THE MARKET EFFECT OF IN-SUBSTANCE DEFEASANCE ON BONDHOLDER DEFAULT RISK

By

THOMAS MAXWELL CARMENT

Bachelor of Arts
Oklahoma State University
Stillwater, Oklahoma
1967

Master of Business Administration
Oklahoma State University
Stillwater, Oklahoma
1970

Bachelor of Science
Northeastern State University
Tahlequah, Oklahoma
1981

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 1991

THE MARKET EFFECT OF IN-SUBSTANCE

DEFEASANCE ON BONDHOLDER

DEFAULT RISK

Thesis Approved:

Gary Meek
Thesis Advisor

James W. Jadlow

Thomas C. Collins
Dean of the Graduate College

ACKNOWLEDGEMENTS

I thank my personal Lord and Savior, Jesus Christ for the Way, the Truth, and the abundant Life. I am thankful for the love and support of my family during the period of my graduate studies. I recognize and appreciate the help given to me by my wife, Dr. Deborah Carment.

I am especially indebted to Dr. Gary Meek, my thesis advisor, who has given generously of his time, guided me with intelligence and provided encouragement. I am grateful to my committee members, Dr. Janice Jadlow, Dr. Larry Hammer, Dr. William Warde, and Dr. Larkin Warner for their time and assistance. I also thank Dr. Dale Armstrong, Dr. Mary Broske, Dr. Jim Groff, Dr. Keshav Gupta, Dr. Dennis Patz, and Dr. Charles Ransom for giving generously of their time to provide guidance in the planning stage of this dissertation.

I also recognize and appreciate the support and assistance of Carol Chambers, Lanita Diller, Dr. Don Gribbin, Bill King, Julie Nichols, and Dave Nichols. I thank Mrs. Sandi Ireland for final typing of the dissertation.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In-substance defeasance (ISD) is a recent financial innovation used by firms to extinguish debt before the due date specified in the debt contract. In an in-substance defeasance transaction, the firm places risk-free assets in an irrevocable trust in an amount sufficient to satisfy the cash flow requirements of the debt obligation. Defeased debt is extinguished in an economic sense from the borrower's standpoint, while from a legal standpoint the debt remains since the creditor is not satisfied. The defeased debt and trust assets are removed from the balance sheet of the debtor and an extraordinary gain or loss is recorded. Defeased bonds continue to trade in the market after the transaction date. Before ISDs were used, early debt extinguishment was accomplished either by satisfying the covenants of a debt contract (e.g. through call or sinking fund provisions) or through the early purchase of debt in market transactions.

On November 29, 1983 the Financial Accounting Standards Board (FASB) issued Statement of Financial Accounting Standards (SFAS) No. 76, "Extinguishment of Debt." The Statement allows firms to consider debt extinguished through an ISD, even though the firm is not legally relieved of the primary obligations by the creditor. SFAS No. 76 imposes the following requirements for ISDs:

(a) the debt is fixed (non-variable) as to maturity and interest rate, and,

(b) the debtor places sufficient risk-free assets (e.g., cash or U.S. government securities) in an irrevocable trust solely for the purpose of satisfying the debt, and,

(c) the possibility that the debtor will be required to make further payments is remote (FASB, 1983, paragraph 3c).

SFAS No. 76 states:

> The Board believes that in general, recognizing the effect of in-substance defeasance transactions as extinguishing debt is reasonable because settlement in cash is not always feasible and the effect of an in-substance defeasance is essentially the same (FASB, 1983, paragraph 25).

Criticism of SFAS No. 76 is based upon economic rather than accounting grounds. Weil (1983) dismisses the accounting effects as window dressing, and he protests the stewardship by managements of corporations entering into an ISD transaction because ISDs would implicitly and explicitly transfer wealth from stockholders to bondholders. The explicit wealth transfer is accomplished by removing assets from the firm and pledging them through the creation of a defeasance trust for the benefit of ISD bondholders. An implicit wealth transfer is accomplished when the firm enters into a low variance, zero net present value investment. Moreover, Van Horne (1985) is concerned that firms are motivated to extinguish debt with an ISD based upon accounting as opposed to economic grounds.

The macroeconomic effect of billions in pecuniary (monetary) transactions is questioned by Warner (1988). The ISD transaction, which is pecuniary, siphons off savings which could otherwise be invested in real investment (e.g., plant assets).

The Bondholder Wealth Transfer Question

The argument that defeased bondholders are better off after their bonds are defeased in an ISD transaction is crucial to the wealth transfer hypothesis. Peterson, Peterson, and Ang (1985) state the wealth transfer hypothesis:

> The trust arrangement presents the potential for a redistribution of wealth . . . The defeased bondholders are net gainers in the ISD transaction, while the non-defeased bondholders and equity holders are net losers (p. 66).

In discussing ISD transactions, Stober (1987) said:

> . . . the real empirical question is how does the bond market assess these transactions? . . . Is the final price of defeased debt significantly different than predicted to be if it were indeed perceived by the market as being secured without risk by government securities held in trust (p. 2)?

Economic Substance versus Legal Form Question

The FASB was persuaded by the economic substance over legal form arguments of ISD proponents during the discussion period leading up to the issuance of SFAS No. 76. An illustration of the divergence between accounting for the presumed economic substance of an ISD transaction and its legal form is shown in Appendix A. Recording the accounting effects of an ISD transaction requires separating the firm and the defeasance trust. The defeased debt is removed from the ISD firm's liabilities and an extraordinary gain or loss is recorded for the difference between the carrying value of the defeased debt and the amount of cash or treasury securities placed in the defeasance trust. The interest expense and revenue are reported by the defeasance trust for financial accounting purposes. An illustration of the accounting treatment of an ISD transaction is shown in Appendix B.

Since a legal form interpretation is taken by the Internal Revenue Service, the ISD transaction does not result in an extinguishment of debt for tax purposes, and an ISD does not give rise to taxable income or loss. Further, since the defeasance trust is a conduit, interest expense and revenue are reported by the ISD firm for tax purposes.

In summary, in-substance defeasance transactions raise questions about wealth transfers from stockholders to bondholders and among various classes of bondholders. When risk-free assets are placed in a defeasance trust, default risk is potentially reduced, thereby causing ISD bondholders to be better off. Also, if defeased bondholders are better off after an ISD, non-defeased bondholders may be worse off after an ISD. If bondholder wealth positions change after an ISD transaction, an ISD approximates an actual defeasance and is substantially the same as an early debt extinguishment for cash.

Statement of the Problem

The first question examined in this dissertation is:

> Is the default risk of defeased debt significantly different than what would be predicted if it were perceived by the market as being costlessly and unconditionally secured without risk by government securities held in trust?

This question addresses the a priori argument of economic substance versus legal form. Debt holders discover their claim has been conveyed to a trust guaranteed by risk free assets. There may be wealth transfer effects from stockholders and non-defeased bondholders to the holders of extinguished ISD debt. Returns should increase for a bond which is defeased. The returns may be the result of bond market recognition of a change in default risk after an ISD transaction.

The question asks if observed default risk is different than predicted default risk for ISD bonds. Another way of stating the question is to ask if the default risk of ISD bonds is more closely associated with risky corporate debt or with riskless debt (i.e., government securities).

The second question addressed in this study is:

> Does the bond market assess that default risk has increased for the senior bonds which are de facto subordinated and therefore, junior in claim to bonds defeased in an ISD?

Senior debt holders can find their claim priority suddenly junior to defeased debt. Their protective covenants were incomplete to protect them from an ISD transaction. There may be wealth transfer effects of going from senior debt to junior debt, and returns may decrease for a bond that is de facto subordinated but not defeased. The return decrease may result from non-defeased bondholders' recognition of a decrease in the probability of their future cash flows.

Summary of Contents

The remainder of this dissertation is organized as follows. Chapter II discusses relevant prior research. Chapter III describes the data collection procedures followed in this dissertation. Chapter IV presents the details of the research method. Chapter V contains the results with respect to determining the effects of ISD on bondholder default risk. Finally, Chapter VI concludes the paper and considers the implications for future research.

CHAPTER II

PRIOR RESEARCH

Impact of ISD on Bondholders

Accountants are concerned with the production of financial information for a variety of decision makers. Bondholders, because of the dollar volume of new capital they provide, represent one of the most important user groups of accounting information. Prior research in accounting and finance has concerned itself with the wealth transfer effect of ISD on holders of equity securities and bonds. These investigations have only weakly confirmed a wealth transfer effect.

Johnson, Pari, and Rosenthal (1989) investigated the impact of ISD on bondholder and shareholder wealth. They used the NAARS data base to choose their sample of 28 firms with 42 ISD bond issues. Two data sources[1] were used to measure bond market prices and returns: (a) Merrill Lynch monthly bond price series were obtained for 28 of the bond issues identified in their sample, and (b) Moody's monthly bond prices were obtained for the remaining 14 issues.

---

[1]Merrill Lynch bond data are available on magnetic tape and Moody's is collected by hand from printed materials.

Monthly holding period returns were calculated on the bond portfolios because of both uncertainty regarding event time and thin bond trading. They used the Merrill Lynch long-term corporate bond index to estimate a market model for ISD bonds. Bond excess returns were significant at the 2% level in the month of announcement for the Merrill Lynch subsample. However, the bond excess returns were not significant for the full sample which included Moody's prices as a data source.

Stockholder excess returns were not significant in the month of an ISD for either the Moody's subsample or the full sample. However, the latter results may be sensitive to the lack of a precise date of ISD disclosure, because groups of 20 daily stock returns were used to measure the stockholder wealth transfer.

The Merrill Lynch sample of bonds examined by Johnson, Pari, and Rosenthal (1989) used matrix prices. Using matrix pricing, if a bond does not trade, the price at which it would have traded is imputed from a bond with similar characteristics. Nunn, Hill, and Schneeweis (1986) demonstrate the superiority (reduced noise) of using matrix bond prices over Moody's non-matrix prices when there is thin trading. As noted later, the bond prices used for this dissertation are matrix prices.

Hand, Hughes, and Sefcik (1990) could not find convincing evidence of a wealth transfer from stockholders to bondholders. They matched monthly holding period returns for ISD bonds with U.S. government bonds of similar coupon and maturity. Hand, Hughes, and Sefcik (1990) predicted a 6.3% bond price increase if the defeased bonds were perceived by investors to be (default) riskless. However, the subsample of 13 firms and 24 bonds only had an 0.84% price increase. Hand, Hughes, and Sefcik (1990) assert that the mean actual price reaction of defeased bonds is only about 14% of that predicted to have occurred if the bonds had been perceived as riskless. They found that while an ISD made the bonds less (default) risky, it did not make them riskless. Their results also may be sensitive to the problems of small sample size and the lack of a precise date for ISD disclosures.

Bond Ratings Process

There are three bond ratings agencies in the United States: Moody's Investor Service, Standard & Poor's Corporation and Fitch Investors Service. The purpose of bond ratings is to measure default risk.[2] Moody's rates bonds from Aaa (highest quality) down to C (lowest quality). Standard & Poor's and Fitch have similar ratings. Appendix C shows Moody's ratings for public traded corporate debt.

