to meet with Chinese delegation to discuss possible production of up to 150 mid-sized jetliners in China.
09/16/87	Northwest files $20 million suit against machinists union, alleging slowdown; union calls suit frivolous.
09/21/87	McDonnell Douglas wins $361.8 million in work for Navy, Air Force, and Army.
09/24/87	U.S. justice Department joins civil lawsuit alleging that McDonnell Douglas improperly charged more than $1.1 million on Army's Apache helicopter program.
09/25/87	Units of McDonnell Douglas win contracts totaling $47.6 million from Air Force, Navy, and Army.
09/28/87	Units of McDonnell Douglas win contracts totaling $39.9 million from Air Force, Navy, and Army.
09/29/87	Northwest Airlines to add five McDonnell Douglas DC-9s to its fleet; will buy one from Yugoslav Air and lease four from Swissair.
09/30/87	McDonnell Douglas units win $105.7 million in jobs for Air Force and Army.
10/07/87	General Dynamics, Rockwell, and McDonnell Douglas each awarded $25.5 million to develop designs for prototypes of hypersonic aerospace plane; Boeing and Lockheed are losers.

Date	Event
10/12/87	McDonnell Douglas Corp. announced that its Information Systems Group had laid off 300 workers (3% of its workforce) since September.
10/14/87	McDonnell Douglas wins Defense work totaling $89.6 million.
	McDonnell Douglas to hold talks with Airbus about possibility of cooperating on new aircraft projects.
10/21/87	McDonnell Douglas and Boeing are developing propfan aircraft; could bring propfan-powered MD-80s onto market by 1991; believes orders will begin to stream in early in 1988.
10/27/87	U.S., European governments continue to negotiate Airbus dispute; McDonnell Douglas welcomes talks, but will not rule out unfair trade case until negotiations concluded.
10/28/87	McDonnell Douglas Corp. income rose 88.4% to $80.3 million in third quarter.
11/02/87	McDonnell Douglas wins Navy contracts totaling $311 million to produce Tomahawk cruise missiles and aircraft.
11/04/87	Army accepts delivery of 285 new Apache helicopter gunships made by McDonnell Douglas, even though a number of problems identified two years ago are still not resolved; McDonnell Douglas is absorbing costs relating to the repairs.
11/08/87	Canadian government ordered McDonnell Douglas to suspend delivery of F-18 fighters due to problems with General Electric (GE) engines that may cause fires; Canada has suspended payment and is working with GE and McDonnell Douglas to negotiate sharing of repair costs.

Date	Event
11/11/87	Northwest's October traffic fell slightly to 2.84 billion revenue passenger miles from 2.86 billion a year earlier; percent of available seats filled rose from 55% to 59.4%.
11/15/87	McDonnell Douglas found metal fatigue problems in six of 150 navy F-18s that have been inspected so far; repairs, to start next year, will result in material change to future earnings. McDonnell Douglas wins $510 million in Army contracts for AH-64 helicopters and support equipment.
11/17/87	Northwest unilaterally decides to raise wages of 2,900 former Republic Airlines mechanics and ground workers; union protests, wants all employees' contracts negotiated at same time.
11/18/87	U.S. Marine commander in California bans night flights of F-18s over oceans following crashes involving unexplained engine (GE) fires; asks McDonnell Douglas and GE to determine cause of fires; Canada also experienced recent problems with F-18s, with costs of repairs estimated at minimum of $60 million.
11/22/87	Northwest sued by union over raises unilaterally imposed by Northwest; says no contracts can be imposed until Federal mediator reviews wage talks, which reached an impasse on November 4. Denver crash inquiry focuses on engine noise (thumps) and possible link to ice/snow on wings.
11/24/87	Units of McDonnell Douglas win Air Force and Navy contracts totaling $14 million.
12/01/87	McDonnell Douglas wins $21 million Navy contract for EF-18A aircraft production.