The degree to which ratings agencies randomly and continually monitor firms for changes in default risk is not public information. Nor is the degree to which publicly

---

[2]This discussion follows Holthausen and Leftwich (1986, pp. 60-62).

available data are used in their ratings decisions. Ratings agencies state that the review process is a committee decision which includes private sources of information such as forecasts by management, visits to the firm's offices, and discussions with management. Once a rating has been determined, it is the rating agencies' policy to discuss the rating and the reasons for the rating with the management in order for them to respond to it. After this discussion, the rating committee considers any new information. After the review process, the rating is made public.

The degree of reliance or weighting that ratings agencies place on measurable, quantitative information such as audited financial statements as opposed to qualitative information is unknown. The agencies sell their monitoring services and while they are willing to make their rating methodology known, for propriety reasons they are reluctant to discuss their actual weighting of variables or decision criteria.

Roy Taub, chairman of the debt rating committee at Standard & Poor's, said the agency would not raise the ratings of ISD bond issues until attorneys provide assurance that other corporate creditors could not obtain the irrevocable trust assets. So far, attorneys have been unwilling to provide that assurance.

Bond Default Risk

Bondholder risk can be of two types according to Fisher (1959): (a) default risk and (b) interest rate (variability) risk. Default risk may be thought of as having two components:

1. Pure Default Risk: Investors require a premium to assume the firm specific risk for their ex-ante expectations of the risk of default.

2. Liquidity or Marketability Risk: Investors require a premium for the risk that they may not obtain a favorable sales price if they liquidate before maturity, since seasoned corporate bonds trade in thin markets.

These two theoretic elements are both components of default risk and have positive covariance. Empirically, they are both included in the measurement of default risk assessed by bondholders.

Summary

This dissertation extends earlier studies by explicitly dealing with changes in bond default risk in the ISD transaction. If changes in default risk are detected for ISD bondholders, then the economic substance argument is supported. If changes in default risk are not detected, it can be reasoned that the bond market either does not impound the information that debt is extinguished in an ISD transaction or does not consider that the effect of an ISD is essentially the same as an actual or legal defeasance. This dissertation also extends earlier studies by explicitly considering the change in default risk for senior debt (non-defeased bonds).

This dissertation examines the implications of ISD on the economic distribution of wealth among different classes (defeased and non-defeased) of bondholders. This is accomplished by computing a measure of bondholder default risk--referred to as delta--and determining whether there is a difference in this measure of risk before and after the defeasance transaction. By examining one element of the wealth transfer hypothesis, bondholder default risk, this dissertation extends previous work and attempts to improve the understanding of the complex economic issues surrounding the ISD transaction.

CHAPTER III

THE DATA

Sample Selection

The sample of bonds defeased in ISD transactions and the related date of defeasance was initially identified with two searches of the National Automated Accounting Research System (NAARS) database. Key words used in the NAARS searches were "in-substance," "defease," (and other variations, e.g., defeasance), and "irrevocable." The NAARS sample was expanded by comparison with the samples of Press (1987), Deppe and Bartley (1989), and Hand, Hughes, and Sefcik (1989). Information contained in 10-K reports from Disclosure Microfiche Records was then used to verify and correctly classify ISDs. When a firm defeases more than one bond, multiple issues are accepted from the same firm. This process yielded a potential sample of 61 in-substance defeasances for 42 firms. An attempt was made to secure price data from Compuserve for every bond issue that met the following criteria:

1. Complete Compuserve files of weekly price data available for all bonds;
2. No short bond maturities or calls of less than one year.

Short maturities were eliminated from the final sample because assessed default risk is a function of time. Short maturities are assessed as having less default risk than long maturities for otherwise similar bonds issued by the same firm.

The final sample consists of 24 ISD bonds for 15 firms. Table I reconciles the initial sample of in-substance defeased bonds to the final sample.

Defeased bonds are grouped into portfolios by Moody's bond rating. While the portfolios are balanced, no attempt was made to accomplish this. Limited data availability is responsible for the final sample size.

Table II shows the final sample of defeased bonds. Also, Table II shows the matched U.S. Treasury bond for each defeased bond. U.S. Treasury bonds are assumed to have no default risk. Congress has the authority to issue money to settle its debt.

As stated in Chapter II, seasoned corporate bonds trade in thin (less liquid) markets, whereas seasoned U.S. treasury bonds are traded in thick (more liquid) markets. Bond prices have been shown to be influenced by thin trading. Nunn, Hill, and Schneeweis (1986) demonstrated the superiority of matrix prices over the usual source of bond prices and yields, namely, monthly quotes from Moody's, or Standard & Poor's. Using matrix pricing, if a bond does not trade, the price it would have traded at is inputed from a bond with similar characteristics. It is possible that Johnson, Pari, and Rosenthal (1987) and Hand, Hughes, and

Sefcik (1990) obtained conflicting results because matrix prices were used in the former, whereas Moody's prices were used in the latter.

TABLE I

RECONCILIATION OF TEST PORTFOLIOS

	Total Firms	Total ISD Bonds
ISD Portfolios		
Initial sample	42	61
Number of firms excluded because of incomplete market information	<21>	<29>
Number of firms whose ISDs mature or are called within one year	<6>	<8>
Final ISD Sample	15	24
Non-ISD Portfolios		
Initial sample	15	17
Number of firms excluded because of incomplete market information	<5>	<7>
Final Non-ISD Sample	10	10

TABLE II

SAMPLE OF DEFEASED BONDS - DURATION MATCHING

PORTFOLIO ISD BONDS Aaa Moody's Bond Rating at Defeasance

Bond	Maturity	D1	U.S. Treasury Bond		D1
Exxon	1997	8.08	7	1993-98	8.10
Exxon	1998	8.03	7	1993-98	8.10
ARCO	1988	4.44	8 1/4	1990	4.85
Amer Pres Lines	1990	5.19	7 1/4	1992	5.84
Amer Pres Lines	1991	5.18	7 1/4	1992	5.84

PORTFOLIO ISD BONDS Aa Moody's Bond Rating at Defeasance

Bond	Maturity	D1	U.S. Treasury Bond		D1
General Mills	1995	7.09	7	1993-98	7.07
Ralston Purina	1988	4.24	8 1/4	1990	4.01
General Mills	1999	7.56	7 7/8	1995-00	7.67
Shell Oil Co.	1992	5.82	9	1994	5.92
Shell Oil Co.	2000	7.90	10 3/4	2003	7.93
Shell Oil Co.	2002	8.37	10	2010	8.43
Shell Oil Co.	2007	8.73	11 3/4	2009-16	8.81

PORTFOLIO ISD BONDS Baa Moody's Bond Rating at Defeasance

Bond	Maturity	D1	U.S. Treasury Bond		D1
Houston Nat. Gas	1992	5.59	7 1/4	1992	5.68
USX	1996	7.68	12 3/8	2004	7.52
USX	2001	8.04	11 1/8	2003	8.15
Montgomery Ward	1990	3.41	12 3/8	1991	3.41
Carter Hawley	2008	9.32	13 7/8	2006-11	9.27
Cinn Gas & Elec	1992	4.37	11 3/4	1992	4.12

PORTFOLIO ISD BONDS NR Moody's Bond Rating at Defeasance

Bond	Maturity	D1	U.S. Treasury Bond		D1
Crane Co.	1992	5.33	7 1/4	1992	5.38
United Airlines	1992	6.61	6 3/4	1993	6.49
Marine Midland	1994	6.30	9	1994	5.92
Marine Midland	2003	8.01	10 3/4	2003	7.93
Fremont General	1992	3.61	11 3/4	1992	5.08
Fremont General	1990	7.49	7 1/2	1988-93	7.81

This dissertation uses industrial and U.S. Treasury weekly matrix bond prices obtained from Compuserve for a fifty-two week period before and a fifty-two week period after the ISD event date. Compuserve matrix bond prices are limited to the issues which are widely traded by institutional investors.

Bonds listed by Compuserve generally have the attributes of high credit quality and marketability. Using Compuserve as a data source has two important implications for the proposed study: (1) matrix prices compensate for the bias introduced by "thin trading," and (2) because the bond price data are transmitted in electronic magnetic form, there is less likelihood of clerical errors in recording bond price data.

A similar process as described above was used to identify the sample of non-ISD bonds which were made junior by a senior ISD bond. The initial search yielded seventeen bonds for fifteen companies. Applying Criteria 1 and 2 above yields a final sample of ten bonds for ten companies. Table I reconciles the initial sample of non-ISD bonds to the final sample, and Table III shows the final sample of non-defeased bonds. The data are grouped into two portfolios based upon Moody's bond rating. It was necessary to combine the Aaa and Aa bonds because of data availability.

TABLE III

SAMPLE OF NON-DEFEASED BONDS

PORTFOLIO NONISD Aaa & Aa		Moody's Bond Rating at Defeasance			
Bond	Maturity	D1	U.S. Treasury Bond		D1
ARCO	1997	8.46	7	1998	8.13
Amer Pres Lines	1990	7.48	7 1/4	1992	7.25
Shell Oil Co.	2005	8.41	8 1/4	2005	8.66
General Mills	1999	8.00	8	2001	8.16
Ralston Purina	1996	7.14	7 7/8	2000	6.87
PORTFOLIO NONISD Baa		Moody's Bond Rating at Defeasance			
Bond	Maturity	D1	U.S. Treasury Bond		D1
Burlington Ind.	1995	6.33	10 3/8	1995	6.55
Eastern Edison	1993	6.57	7 1/4	1992	5.90
Crane Company	1993	5.61	7 1/4	1992	5.77
Fremont General	1995	6.04	11 1/2	1995	6.39
Montgomery Ward	2000	7.78	8 1/2	1999	7.36

Duration Matching Treasury Bonds

The bond investor purchases a specific promise of future interest and principal payments. The purchase price of the bond is conceptually the present value of the promises discounted at the current market interest rate. This rate is influenced by market rates but also includes a premium for the risks assumed. The promises are fixed as to amount, but the market value of the promise varies with two risks that the investor must bear. In this section, measures are discussed which control for interest rate elasticity and therefore allow for an examination of default risk associated with an ISD.

As noted in Chapter II, these risks are default risk and interest rate risk (Fisher, 1959). Default risk was discussed in Chapter II. It is an endogenous, firm specific risk that the issuer will be unable to make interest and principal payments as agreed. Interest rate risk is an exogenous, market risk that interest rates will change during the holding period. Duration is a measure of interest rate risk. It is the average length of time over which a bond promises interest and principal payments, including any early repayment of principal. Duration is measured as an index which is the present value-weighted average maturity of the bond in which time periods of both interest coupon and principal receipt dates are separately discounted (Francis, 1986).

Hopewell and Kaufman (1973) showed that bonds with high levels of interest rate risk (duration) have more volatile prices than bonds with less interest rate risk (duration). Anything which causes a bond's duration to increase (such as longer maturity and/or lower coupon interest rate) also increases a bond's interest rate risk.

The control for interest rate risk used in this dissertation is to match risky corporate and riskless government bonds as closely as possible based upon calculated D1, Macaulay's duration. Bierwag (1977) states that duration is important in the construction of bond portfolios that are hedged against interest rate risk.

Macaulay's duration, D1, was calculated for each of the bonds in the original sample of ISD bonds. The standard

Macaulay duration measure, as shown in Broske (1982), can be calculated as follows:

$$D1 = \frac{\sum_{t=1}^{T} \frac{t\ P_t}{(1 + r_t)^t}}{\sum_{t=1}^{T} \frac{P_t}{(1 + r_t)^t}} \qquad (1)$$

Where

D1 = the Macaulay duration measure

P_t = payment of interest or principal at time t

t = the amount of time before the cash flow (P) is received

T = the final maturity of the financial contract

r = current market interest rates for the security under consideration

A Fortran program was written to calculate the durations, a copy of which is included as Appendix D. A sample of U.S. Treasury bonds with prices available on Compuserve was obtained and matched as closely as possible to ISD bonds on the basis of calculated duration D1.

CHAPTER IV

RESEARCH METHOD

This dissertation examines investors' market responses to changes in default risk associated with an in-substance defeasance transaction. The dissertation examines the implications of an ISD on the economic distribution of wealth among different classes (defeased and non-defeased) of bondholders. This is accomplished by computing a measure of bondholder default risk, delta, explained in the following section. Delta is measured before, during, and after the date of the defeasance transaction. By examining one element of the wealth transfer hypothesis, bondholder default risk, this dissertation explores an important issue regarding the ISD transaction. One important element of bondholders' assessments of the necessary default risk premium is default costs. Kim, McConnell, and Greenwood (1977) conclude that the risks that bondholders bear are important because they have no managerial control until a firm actually defaults on interest or principal obligations. Baker (1984) points out that an inverse relationship exists between bond credit rating and pre-tax cost of an ISD. The smaller the spread between corporate bonds and government bonds, the smaller the potential wealth transfer effect. The ISD transaction may influence investors to alter their assessment of the bond's default risk. Default costs will reduce the amount of cash flows available to pay interest and principal in the event of default. Some of the costs include information, contracting, and policing costs as described by Demsetz (1964). Default cost estimates are responsible for a difference between returns of risky and risk-free bonds. Jensen and Meckling (1976) argue that debt gives rise to incentive problems and agency costs. The investor's assessment of default premium will determine how close to the returns of the risk-free assets that the defeased bond trades.

Second Degree Stochastic Dominance

This dissertation uses moving second degree stochastic dominance methodology (SDSD) which is less sensitive to a precise event date of ISD disclosure than is the market model. The market model has been used by other researchers, as discussed in Chapter II. Moreover, SDSD methodology has been used in other accounting research studies involving the ranking of probability distributions. For example, it has been used to compare the frequency distribution of returns on two or more populations of marketable securities, the distribution of errors from two or more estimation techniques, the utility functions of financial information users, and the error occurrence under two or more different internal control systems. Ordering such distributions using SDSD is superior to the use of traditional mean-variance analysis because the latter may not result in a conclusive ranking when the distribution with the preferable mean value also has a higher variance. It also does not allow for a prediction with a known upward or downward bias which might be preferable to an unbiased prediction that could err in either direction. In addition, mean-variance analysis assumes a normally distributed population, an assumption which does not hold in many accounting research applications.

Levy and Sarnat (1984) outline the theoretical framework for studies seeking evidence of a market reaction to a broad set of transactions (e.g., an ISD transaction). Second Degree Stochastic Dominance (SDSD) provides a conclusive ranking for probability distributions. This is an optimal efficiency criterion which produces the smallest possible efficient set for all risk-averse investors. Stochastic dominance theory is based on the von Neumann-Morgenstern axioms of expected utility. The utility function characteristics are expressed in terms of the derivatives of an investor's utility of wealth function with respect to a change in return. First-degree stochastic dominance requires $u' \geq 0$; second-degree, $u' \geq 0$, $u'' \leq 0$; and third degree, $u' \geq 0$, $u'' \leq 0$, and $u''' \geq 0$, where u is a utility function.

Second Degree Stochastic Dominance (SDSD) Rule

Let F and G denote the cumulative distributions of the returns of two investments. Then F dominates G by SDSD (for all risk-averse investors) if and only if for every return value R,

$$\int_{-\infty}^{R} [G(t) - F(t)]dt \geq 0 \qquad (2)$$

and a strict inequality is observed at least for one R.

Methodology: Delta-Measure of Default Risk

Let $F_{\alpha}(x)$ be the cumulative probability distribution of the rates of return on investment in ISD bonds, where x is the rate of return; similarly, $F_{\pi}(x)$ is the cumulative probability distribution for U.S. government securities. By using SDSD, the cumulative probability distribution F_{α} should be observed to dominate F_{π} and therefore F_{α} would be preferred by all risk-averse investors; however, ISD bonds possess greater default risk than U.S. government securities. The technique to be used involves shifting the F_{α} distribution by iterative application of estimates of default probability in a systematic manner until the dominance exactly disappears. The final adjustment, which is called delta, may be interpreted as a measure of the premium for default as perceived by the bond market when comparing an ISD bond with the riskless government securities.

Following Broske (1985), delta is defined in such a way that its incorporation in the distribution of the riskier asset would result in the risk-averse investor being indifferent between the two assets, and thus, dominance would disappear. The $F\alpha$ distribution is transformed to an $F\alpha'$ distribution by incorporating the market estimate of default until the dominance of $F\alpha$ over $F\pi$ exactly disappears. In other words, the $F\alpha$ distribution is changed to $F\alpha'$ until:

$$\int_{-\infty}^{x} [F\pi(t) - F\alpha'(t)]\,dt < 0$$

for at least one value of x. The economic foundation of stochastic dominance uses the application of the stochastic dominance criteria in deriving a technique to quantify the probability of default. Default results in a zero return to the bondholder. The return, if default results in zero return to the ISD bondholder, can be expressed as:

$$ER\alpha = \begin{cases} 0 & \text{if default occurs} \\ ER & \text{if there is no default} \end{cases}$$

where $ER\alpha$ is the expected value of the ex-post distribution of returns on the ISD bonds.

By including the probability of default delta (δ) - (a return of zero), the ISD bond return can be expressed as:

$$ER\alpha = [\delta(0) + (1-\delta)\,E\alpha(x)] \qquad (3)$$

By setting the expected return on the ISD bonds ($ER\alpha$) equal to the expected return on the government securities ($ER\pi$) so that the risk-averse investor is indifferent between the two assets, one can solve for the value of delta:

$$ER\alpha = [\delta(0) + (1-\delta)\ E\alpha(x)] = ER\pi(x) \quad (4)$$

$$\delta = 1 - \frac{ER\pi(x)}{E\alpha\ (x)} \quad (5)$$

The Broske algorithm is shown in Appendix E. The application of the Broske algorithm results in deltas which are, in the context of this dissertation, the market's estimate of the probability of default of an ISD bond relative to a government security.

This dissertation uses an extension of this algorithm by Jadlow (1991) which calculates the change in delta over time using a moving stochastic dominance procedure (MSDSD). The MSDSD deltas over time should show whether the market assesses a declining risk premium to bonds that have been defeased in an ISD transaction. Jadlow used an MSDSD to examine the Eurodollar default risk over time.

Delta can assume a value between zero and one. Smaller values of delta are interpreted as measuring less default risk that higher values of delta. If a bond portfolio has a delta of zero, this result is interpreted to mean that investors believe it is equivalent in default risk to a portfolio of U.S. government securities. This interpretation assumes that the two portfolios are similar in all other relevant investment attributes (e.g. duration).

A Fortran program was written to calculate the MSDSD deltas, a copy of which is included as Appendix F. Weekly holding period returns were calculated for U.S. Treasury bonds and duration matched ISD bonds and non-ISD bonds. These were combined into portfolios based upon the bond ratings of the ISD and non-ISD bonds. These portfolio returns were inputs to the Fortran program which calculated MSDSD deltas shown as results reported in Chapter V.

For the purpose of analysis, 104 weekly time series observations representing two event time years' matched ISD and U.S. Government bond portfolio returns, are taken six at a time, and the delta for that six-week period calculated. For the next six-week period, the initial observation is incremented by three weeks and the calculation of delta repeated. This process yields 33 overlapping deltas over the two-year time period. Each delta quantifies default risk for a period of six weeks.

Statistical Measures

The first question is concerned with wealth transfers to bondholders when their bonds are defeased. Do bondholders act as if the in-substance defeasance transaction provides them with a bond which is free of default risk? Default risk, as measured by moving stochastic dominance deltas, is tested by calculating the t-statistic. The t-statistic used to test the first question for portfolios of ISD bonds is a measure of the statistical distance of a calculated mean of bond portfolio deltas compared to an expectation of delta. To test the first question, the null hypothesis is: the calculated mean of post-defeasance deltas is equal to zero for each portfolio tested. Rejection of the null hypothesis suggests that investors believe that defeased bonds are not free of default risk.

The second question is concerned with wealth transfer from bondholders when their bonds are not defeased. Do bondholders act as if an in-substance defeasance transaction, by rearranging the claims structure of bondholders of the same firm, converts their bond to a lower priority or junior claim relative to defeased bonds? If non-defeased bondholders believe that their bonds have lower priority in a firm's claim structure, this should result in an upward revision of their assessment of default risk. If delta is observed to increase, then the second question is tested by calculating the t-statistic for the difference in the means of post-defeasance deltas of non-defeased bonds relative to pre-defeasance deltas.

CHAPTER V

FINDINGS

Results of MSDSD Tests--ISD Portfolios

As shown in Table I, the sample of defeased bonds is grouped into four portfolios. The first portfolio consists of the Aaa rated bonds, i.e., bonds with the highest Moody's rating and the lowest default risk. The other three portfolios have a Moody's rating of Aa, Baa, and NR, representing progressively declining Moody's ratings and increasing default risk.

The first question addressed in the dissertation is whether the default risk of defeased debt is significantly different than what would be predicted if it were perceived by the market as being costlessly and unconditionally secured without risk by government securities held in trust. In other words, SFAS No. 76 predicted that default risk of defeased debt should be zero. The bondholders' assessment of default risk in the post-defeasance period will provide an answer to the question of substance over form. If ISD bondholders are made better off as a result of an ISD, one should observe deltas that decrease to zero in the post-defeasance event time. If bondholders believe that their bonds are made default risk free, one would expect that mean deltas should decrease to approximately zero for the period following a defeasance transaction.

Table IV presents the results of t-tests on the means of deltas in event time as pre-ISD and post-ISD event dates. The right side of Table IV shows the results of t-tests on the first question described above.