Date	Event
12/01/87	Boeing, McDonnell Douglas win space station contracts from NASA, $14 billion to $23 billion, but may be funding problems.
12/02/87	McDonnell Douglas wins $200 million Navy contract for aircraft production.
12/03/87	Scandinavian Airlines Systems pulls $1.4 billion order for McDonnell Douglas MD-11 jets.
12/06/87	Iberia Airlines selects McDonnell Douglas for big order -- 17 MD-87 planes to renew part of its passenger fleet; Boeing had been favored, but McDonnell Douglas won with last-minute offer.
12/10/87	U.S. District judge issued preliminary injunction blocking Northwest from implementing new contract for 2,900 employees; supports union suit.
	McDonnell Douglas gets $240 million contract to deliver F-18s to Navy.
12/20/87	Swissair will purchase six McDonnell Douglas MD-11 long-range jets and one MD-81 twin-engine, valued at a total of more than $600 million; represents win over Airbus in new generation of wide-body jets.
12/21/87	Northwest will resume flights to Seoul on January 1, which had been cancelled due to wildcat strike by South Korean workers.
	McDonnell-Douglas wins $54.2 million Air Force contract and $19 million Navy contract.

Appendix D

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns

Date	Event	Abnormal Returns (%) (Z-Statistic) McDonnell Douglas	Boeing	Lockheed	American	Major Airline Carrier Industry
05/25/79 Friday	McDonnell Douglas DC-10 owned by American Airlines crashes in Chicago shortly after takeoff from O'Hare Airport (4:04 pm, EDT).	-0.40 (-0.20)	-0.36 (-0.17)	-0.97 (-0.28)	-4.02 (-1.69)	-1.37 (-1.15)
05/28/79 Monday	FAA issues airworthiness directive instructing all U.S. DC-10 operators to inspect engine mounting bolts (10:58 am, EDT).	Holiday -- No Trading				
05/29/79 Tuesday	FAA grounds all DC-10s for further inspection by issuing a second airworthiness directive (8:59 pm, EDT).	-9.72 (-4.78)	1.33 (0.64)	0.06 (0.02)	-2.08 (-0.88)	-1.04 (-0.88)
05/30/79 Wednesday	Some DC-10s return to service after grounding.	-3.35 (-1.64)	-0.79 (-0.38)	-0.88 (-0.26)	0.42 (0.18)	-0.02 (-0.02)
05/31/79 Thursday	"Bolt" theory dismissed. FAA tallies the results of the second inspection. Safety defects were found in 37 of 138 U.S. registered DC-10s (revealed after market close). Also, Wall Street Journal reports on McDonnell Douglas' bid to supply F-18s to Canada and a $3.9 million Army contract.	6.18 (3.03)	0.62 (0.30)	0.60 (0.18)	2.25 (0.95)	1.22 (1.03)

Note: All abnormal return data presented here are based on estimation model number 2, i.e., using the equally-weighted market index as the independent variable and an estimation period of 150 trading days before the accident.

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Carrier Industry
06/01/79 Friday	The Airline Passengers Association announces it will file suit to ground all DC-10s until the problem(s) that caused the Chicago crash can be found and corrected.	-6.93 (-3.41)	0.15 (0.07)	-0.87 (-0.26)	-1.28 (-0.54)	-0.44 (-0.37)
06/04/79 Monday	NTSB issues its safety recommendations publicly. FAA announces that the second inspection it ordered may have caused more damage. Some DC-10s are regrounded at 9:00 pm EDT.	-8.90 (-4.37)	0.57 (0.28)	-0.73 (-0.22)	-0.05 (-0.02)	-0.05 (-0.04)
06/05/79 Tuesday	Federal judge orders all DC-10s be grounded until the cause of the Chicago crash is found and the problem(s) resolved (4:45 pm EDT). FAA wins a stay of the order (9:30 pm EDT) to contest it in court the following day.	5.80 (2.84)	1.10 (0.52)	5.46 (1.60)	-1.47 (-0.62)	0.23 (0.19)
06/06/79 Wednesday	At 3:00 am EDT the FAA decides to ground all DC-10s and starts informing operators immediately. McDonnell Douglas learns of it at 5:45 am EDT. At 9:00 am EDT the FAA announces that it does not object to the temporary restraining order. At 2:00 pm EDT the FAA explains its position at a press conference.	-10.79 (-5.29)	3.71 (1.78)	1.43 (0.42)	-5.31 (-2.23)	-0.61 (-0.51)