TABLE IV

PORTFOLIOS OF IN-SUBSTANCE DEFEASED BONDS
T-STATISTICS FOR THE MEANS OF PORTFOLIOS
PRE-ISD AND POST-ISD PERIODS
AROUND THE EVENT DATE

Portfolio	Pre-ISD Period: Mean Delta Std. Dev.	Pre-ISD Period: t-Statistic Prob ≥ |t|	Post-ISD Period: Mean Delta Std. Dev.	Post-ISD Period: t-Statistic Prob ≥ |t|
Aaa	.40 (.28)	2.52 n.s. (2 d.f.)	.18 (.17)	1.83 n.s. (2 d.f.)
Aa	.16 (.21)	1.35 n.s. (2 d.f.)	.21 (.16)	2.21 n.s. (2 d.f.)
Baa	.46 (.27)	3.86 .01 (4 d.f.)	.53 (.20)	5.91 0.005 (4 d.f.)
NR	.15 (.21)	1.45 n.s. (3 d.f.)	.51 (.23)	4.37 0.025 (3 d.f.)

Mean deltas for the Aaa and Aa portfolios are not significantly different from zero in both the post- and pre-defeasance periods. Generally speaking, the ISD transaction does not appear to affect default risk for these two portfolios. However, Aaa and Aa bonds have the highest bond ratings and already possess low default risk. Thus it may be difficult to measure the effect of an ISD transaction on bonds that are approximately riskless in the first place. The t-tests of the observed post-ISD mean deltas for the Baa and NR portfolios are significant at an alpha level of .05 or lower. The significant results for the Baa and NR portfolios are not as predicted and allow the rejection of the null hypothesis of a zero default risk after defeasance for the two portfolios with the lowest bond ratings. Taken overall, the results for all four portfolios do not support the wealth transfer hypothesis.

Figures 1 through 4 graphically present the delta values for the four portfolios during the pre- and post-defeasance periods. In general, visual inspection of Figures 1 to 4 supports the statistical tests reported in Table IV.

Results of MSDSD Tests--Non ISD Portfolios

Question 2 addresses the issue of whether default risk has increased for the senior bonds which are made junior in claim to bonds defeased in an in-substance defeasance. Two portfolios of bonds which were made junior to an ISD bond as

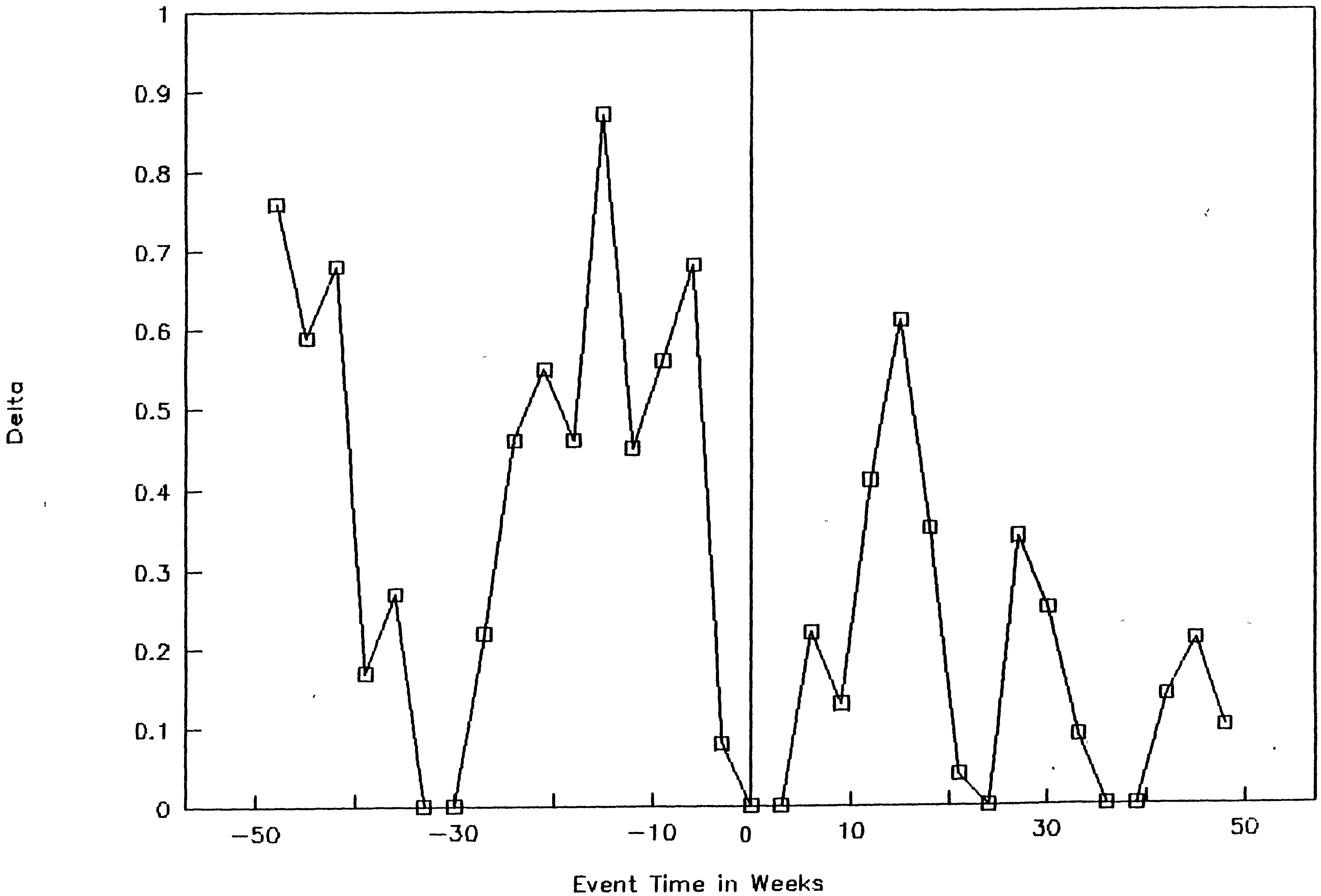


Figure 1. Moving SDSD Aaa ISD Bonds Portfolio

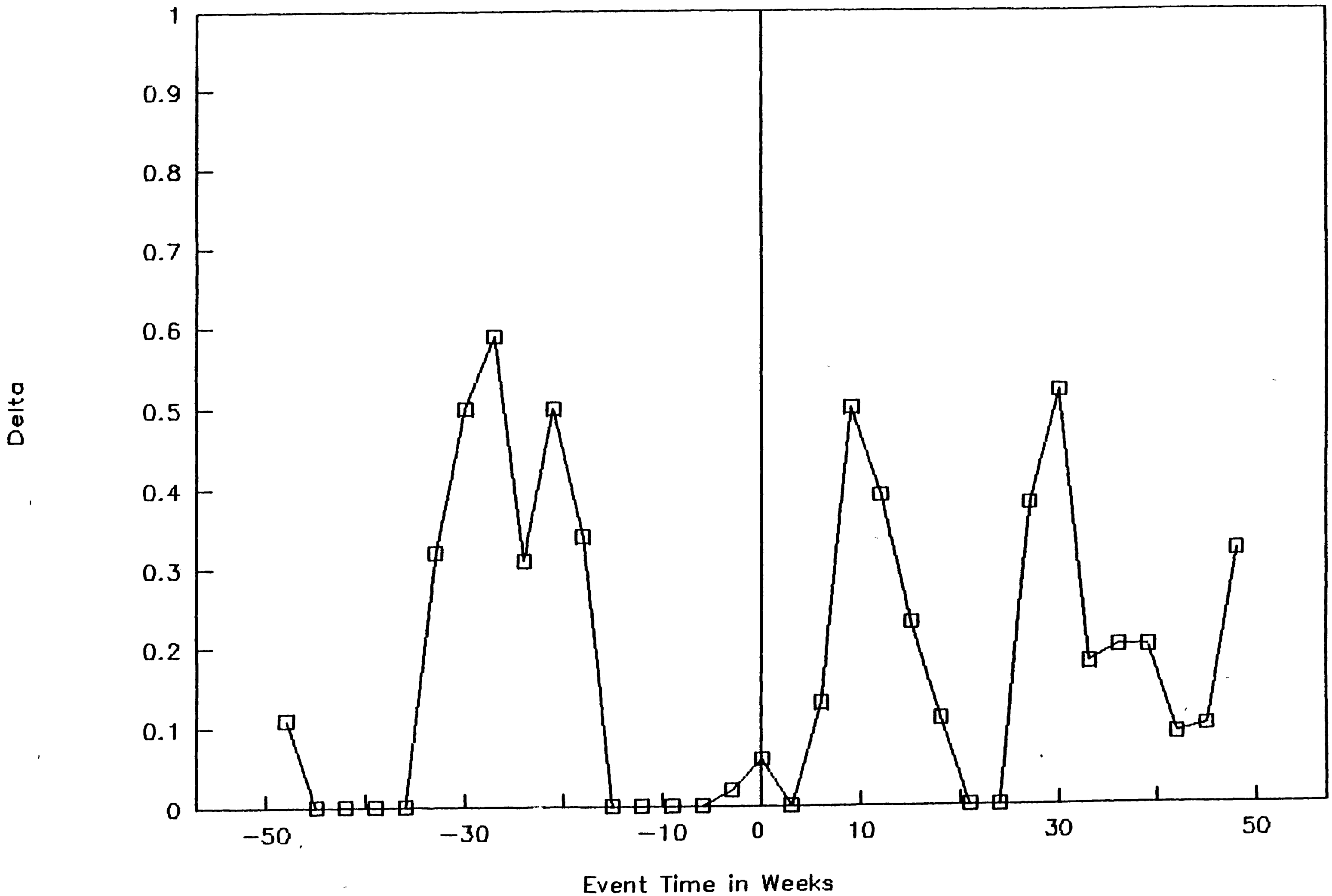


Figure 2. Moving SDSD Aa ISD Bonds Portfolio

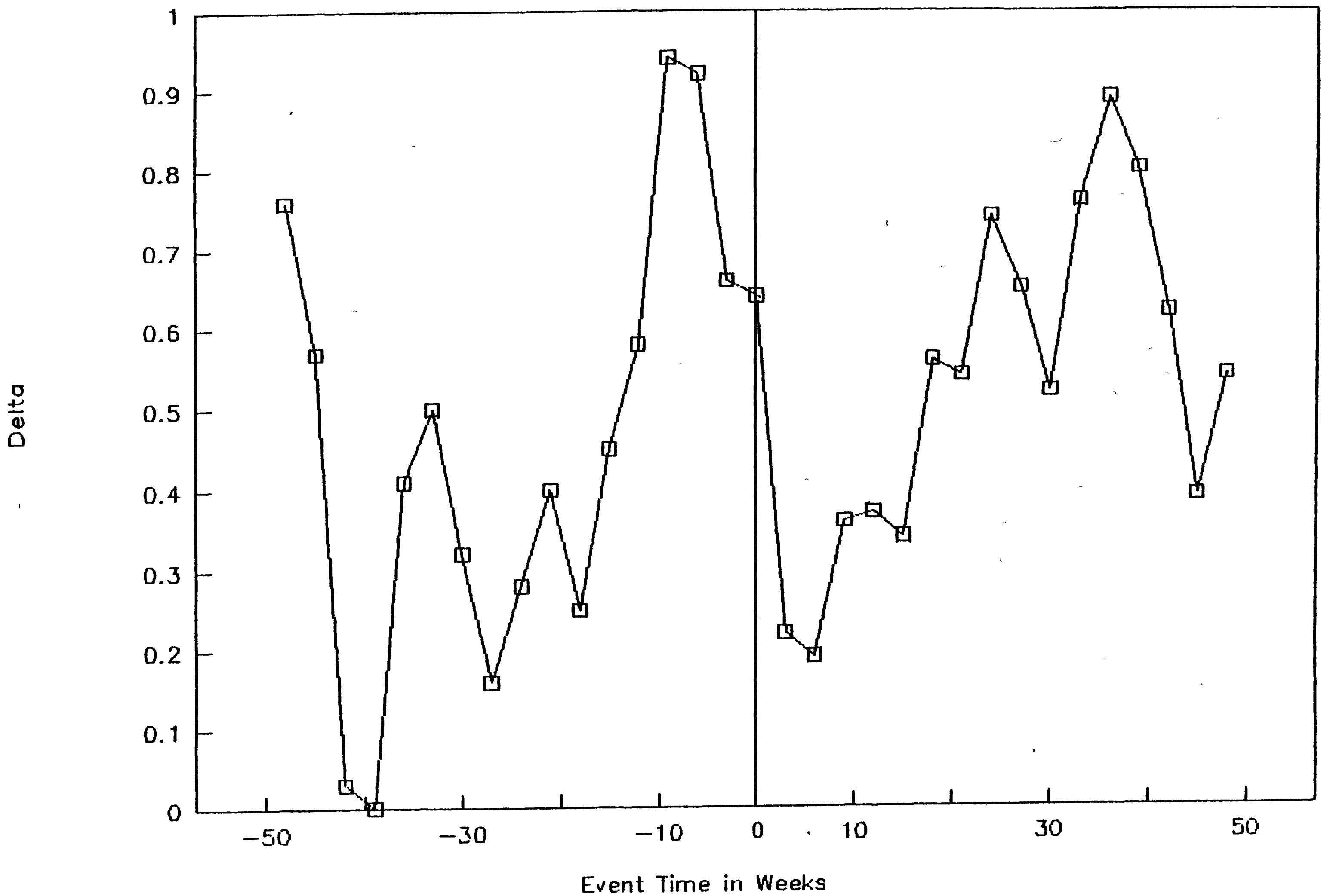


Figure 3. Moving SDSD Baa ISD Bonds Portfolio

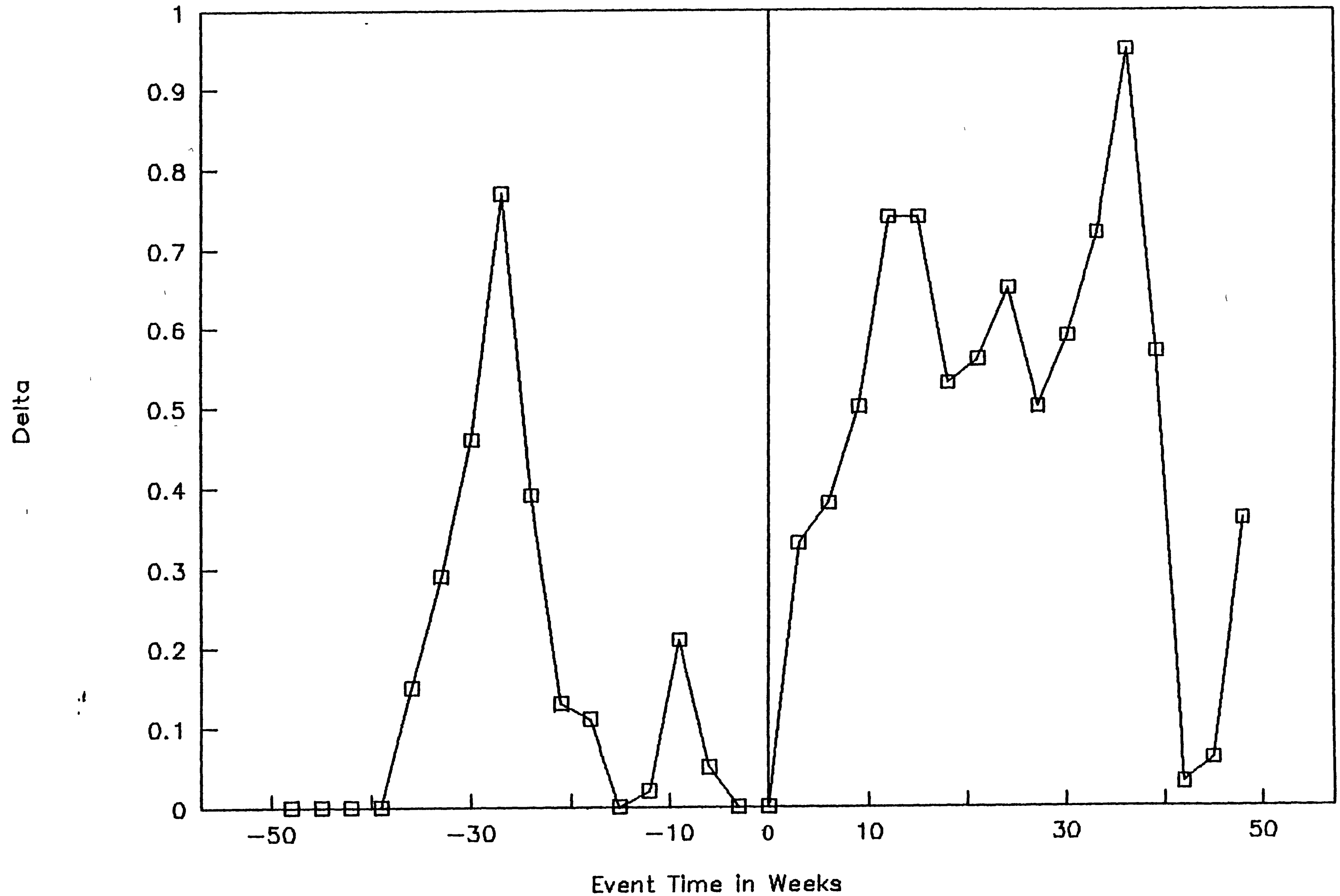


Figure 4. Moving SDSD NR ISD Bonds Portfolio

a result of the ISD are examined to answer Question 2. The two non-defeased bond portfolios have a Moody's rating of Aaa, Aa (grouped together), and Baa. The data are classified into two portfolios based upon Moody's bond ratings. It is necessary to combine the Aaa and Aa bonds because of limited data availability.

If default risk increases in the post-defeasance period relative to pre-defeasance period, then the difference between post- and pre-defeasance deltas should be greater than zero. Mean deltas for the two portfolios during the two periods are reported in Table V. Contrary to the relationship hypothesized in Question 2, the mean deltas do not increase. The mean of deltas for the Aaa/Aa non-defeasance portfolio decrease from .46 in pre-defeasance to .23 in the post-defeasance period. Similarly, the Baa non-defeasance portfolio mean deltas decrease from .49 in the pre-defeasance period to .25 in the post-defeasance period. Visual inspection of Figures 5 and 6 also shows a pattern of lower deltas after defeasance. Given this it is unnecessary to conduct statistical tests, as outlined earlier. No support is found for the view that non-ISD bondholders are harmed as a result of an ISD transaction.

TABLE V

PORTFOLIOS OF NON-DEFEASED BONDS MEANS OF PORTFOLIOS PRE-ISD AND POST-ISD PERIODS AROUND THE EVENT DATE

Portfolio	Pre-ISD Period Mean Delta Std. Dev.	Post-ISD Period Mean Delta Std. Dev.
Aaa-Aa-Non	.46 (.31)	.23 (.15)
Baa-Non	.49 (.18)	.25 (.20)