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Carrier Industry
06/07/79 Thursday	Two DC-10 customers rumored to be ready to cancel orders for 10 DC-10s worth $400 million. McDonnell Douglas receives $110 million Air Force contract.	-4.09 (-2.01)	0.63 (0.30)	0.95 (0.28)	0.44 (0.19)	-0.22 (-0.19)
06/08/79 Friday	Maintenance emerges as the principle cause of the crash. Court battles to lift the grounding figure prominently. McDonnell Douglas wins Allegheny order for 10 DC-9s valued at $115 million.	4.07 (2.00)	-0.29 (-0.14)	0.76 (0.22)	-0.33 (-0.14)	-0.85 (-0.71)
06/11/79 Monday	Congressional hearings on air travel safety start.	2.86 (1.40)	-0.13 (-0.06)	-1.32 (-0.39)	-2.43 (-1.02)	-0.72 (-0.61)
06/15/79 Friday	Judge issues order staying further proceedings.	-0.69 (-0.34)	-0.19 (-0.09)	-1.47 (-0.43)	-2.43 (-1.02)	-0.27 (-0.23)
06/18/79 Monday	NTSB tells Congressional hearing that the American Airlines DC-10 that crashed was probably damaged during maintenance in March. European airlines agree on a maintenance plan that would allow their DC-10s to fly again, but not in U.S. airspace.	-1.78 (-0.88)	0.35 (0.17)	2.33 (0.68)	-0.63 (-0.26)	-0.61 (-0.51)

151

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns
(Continued)

Abnormal Returns (%) (Z-Statistic)

Date	Event	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Carrier Industry
06/19/79 Tuesday	FAA clears the Boeing 747, Airbus A300B, and Lockheed L-1011 of faults similar to the DC-10s.	3.29 (1.61)	-0.88 (-0.42)	-1.20 (-0.35)	-1.12 (-0.47)	1.02 (0.86)
	European airlines resume non-U.S. DC-10 flights.					
06/25/79 Monday	At hearings before an administrative law judge of the NTSB, the FAA and McDonnell Douglas agree to a one-week postponement to try to reach an out-of-court settlement.	-1.86 (-0.91)	-0.83 (-0.40)	-0.20 (-0.06)	-2.44 (-1.03)	-1.45 (-1.22)
07/04/79 Wednesday	FAA announces it will tighten its supervision of carrier maintenance procedures.	Holiday -- No Trading				
07/05/79 Thursday		1.56 (0.77)	0.43 (0.21)	-0.69 (-0.20)	0.53 (0.22)	0.37 (0.31)
07/06/79 Friday	FAA announces it hopes to lift grounding order on Tuesday, July 10. DC-10s would not fly until 24 hours later due to court-imposed moratorium.	0.11 (0.06)	2.10 (1.01)	-0.17 (-0.05)	-1.20 (-0.50)	-0.43 (-0.36)

Major Events Surrounding The 1979 DC-10 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	American	Major Airline Carrier Industry
07/10/79 Tuesday	FAA says that the design of the DC-10 pylon assembly poses hazards and recommends changes.	-3.03 (-1.49)	-2.03 (-0.97)	-1.22 (-0.36)	0.44 (0.19)	-- --
07/13/79 Friday	DC-10 type certificate reinstated. Planes start flying again.	3.36 (1.65)	-1.14 (-0.54)	-0.59 (-0.17)	0.56 (0.23)	0.47 (0.39)
07/17/79 Tuesday	FAA charges McDonnell Douglas made manufacturing mistake, quality control broke down. American Airlines defends its maintenance practices, which were also criticized by the FAA.	-4.71 (-2.31)	-2.53 (-1.21)	-3.65 (-1.07)	-0.67 (-0.28)	-0.81 (-0.68)
07/30/79 Monday	Metallurgist at NTSB hearings blames American Airlines for the Chicago accident.	-1.70 (-0.83)	1.57 (0.75)	0.82 (0.24)	-0.24 (-0.10)	0.12 (0.11)