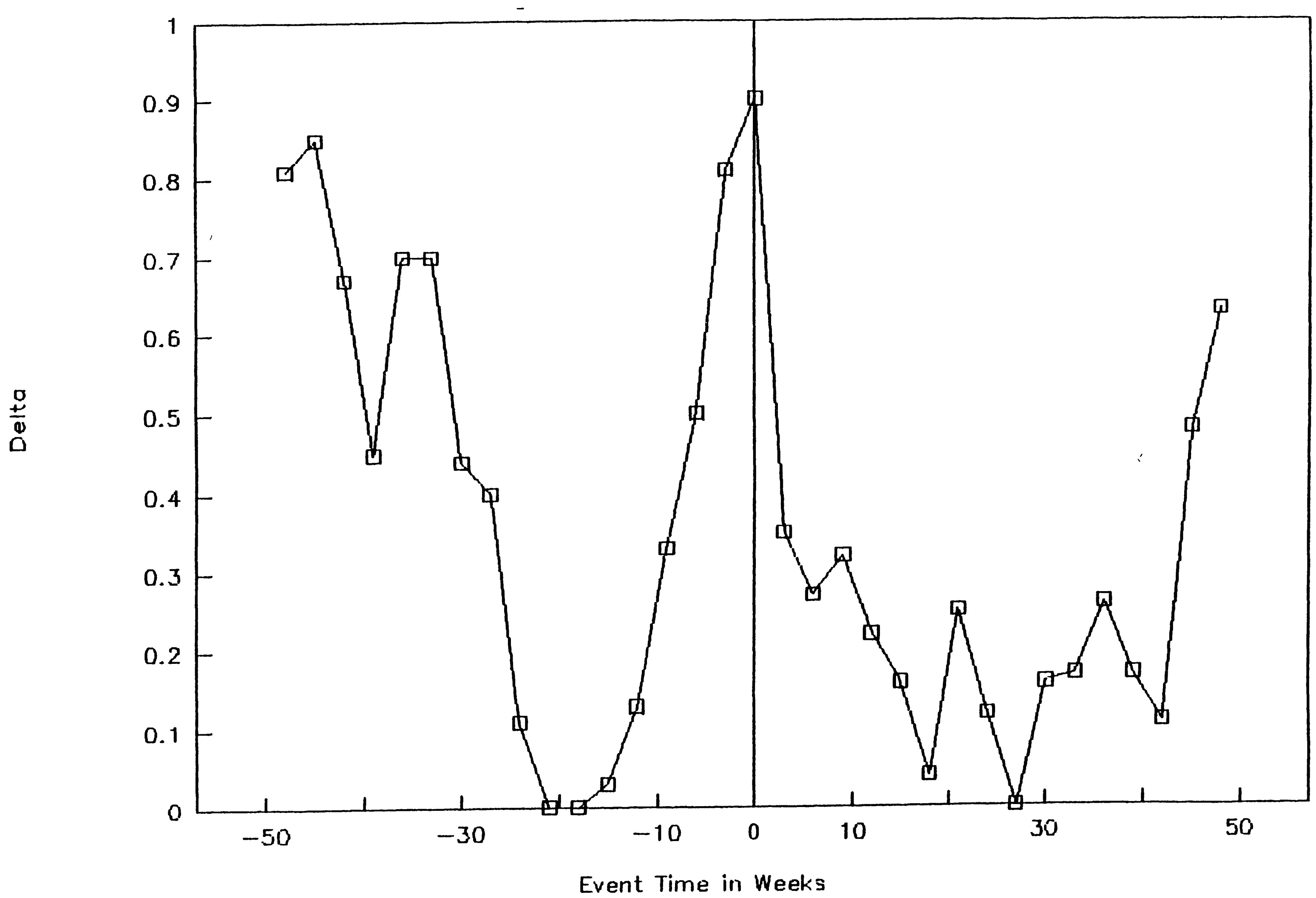


Figure 5. Moving SDSD Aaa/Aa Non-ISD Bonds Portfolio

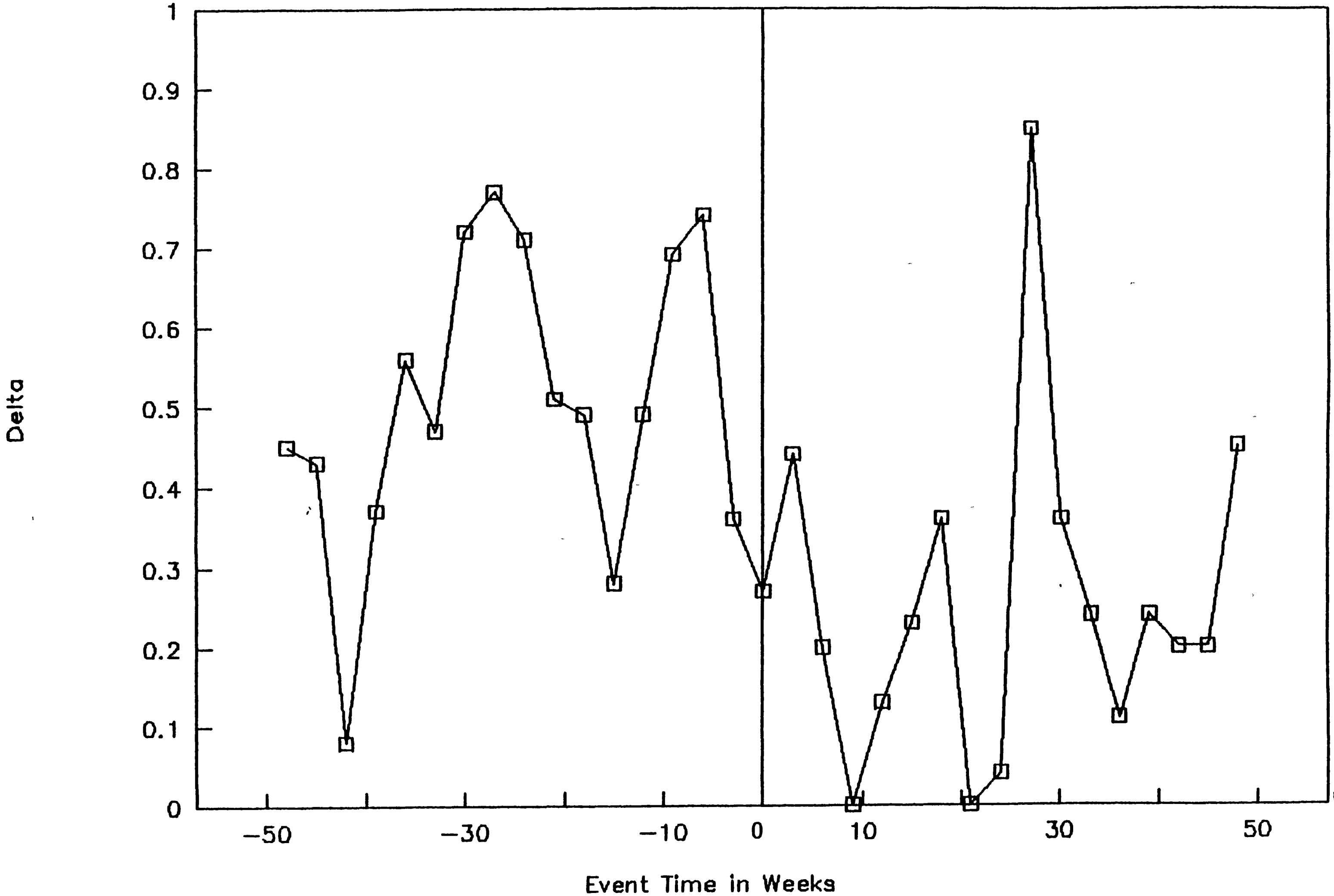


Figure 6. Moving SDSD Baa Non-ISD Bonds Portfolio

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

Discussion of Results

The first question addressed in this dissertation is whether the default risk of defeased debt is significantly different than what would be predicted if it were perceived by the market as being costlessly and unconditionally secured without risk by government securities held in trust. In other words, SFAS No. 76 predicts that default risk of defeased debt should be zero. The bondholders' assessment of default risk in the post-defeasance period provides an answer to the question of substance over form. This dissertation extends earlier studies by explicitly dealing with changes in bond default risk in the ISD transaction. The results for the Aaa and Aa portfolios indicate that the ISD transaction does not appear to change perceived default risk. In both the pre- and post-defeasance periods, the default risk measure, delta, is not significantly different from zero. For the Baa and NR portfolios, the defeasance transaction does not appear to have reduced default risk to approximately zero. The view that an ISD is economically like an actual defeasance is not supported for these two portfolios. Overall, the results for all four portfolios do not support the wealth transfer hypothesis.

The second question is concerned with wealth transfers from bondholders when their bonds are not defeased. Do bondholders act as if an in-substance defeasance transaction, by rearranging the claims structure of bondholders of the same firm, converts their bonds to a lower priority or junior claim relative to the defeased bonds? If non-defeased bondholders believe that their bonds have a lower priority in a firm's claim structure, this should result in an upward revision of their assessment of default risk. This dissertation also extends earlier studies by explicitly considering the change in default risk for such senior debt (non-defeased bonds). The non-defeased bondholders' assessment of default risk in the post-defeasance period provides an answer to the question of claim priority after defeasance. The results show that defeasance does not result in increases of assessed default risk for non-defeased bondholders. No evidence is found that non-ISD bondholders are harmed as a result of an ISD transaction.

Implications

The results reported here do not support the view that defeased bondholders received a permanent wealth transfer as a result of the in-substance defeasance transaction. These findings tend to support previous investigations of the ISD transaction by Johnson, Pari, and Rosenthal (1989) and Hand, Hughes, and Sefcik (1990). The findings have an implication for accounting policy makers: the Financial Accounting Standards Board may have a basis to reexamine SFAS No. 76. The argument of substance over form that persuaded the FASB to issue SFAS No. 76 is not supported by the results of this dissertation or the research reported above.

The implications of the findings for Question 2 are that since non-defeased bondholders are not found to be worse off after an ISD, they do not find it necessary to protect themselves from ISD. The fear of negative wealth transfers which may result from incomplete protection debt covenants is not supported by the results of this dissertation.

Limitations

Default risk as assessed by bondholders depends upon the specific conditions that exist in the economy. Default risk is not stable over time but changes with events that alter investor expectations: economic conditions and expectations of future economic conditions (e.g., business cycles) influence default risk. The event period in this dissertation is 1981 to 1986, which includes both economic recession and expansion. A limitation of the experimental design of this dissertation is that the effect of the business cycle on default risk has not been explicitly controlled.

The small sample of in-substance defeasance bonds available limits the ability to generalize these results to other classes of liabilities extinguished with in-substance defeasance transactions. The results of this dissertation suggest the need for further research examining the effects of the in-substance defeasance transaction on a broader class of liabilities.

SELECTED REFERENCES

Altman, Edward I. "The Anatomy of the High-Yield Bond Market." Financial Analysts Journal (July 1987): 12-25.

Baker, Marci. "Banks Mount a Full-Scale Charge into Corporate Defeasance Deals." American Banker (February 1984): 18-22.

Bey, Roger P., Richard C. Burgess, and Richard B. Kearns. "Moving Stochastic Dominance: An Alternative Method for Testing Market Efficiency." The Journal of Financial Research (Fall 1984): 185-97.

Bierwag, G. O. "Immunization, Duration, and the Term Structure of Interest Rates." Journal of Financial and Quantitative Analysis 12 (December 1977): 526-543.

Broske, Mary S. "Quantifying the Probability of Default Risk as Assessed by the Bond Market: An Analysis of Default Risk Measures." Ph.D. Dissertation, University of Florida, 1982.

__________. "The Measurement of Bond Default Risk." Research in Finance 5 (1985): 107-143.

Demsetz, H. "The Exchange and Enforcement of Property Rights." Journal of Law and Economics (October 1964): 121-135.

Deppe, L. A. and J. W. Bartley. "The Economic Motivations for and the Security Price Reaction to the In-Substance Defeasance of Debt." Working Paper, Brigham Young University, 1989.

Fama, E. F. and K. R. French. "Business Conditions and Expected Returns." Journal of Financial Economics 25 (April 1989): 23-49.

Financial Accounting Standards Board. "Statement No. 76, Extinguishment of Debt." Stamford, Connecticut: FASB, 1983.

Fisher, Lawrence. "Determinants of Risk Premiums on Corporate Bonds." The Journal of Political Economy (June 1959): 217-237.

Francis, F. C. Investments: Analysis and Management, Fourth Edition. New York: McGraw-Hill Book Company, 1986.

Hand, John R. M., Patricia Hughes, and Steven E. Sefcik. "Insubstance Defeasance: Security Price Reactions and Motivations." Journal of Accounting and Economics 13 (March 1990): 47-89.

Holthausen, Robert W. and Richard W. Leftwich. "The Effect of Bond Rating Changes on Common Stock Prices." Journal of Financial Economics 17 (April 1986): 57-89.

Hopewell, M. H. and G. G. Kaufman. "Bond Price Volatility and Term to Maturity: A Generalized Respecification." American Economic Review (September 1973): 749-53.

Jadlow, Janice Wickstead. "Market Assessment of the Euro dollar Default Risk Premium." Advances in Financial Planning & Forecasting: International Dimensions JAI Press, 1991.

Jensen, M. C. and W. H. Meckling. "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure." Journal of Financial Economics 3 (October 1976): 305-360.

Johnson, James M., Robert A. Pari, and Leonard Rosenthal. "The Impact of In-substance Defeasance on Bondholder and Shareholder Wealth." The Journal of Finance 44 (September 1989): 1049-1057.

Kim, E. H., J. J. McConnell, and P. R. Greenwood. "Capital Structure Rearrangements and Me-First Rules in an Efficient Capital Market." Journal of Finance 32 (June 1977): 789-810.

Levy, Haim and Marshall Sarnat. Portfolio and Investment Selection: Theory and Practice. Englewood Cliffs, NJ: Prentice-Hall, 1984.

Nunn, K., J. Hill, and T. Schneeweis. "Corporate Bond Price Data Sources and Risk/Return Measurement." Journal of Financial and Quantitative Analysis 20 (January 1986): 197-208.

Peterson, David, Pamela Peterson, and James Ang. "The Extinguishment of Debt Through In-Substance Defeasance." Financial Management (Spring 1985): 59-67.

Phillips, A. L. and S. M. Moody. "The Effects of Defeased Debt on Loan Decisions." Journal of Commercial Bank Lending 72 (February 1989): 28-35.

Press, Eric Geoffrey. "Toward a Theory of Debt Refunding: The Case of In-Substance Defeasance." Ph.D. Dissertation, The University of Oregon, 1987.

Stober, Thomas L. "Critique: Hughes & Sefcik (1987)." Cincinnati, OH: American Accounting Association (August 1987).

Van Horne, J. C. "Of Financial Innovations and Excesses." _The Journal of Finance_ 40 (July 1985): 621-631.

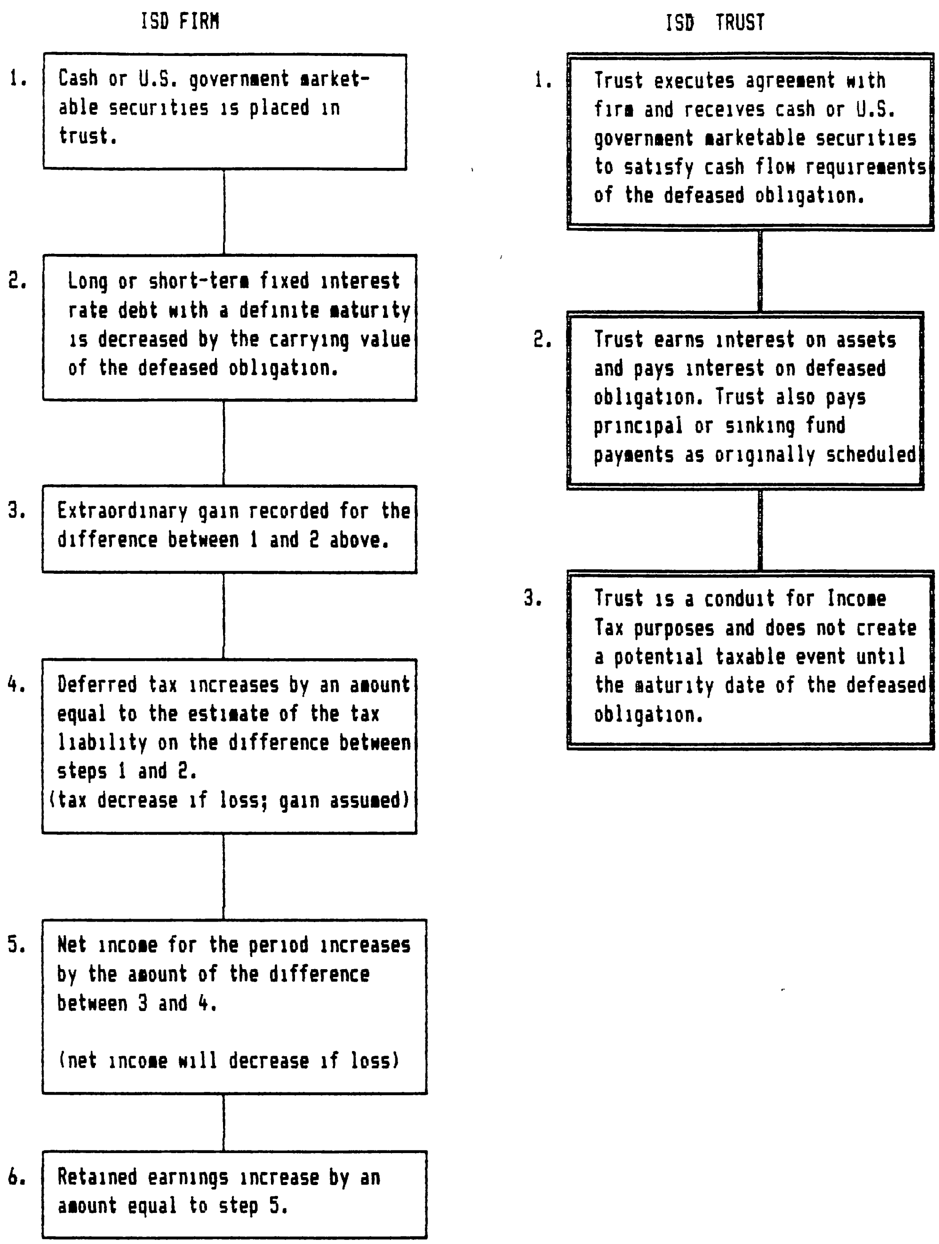
Warner, Larkin. "A Primer on What's Wrong with U.S. Saving and Investment." _Oklahoma Business Bulletin_ (March 1988): 1-4.

Weil, R. L. "De or Misfeasance?" _Barron's_ (December 1983): 50, 76-77.

APPENDIXES

APPENDIX A

IN-SUBSTANCE DEFEASANCE TRANSACTION



Adapted from: Phillips and Moody (1989) p. 30-31.

APPENDIX B

ACCOUNTING FOR THE ISD TRANSACTION

ACCOUNTING FOR THE ISD TRANSACTION

An example will illustrate the accounting for an ISD transaction: A firm issues $1 million, 20-year, 5% bonds for par on January 1, 1972. On January 1, 1982, the market rate for 10-year bonds in the firm's risk class is 12%. U.S. Government 5% bonds with a 10-year maturity are yielding 10%. The present value of the original bond issue is $598,553. U.S. Government bonds which will service the firm's debt can be purchased for $688,444. If the firm enters into an ISD transaction on December 31, 1981, the government bonds are transferred to an irrevocable trust to service the firm's 20-year, 5% bonds of 1992. The income statement will show an extraordinary $311,556 pre-tax gain for the period. The balance sheet will no longer reflect the $1 million debt or trust assets because they have been offset.

The $401,447 ($1 million - $598,553) is a bondholder's unrealized economic loss and a shareholder's unrealized economic gain which the firm would report if it repurchased the bonds.

The $89,891 ($401,447 - $311,556) of unrecognized economic gain that retirement by defeasance transfers from the shareholders back to the bondholders is troublesome.

APPENDIX C

MOODY'S BOND RATINGS

MOODY'S BOND RATINGS

The following is quoted from <u>Moody's Bond Record</u> (1982):

Aaa

Bonds which are rated Aaa are judged to be of the best quality. They carry the smallest degree of investment risk and are generally referred to as "gilt edge." Interest payments are protected by a large or by an exceptionally strong margin and principal is secure. While the various protective elements are likely to change, such changes as can be visualized are most unlikely to impair the fundamentally strong position of such issues.

Aa

Bonds which are rated Aa are judged to be of high quality by all standards. Together with the Aaa group they comprise what are generally know as high grade bonds. They are rated lower than the best bonds because margins of protection may not be as large as in Aaa securities or fluctuation of protective elements may be of greater amplitude or there may be other elements present which make the long term risks appear somewhat larger than in Aaa securities.

A

Bonds which are rated A possess many favorable investment attributes and are to be considered as upper medium grade obligations. Factors giving security to principal and interest are considered adequate but elements may be present which suggest a susceptibility to impairment sometime in the future.

Baa

Bonds which are rated Baa are considered as medium grade obligations, i.e., they are neither highly protected nor poorly secured. Interest payments and principal security appear adequate for the present but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well.

Ba

Bonds which are rated Ba are judged to have speculative elements; their future cannot be considered as well assured. Often the protection of interest and principal payments may be very moderate and thereby not well safeguarded during both good and bad times over the future. Uncertainty of position characterizes bonds in this class.

B

Bonds which are rated B generally lack characteristics of the desirable investment. Assurance of interest and principal payments or of maintenance of other terms of the contract over any long period of time may be small.

Caa

Bonds which are rated Caa are of poor standing. Such issues may be in default or there may be present elements of danger with respect to principal or interest.

Ca

Bonds which are rated Ca represent obligations which are speculative in a high degree. Such issues are often in default or have other marked shortcomings.

C

Bonds which are rated C are the lowest rated class of bonds and issues so rated can be regarded as having extremely poor prospects of ever attaining any real investment standing.

NR

Indicates that no rating has been requested, that there is insufficient information on which to base a rating, or that Moody's does not rate a particular type of obligation as a matter of policy.

APPENDIX D

FORTRAN PROGRAM TO CALCULATE D1

FORTRAN PROGRAM TO CALCULATE BOND DURATION D1

```
      WRITE (6,895)
  895 FORMAT (///,6X,'CASE COUPON YRSTOMAT MATVAL YTM
     1   PERIOD D1',)
      NC=49.
      DO 300 I=1,NC
   10 FORMAT (1X,I3,3X,F6.2,3X,F8.2,3X,F6.4,3X,I2)
      READ (5,10) ICASE,COU,TIME,VM,R,M
      X1=(1+R/M)**(TIME*M+1)
      X2=(1+R/M)+R*TIME
      X3=(R/M)**2
      X4=(VM)*TIME*M
      X5=(X3*X4)
      X6=COU*R/M
      X7=(1+(R/M))**(TIME*M)
      X8=X6*(X7-1)
      X9=VM*X3
      DU1=(COU*(X1-X2)+X5)/(X8+X9)
      DUR=DU1/M
      WRITE (6,904)
  904 FORMAT(//)
      WRITE (6,908) ICASE,COU,TIME,VM,R,M,DUR
  908 FORMAT(6X,I3,4X,F5.2,1X,F5.1,6X,F6.0,1X,F5.4,
     1   3X,I2,1X,F9.4)
  300 CONTINUE
      STOP
      END
```

APPENDIX E

BROSKE ALGORITHM

AN ALGORITHM FOR CALCULATING THE PROBABILITY OF DEFAULT WHEN THERE ARE N INTERSECTIONS BETWEEN THE CUMULATIVE PROBABILITY DISTRIBUTIONS

For discrete distributions, as noted above, it is only necessary to check the points of intersection. This is the basis for developing the algorithm. For purpose of analysis, assume two discrete cumulative probability distributions of a given variable, which we call $F_{X'}(x)$ and $F_Y(y)$, where X' has default risk and Y does not, and proceed as follows:

1. Order (rank) the observations of the given variable for X' and then for Y from the smallest value to the largest.
2. As X' is defined as having some probability of default, we know that it contains some implied level of delta. As we have discrete distributions, the cumulative probability at any point can be written as an interval as follows:

$$x' = \begin{cases} 0 & 0 < p \leq \delta \\ x'_1 & \delta < p \leq \left[(1-\delta)\left(\frac{1}{n}\right) + \delta\right] \\ x'_2 & \left[(1-\delta)\left(\frac{1}{n}\right) + \delta\right] < p \leq \left[2(1-\delta)\left(\frac{1}{n}\right) + \delta\right] \\ x'_3 & \left[2(1-\delta)\left(\frac{1}{n}\right) + \delta\right] < p \leq \left[3(1-\delta)\left(\frac{1}{n}\right) + \delta\right] \\ \vdots & \\ x'_n & \left[(n-1)(1-\delta)\left(\frac{1}{n}\right) + \delta\right] < p \leq 1, \end{cases}$$

where n is the number of observations, and all observations are assigned the same probability 1/n.