153

Appendix E

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
08/02/85 Friday	Lockheed L-1011 owned by Delta Airlines crashes while trying to land during thunderstorm at Dallas-Fort Worth Airport at 6:05 pm, CDT. Witnesses report plane hit by lightning; also speculation regarding possible wind shear.	0.01 (0.01)	0.09 (0.07)	-0.19 (-0.13)	-0.26 (-0.17)	-0.39 (-0.35)
08/03/85 Saturday	NTSB investigators indicate that wind shear appears to be probable cause of accident, although airport sensors had not gone off and air traffic controllers had given no warnings of hazardous wind conditions. No confirmation of reports that lightning struck plane.	Weekend -- No Trading				
08/04/85 Sunday	NTSB says that crashed jet had been ordered by air traffic controllers to slow from 210 to 150 knots minutes before crash, in order to maintain distance from plane ahead. This would have made it difficult to escape if wind shear did hit. Airport wind shear alarms went off 12 to 14 minutes after crash.	Weekend -- No Trading				

Note: All abnormal return presented here are based on estimation model number 2, i.e., using the equally-weighted market index as the
          independent variable and an estimation period of 150 trading days before the accident.

155

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
08/05/85 Monday	NTSB says other causes not yet ruled out, but main theory is plane was hit by wind shear and crew could not pull out due to slower speed. No suggestion of pilot/controller error. Velocity and direction changes of air around plane shown by flight recorder indicative of wind shear. No evidence of problems with plane. Key question is how much did crew know of possibility of dangerous storm; last weather report they received indicated no dangerous winds.	0.45 (0.35)	0.75 (0.54)	-1.13 (-0.77)	-0.73 (-0.49)	0.26 (0.23)
08/07/85 Wednesday	NTSB says probe turning to Delta's pilot training programs. Cause still unknown for sure, but speculation focusing on wind shear.	-0.48 (-0.37)	2.75 (1.99)	0.03 (0.02)	1.15 (0.77)	1.00 (0.89)
08/08/85 Thursday	NTSB says Delta flight crew was not given the latest National Weather Service report that indicated the presence of cumulonimbus clouds, which usually develop into thunderstorms. Speculative whether this information would have affected the crew's decision to land.	-0.01 (-0.01)	0.02 (0.01)	-1.93 (-1.32)	0.04 (0.02)	0.31 (0.27)

156

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
08/09/85 Friday		-0.64 (-0.50)	0.13 (0.09)	1.32 (0.91)	0.35 (0.24)	0.26 (0.23)
09/04/85 Wednesday	Revealed that in court papers filed on August 29, Delta named the FAA as a third party in several lawsuits filed against Delta by passengers' relatives. Delta's suits allege that negligence of the air traffic controllers was partly to blame for the accident. No comment from FAA. NTSB investigation proceeding.	0.65 (0.50)	-1.13 (-0.81)	-1.79 (-1.22)	-1.28 (-0.86)	-0.66 (-0.59)
09/05/85 Thursday		-0.21 (-0.16)	3.78 (2.74)	1.19 (0.82)	-0.64 (-0.44)	-0.35 (-0.31)

157

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
09/30/85 Monday	NTSB releases transcripts of crew conversations and other documents. Crew of another Delta plane that landed 4 minutes before crash spoke, while taxiing, of very severe weather in area of crash. Crashed pilots were aware of storms in area -- they had requested route changes twice to avoid weather. Pilot complained of the inexperience of the air traffic controllers at Dallas-Fort Worth. Crew realized trouble just before crash; saw lightning and tried to abort landing, but it was too late. FAA says the thunderstorm report available 14 minutes before the crash was not of such severity that it would be forwarded routinely to flight crews. First official reports of thunderstorms and lightning came one minute after crash. Business jet that preceded Delta flight to same runway experienced loss of speed/altitude typical of wind shear.	-0.02 (-0.01)	0.14 (0.10)	-1.45 (-0.99)	-1.11 (-0.75)	0.66 (0.59)
10/01/85 Tuesday		1.45 (1.11)	0.86 (0.62)	-0.46 (-0.31)	-0.32 (-0.22)	0.94 (0.83)