$$y = \begin{cases} y_1 & 0 < p \leq \left(\frac{1}{n}\right) \\ y_2 & \left(\frac{1}{n}\right) < p \leq \left(\frac{2}{n}\right) \\ y_3 & \left(\frac{2}{n}\right) < p \leq \left(\frac{3}{n}\right) \\ \vdots & \\ y_n & \left(\frac{n-1}{n}\right) < p \leq 1. \end{cases}$$

3. Calculate $(y - x')$ for each change in probability. Call these areas, $1, \ldots, 2n$. Formulas for each area $(y - x')$ follow:

Area	$y - x'$
1.	$(y_1 - 0)\delta.$
2.	$(y_1 - x'_1)\left(\frac{1}{n} - \delta\right).$
3.	$(y_2 - x'_1)\left\{\left[\left(\frac{1}{n}\right)(1 - \delta) + \delta\right] - \left(\frac{1}{n}\right)\right\}.$
4.	$(y_2 - x'_2)\left\{\left(\frac{2}{n}\right) - \left[\left(\frac{1}{n}\right)(1 - \delta) + \delta\right]\right\}.$
⋮	
2n − 1	$(y_n - x'_{(n-1)})\left[\left(\frac{n-1}{n}\right)(1 - \delta) + \delta\right] - \left(\frac{n-1}{n}\right).$
2n.	$(y_n - x'_n)\left\{\frac{n}{n} - \left[\frac{(n-1)}{n}(1 - \delta) + \delta\right]\right\}.$

4. Begin with a large value for δ (so that YDX′ by SSD) and reduce it until the cumulative difference is no longer greater than zero (i.e., until exact SSD results and any further reduction in δ would result in X′DY).

Before presenting the algorithm, it is necessary to define the following variables:

$$\alpha_i = (y_{i+1} - x'_i)\left[\delta\left(1 - \frac{i}{n}\right)\right], \qquad i = 0, 1, \ldots, n - 1, \qquad \text{(A2.1)}$$

$$\beta_i = (y_i - x'_i)\left[\frac{i}{n} + \delta\left(\frac{i-1}{n} - 1\right)\right], \qquad i = 1, \ldots, n, \qquad \text{(A2.2)}$$

$$\psi_i = \alpha_i + \beta_i, \qquad i = 0, 1, \ldots, n. \qquad \text{(A2.3)}$$

The following two rules must hold for the delta which results in precise SSD:

Rule 1 $\quad \sum_{i=0}^{I} \psi_i \geq 0 \quad$ for all i; $\qquad$ (A2.4)

Rule 2 $\quad \sum_{i=1}^{I} \psi_i - \alpha_i \geq 0 \quad$ for all i. $\qquad$ (A2.5)

Source: Broske (1985), pp. 142-143.

APPENDIX F

FORTRAN PROGRAM TO CALCULATE DELTA

FORTRAN PROGRAM TO CALCULATE DELTA

```
      REAL*8 X(1000),Y(1000),YS(0:100),XS(100),DELT,DELTI
      INTEGER*4 N,PASS,OUT,GET_DEVICE
      OUT = GET_DEVICE()
10    WRITE(6,*)'PLEASE ENTER DELTA AND DELTA DECREMENT '
      READ(5,*)DELTA,DECREMENT
      WRITE(6,*)'PLEASE ENTER THE STEP SIZE '
      READ(5,*)N
      PASS = 1
      M=1
      I = N
      CALL INPUT(X,Y,NUM,OUT)
        DO WHILE(I.LE.NUM)
          DELT = DELTA
          DELTI = DECREMENT
          YS(0) = 0.D0
          DO J=1,N
            XS(J) = X(J+M-1)
            YS(J) = Y(J+M-1)
          ENDDO
          CALL SORTER(XS)
          CALL SORTER(YS)
          CALL CALCULATE(OUT,PASS,YS,XS,N,DELT,DELTI)
          PASS = PASS + 1
          I = I + N/2
          M = M + N/2
        END DO
        CALL CONTINUE
      GOTO 10
      END
*
      SUBROUTINE INPUT(X,Y,NUM,OUT)
      REAL*8 X(1000),Y(1000)
      CHARACTER*8 FILENAME
      INTEGER*4 NUM,IOS,OUT
      WRITE(6,*)'ENTER THE NAME OF FILE TO READ: '
      READ(5,'(A)')FILENAME
      CALL HEADER(FILENAME,OUT)
      OPEN(8,FILE=FILENAME,IOSTAT=IOS)
      REWIND 8
      NUM = 0
      DOWHILE(IOS.NE.-1)
      READ(8,'(4X,F8.0,1X,F8.0)',IOSTAT=IOS)X(NUM+1),Y(NUM+1)
        NUM = NUM + 1
      END DO
      NUM = NUM - 1
      CLOSE(8)
      RETURN
      END
```

```
*
      SUBROUTINE HEADER(FILENAME,OUT)
      CHARACTER*8 FILENAME
      INTEGER OUT
      J = INDEX(FILENAME,' ')
      WRITE(OUT,100)FILENAME(1:J-1)
100   FORMAT(1X,'THE FOLLOWING OUTPUT IS FROM FILE ',A)
      RETURN
      END
*
      SUBROUTINE SORTER(IN)
      REAL*8 IN(20),TEMP
      INTEGER PASS
      LOGICAL NOTORDERED
      NOTORDERED = .TRUE.
      PASS = 1
      DO WHILE(PASS.LE.19.AND.NOTORDERED)
        NOTORDERED = .FALSE.
        DO I = 1,20-PASS
          IF(IN(I).GT.IN(I+1))THEN
             TEMP = IN(I)
             IN(I) = IN(I+1)
             IN(I+1) = TEMP
             NOTORDERED = .TRUE.
          ENDIF
        END DO
        PASS = PASS + 1
      END DO
      RETURN
      END
*
*
      SUBROUTINE CALCULATE(OUT,PASS,X,Y,N,DELTA,DELTI)
      REAL*8 DELTA,X(0:N),Y(N),ALPHA(0:N),BETA(0:N)
      REAL*8 PSI(0:N),TOTPSI(0:N),Z,ZI,DELTI
      INTEGER OUT,N,PASS
      CHARACTER*30 MESSAGE
      LOGICAL RULE1,RULE2
      Z = DBLE(N)
      RULE1 = .TRUE.
      RULE2 = .TRUE.
      DO WHILE(DELTA.GT.0.AND.RULE1.AND.RULE2)
        DO I = 0,N-1
          ZI = DBLE(I)
          ALPHA(I) = (Y(I+1)-X(I))*(DELTA*(1.D0 - ZI/Z))
        END DO
        ALPHA(N) = 0.D0
        BETA(0) = 0.D0
        DO I = 1,N
        ZI = DBLE(I)
        BETA(I) = (Y(I) - X(I))*(1.D0/Z + DELTA*((ZI-1.D0)/Z
        1.D0))
```

```
        END DO
        DO I = 0,N
          PSI(I) = ALPHA(I) + BETA(I)
        END DO
        DO I = 1,N
          TOTPSI(I) = 0.D0
          DO J = 1,I
            TOTPSI(I) = TOTPSI(I) + PSI(J)
          END DO
          IF(TOTPSI(I).LT.0)THEN
             MESSAGE = 'RULE 1 FAILED '
             RULE1 = .FALSE.
          ENDIF
        END DO
        DO I = 1,N
          TOTPSI(I) = 0.D0
          DO J = 1,I
            TOTPSI(I) = TOTPSI(I) + PSI(J) - ALPHA(J)
          END DO
          IF(TOTPSI(I).LT.0)THEN
            MESSAGE = 'RULE 2 FAILED '
            RULE2 = .FALSE.
          ENDIF
        END DO
        DELTA = DELTA - DELTI
      END DO
      DELTA = DELTA + 2*DELTI
      MESSAGE = 'BOTH RULES HOLD AT DELTA = '
      CALL OUTPUT(OUT,PASS,DELTA,MESSAGE)
      RETURN
      END
*
      SUBROUTINE OUTPUT(OUT,PASS,DELT,MESSAGE)
      REAL*8 DELT
      INTEGER OUT,PASS
      CHARACTER*30 MESSAGE
      WRITE(OUT,100)PASS,MESSAGE,DELT
      RETURN
100   FORMAT('0',I4,2X,A,F8.4,)
      END
*
      INTEGER*4 FUNCTION GET_DEVICE()
      WRITE(6,*)'ENTER THE DESIRE OUTPUT DEVICE '
      WRITE(6,*)'ENTER 2 FOR PA PRINTER '
      WRITE(6,*)'ENTER 3 FOR SCIENCE PRINTER '
      WRITE(6,*)'ENTER 6 FOR TERMINAL '
      WRITE(6,*)'PLEASE ENTER 2, 3, OR 6 :'
      READ(5,*)GET_DEVICE
      RETURN
      END
*
```

```
      SUBROUTINE CONTINUE
      CHARACTER*3 RESPONSE
10    WRITE(6,*)'DO YOU WISH TO GO AGAIN? '
      READ(5,'(A)')RESPONSE
      IF(RESPONSE.EQ.'Y'.OR.RESPONSE.EQ.'YES')THEN
        RETURN
      ELSEIF(RESPONSE.EQ.'y'.OR.RESPONSE.EQ.'yes')THEN
        RETURN
      ELSEIF(RESPONSE.EQ.'N'.OR.RESPONSE.EQ.'NO')THEN
        STOP
      ELSEIF(RESPONSE.EQ.'n'.OR.RESPONSE.EQ.'no')THEN
        STOP
      ELSE
        WRITE(6,*)'PLEASE ENTER YES OR NO '
        WRITE(6,*)
        GOTO 10
      ENDIF
      END
```

VITA

Thomas Maxwell Carment

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE MARKET EFFECT OF IN-SUBSTANCE DEFEASANCE ON BONDHOLDER DEFAULT RISK

Major Field: Business Administration

Biographical:

Personal Data: Born in Cleveland, Ohio, March 13, 1945, the son of Charles A. And Helen M. Carment.

Education: Graduated from Ponca City Senior High School, Ponca City, Oklahoma, in May, 1963; received Bachelor of Arts Degree in Economics from Oklahoma State University in May, 1967; received Master of Business Administration Degree from Oklahoma State University, May, 1970; received Bachelor of Science Degree in Accounting from Northeastern State University, May, 1981; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in December, 1991.

Professional Experience: Positions in accounting and treasury departments with Ford Motor Company, Burroughs Company, CONOCO, Inc., and Power Pak Company, Inc. Presently employed as an Assistant Professor of Accounting at Northeastern State University, Tahlequah, Oklahoma.