158

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
10/03/85 Thursday	FAA defends Dallas air traffic controllers criticized by pilots of crashed jet; says statements either incorrect or taken out of context.	1.10 (0.85)	-0.55 (-0.40)	0.25 (0.17)	0.32 (0.21)	0.58 (0.52)
	Lockheed to sell 30 P-3C Orion anti-submarine aircraft to Japan, to be built in Japan under license to Kawasaki. Lockheed to receive undisclosed licensing fees and $1.5 million per plane.					
10/04/85 Friday		-0.43 (-0.33)	-2.23 (-1.61)	-0.99 (-0.68)	-1.40 (-0.94)	-0.79 (-0.70)
10/24/85 Thursday	NTSB releases report indicating that Dallas plane encountered severe microburst wind shear, which is the first official statement pinpointing wind shear as the cause. No evidence that lightning struck plane. It took the crew several seconds to decide to go full throttle, but it was too late. NTSB hearings to start next week. Lockheed expected to argue shear was flyable; Delta and pilot groups expected to argue the opposite.	-5.40 (-4.17)	-0.88 (-0.64)	-2.55 (-1.75)	-0.81 (-0.55)	-1.19 (-1.06)

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
10/24/85 Thursday (Cont.)	At annual meeting, Delta shareholders approve three anti-takeover measures. Delta says no known takeover efforts at this time.					
10/25/85 Friday		-1.43 (-1.11)	-1.18 (-0.85)	0.01 (0.01)	-2.71 (-1.83)	-1.52 (-1.36)
10/29/85 Tuesday	First day of NTSB hearings. Testimony focuses on failure of National Weather Service information about rapidly worsening thunderstorm conditions to be relayed to pilots.	-1.86 (-1.44)	0.38 (0.27)	0.53 (0.36)	0.53 (0.36)	0.39 (0.35)
10/30/85 Wednesday		-0.41 (-0.32)	1.58 (1.14)	-0.55 (-0.38)	0.77 (0.52)	0.10 (0.09)
10/31/85 Thursday	Representative from NASA's Ames Research Center testifies that crew did all they could; may have been humanly possible to save plane, but crew fought wildly variable winds in the final seconds.	0.16 (0.13)	-1.19 (-0.86)	1.03 (0.71)	-2.03 (-1.37)	-0.95 (-0.85)

Major Events Surrounding The 1985 L-1011 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Delta	Major Airline Carrier Industry
11/01/85 Friday	Last day of NTSB hearings. Air traffic controller says he saw one flash of lightning and a "wall of rain" just before accident, but informed no one. Although acknowledging that Federal policies require him to report thunderstorms to pilots approaching them, he said he did not feel that one lightning flash and no thunder constituted a thunderstorm. Thirty-two witnesses were called. There appears to be agreement that wind shear was a factor and that no one in a position to do anything about it saw the accident coming.	0.19 (0.15)	-1.33 (-0.96)	0.80 (0.55)	2.32 (1.57)	1.31 (1.17)
11/04/85 Monday		0.43 (0.33)	0.83 (0.60)	-0.88 (-0.60)	0.50 (0.34)	-0.75 (-0.67)

Appendix F

Major Events Surrounding The 1987 MD-80 Accident
And Corresponding Abnormal Returns

Major Events Surrounding The 1987 MD-80 Accident

And Corresponding Abnormal Returns

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Carrier Industry
08/16/87 Sunday	McDonnell Douglas MD-80 owned by Northwest Airlines crashes shortly after takeoff from Detroit Metropolitan Airport at 8:46 pm EST. Early reports cite witnesses' reports of engine fires. Northwest's labor/service problems since merger with Republic in Fall 1986 also cited. First major crash in U.S. in 1987.	Weekend -- No Trading				
08/17/87 Monday	NTSB evening briefing: cause not known; plane gave stall warning, but no evidence yet of engine fires or explosions. Other factors, including wind shear, are being studied, but the focus is on the engines. Past problems with the Pratt & Whitney engines used on crashed plane. Past problems with engines on the specific plane that crashed, but engines had been replaced. McDonnell Douglas wins $10.9 million Navy contract.	-0.05 (-0.05)	0.92 (0.50)	-0.06 (-0.03)	-1.99 (-1.10)	-1.20 (-0.99)

Note: All abnormal return data presented here are based on estimation model number 2, i.e., using the equally-wieghted market index as the independent variable and an estimation period of 150 trading days before the accident.

Date	Event	Abnormal Returns (%) (Z-Statistic)				
		McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Carrier Industry
08/18/87 Tuesday	NTSB evening briefing: plane took off at an unusually steep angle. Wind shear sensors at airport had gone off earlier in the evening. Gross weight and weight distribution being studied, as well. Engine fire/explosion ruled out, but could have been other engine problems. Engine maintenance records for crashed jet were in order.	0.59 (0.54)	-0.27 (-0.14)	6.13 (2.79)	-0.14 (-0.08)	0.22 (0.18)
08/19/87 Wednesday	NTSB evening briefing: "black box" evidence indicates that wing flaps and slats were not properly set for takeoff and that the crew may have neglected these items in a routine pre-flight checklist. The warning that should have sounded if the flaps and slats were not set properly did not go off. McDonnell Douglas wins $26 million Navy contract.	0.37 (0.35)	0.88 (0.47)	-1.64 (-0.76)	-1.12 (-0.62)	0.33 (0.27)

Major Events Surrounding The 1987 MD-80 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Carrier Industry
08/20/87 Thursday	NTSB evening briefing: confirm black box evidence regarding flaps, but stress that not yet confirmed with physical evidence. Experts shocked that routine step overlooked. FAA chairman cites possibility of "cockpit complacency." Airlines Pilots Association warns against assuming all human error. One witness (another Northwest pilot) insists that flaps were set properly.	-0.11 (-0.10)	-0.82 (-0.44)	-1.98 (-0.90)	-1.79 (-0.98)	-1.79 (-1.46)
08/21/87 Friday	NTSB briefing: flap evidence contradictory, so no final determination yet made on position at takeoff. Other possible factors are also being investigated. Coroner releases victim list.	-0.02 (-0.01)	-0.38 (-0.21)	2.69 (1.24)	1.12 (0.62)	-0.09 (-0.08)
08/24/87 Monday		0.15 (0.14)	3.00 (1.62)	-0.33 (-0.15)	1.36 (0.75)	0.65 (0.53)
08/25/87 Tuesday	NTSB says physical evidence from wreckage confirms that flaps were incorrectly set. Focus of investigation turning now to why alarms did not sound.	-0.38 (-0.36)	-0.53 (-0.29)	-0.35 (-0.16)	-0.93 (-0.52)	-0.50 (-0.41)

Major Events Surrounding The 1987 MD-80 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Carrier Industry
08/26/87 Wednesday	Several attorneys indicate plans to file suits against Northwest, with expected damage awards of $1 million to $5 million per person.	0.22 (0.20)	-0.07 (-0.04)	-0.09 (-0.04)	-0.89 (-0.49)	-0.31 (-0.26)
10/16/87 Friday	NTSB releases interim report with no comments or conclusions. Report discloses additional evidence that pilots' failure to deploy flaps may have caused crash.	-1.90 (-1.51)	-3.50 (-1.63)	-3.13 (-1.24)	2.04 (0.97)	1.08 (0.76)
10/19/87 Monday		-0.15 (-0.06)	0.39 (0.09)	-12.47 (-2.50)	5.34 (1.28)	2.32 (0.83)
11/15/87 Sunday	NTSB hearings on Detroit crash to start Monday. NTSB vice chairperson expects to focus on pilots' performance and failure of warning system. No electrical power was flowing to circuit that should have given warning signal. Northwest consultants say that, though not clear, the words "flaps" and "flaps set" can be heard on cockpit tape. Continental Airlines DC-9 crashes while trying to takeoff in snow at Denver Airport.	Weekend -- No Trading				

Major Events Surrounding The 1987 MD-80 Accident
And Corresponding Abnormal Returns
(Continued)

		Abnormal Returns (%) (Z-Statistic)				
Date	Event	McDonnell Douglas	Boeing	Lockheed	Northwest	Major Airline Carrier Industry
11/16/87 Monday	First day of NTSB hearings. One witness (a Northwest pilot) still contends positively that flaps were properly set at takeoff. All other compiled by NTSB indicates otherwise. Investigators in Denver crash focusing on possible effect of ice/snow build-up on wings. Northwest Airlines must pay $325,000 civil to Department of Transportation for mishandling of customer refund claims in 1986 and early 1987. Northwest does not admit to any violations of Federal guidelines, but agreed to settle to avert litigation.	3.58 (3.31)	1.11 (0.60)	1.03 (0.48)	-0.31 (-0.17)	2.49 (2.05)
11/17/87 Tuesday		1.31 (1.19)	0.46 (0.25)	0.48 (0.22)	2.12 (1.15)	0.69 (0.56)

BIBLIOGRAPHY

Akerlof, George A. "The Market For 'Lemons': Quality
    Uncertainty and the Market Mechanism." <u>Quarterly
    Journal of Economics</u> 84 (August 1970): 488-500.

Barnett, Arnold and Lofaso, Anthony J. "After the Crash:
    The Passenger Response to the DC-10 Disaster."
    <u>Management Science</u> (November 1983): 1225-36.

Binder, John J. "Measuring the Effects of Regulation with
    Stock Price Data." <u>Rand Journal of Economics</u> 16
    (Summer, 1985): 167-83.

Chalk, Andrew. "Market Forces and Aircraft Safety: The
    Case of the DC-10." <u>Economic Inquiry</u> XXIV (January
    1986): 43-60.

Chalk, Andrew. "Market Forces and Commercial Aircraft
    Safety." Draft Ph.D. diss., Southern Methodist
    University, Edwin L. Cox School of Business, July 14,
    1986.

Daily and Monthly Data Files. Center for Research in
    Security Prices. University of Chicago, 1987 Version.

Fama, Eugene F. <u>Foundations of Finance</u>. New York: Basic
    Books, 1976.

Golbe, Devra L. "Safety and Profits in the Airline
    Industry." <u>The Journal of Industrial Economics</u> XXXIV
    (March 1986): 305-18.

Klein, Benjamin, and Leffler, Keith B. "The Role of
    Market Forces in Assuming Contractual Performance."
    <u>Journal of Political Economy</u> 89 (August 1981): 615-41.

<u>Los Angeles Times.</u> 8 August 1985; 10 October 1985; 3
    November 1985; 17, 18, 19, 20, 21 August 1987; 17, 29
    October 1987; 16 November 1987; 4 December 1987.

Mitchell, Mark L., and Maloney, Michael T. "The Role of
    Market Forces in Promoting Air Travel Safety."
    Clemson University, Center for Policy Studies,
    September 2, 1987.

<u>New York Times.</u> 3, 4, 5, 6, 12, 13 August 1985; 5
    September 1985; 1, 3, 4, 26 October 1985; 1, 2
    November 1985; 17, 20, 22, 23 August 1987; 1, 6
    September 1987; 8, 12, 13, 15, 17 October 1987; 5, 15,
    17, 18, 21 November 1987; 17 December 1987.

O'Connor, William E. <u>An Introduction to Airline
    Economics.</u> 3d ed. New York: Praeger Publishers,
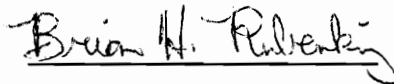   1985.

Schwert, G. William. "Using Financial Data to Measure
    Effects of Regulation." <u>The Journal of Law and
    Economics</u> 25 (April 1981): 121-58.

<u>Wall Street Journal.</u> 5, 23 September 1985; 8, 25 October
    1985; 12 November 1985; 18, 19, 20, 27, 31 August
    1987; 1, 3, 4, 8, 10, 14, 15, 16, 17, 21, 25, 28, 29,
    30 September 1987; 1, 8, 13, 15, 22, 28 October 1987;
    3, 9, 12, 16, 17, 18, 19, 23, 25 November 1987; 2, 3,
    7, 11, 21, 22 December 1987.

<u>Washington Post.</u> 3, 6, 9 August 1985; 1, 25 October 1985;
    3 November 1985; 17, 18, 19, 20, 21, 22, 26, 27 August
    1987; 17 October 1987; 15, 23 November 1987; 2
    December 1987.

VITA

Brian H. Rubenking was born on July 28, 1959 in Alexandria, Virginia. He received his Bachelor of Arts degree in Economics from the College of William and Mary in 1981. From 1981 to 1985, he was employed as an economist with Economic Consulting Services Inc. in Washington, DC. From 1985 to the present, he has worked as a management consultant for Booz, Allen & Hamilton Inc. in Bethesda, Maryland, where he currently holds the title of Associate.

Brian H. Rubenking

Brian H. Rubenking