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FIRMS' USE OF DERIVATIVE SECURITIES: AN EXAMINATION OF THE FIRM-SPECIFIC IMPACT OF DERIVATIVE STRATEGIES ON EARNINGS PERSISTENCE AND EARNINGS RESPONSE COEFFICIENTS

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ACCEPTANCE

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ABSTRACT

Use of derivative securities has increased exponentially over the last 10 years. The purpose of this dissertation is to predict the impact of a firm's interest rate derivative strategy on the valuation relevance of its earnings and to empirically test the predictions using a sample of non-financial firms. The model describes the impact of an interest rate derivative strategy on the persistence of earnings and on the earnings response coefficient. The empirical tests examine changes in persistence and earnings response coefficients for a sample of non-financial firms that have disclosed the use of interest rate swap contracts.

The model describes the earnings process as a combination of two components: one component that is related to interest rates and one component that is independent of interest rates. The model shows that total persistence of earnings is a weighted average of the persistence of each of the components and that total persistence increases when the component that is related to interest rate risk is decreased. When an effective hedging strategy is defined as one that reduces the exposure to interest rate risk, the model predicts that implementation of an effective hedging strategy leads to an increase in earnings persistence.

Earnings persistence has been examined in prior accounting research and has been found to be directly related to earnings response coefficients. Therefore, the second prediction made in this dissertation is that implementation of an effective hedging strategy leads to an increase in the earnings response coefficient.

This dissertation includes empirical tests of the predictions regarding earnings persistence and earnings response coefficients. The tests use regression analysis to examine the change in the relation between analysts' revisions of future earnings and current unexpected earnings following disclosure of an interest rate swap strategy (the persistence test). Also examined is the change in the relation between abnormal returns and unexpected earnings following disclosure of an interest rate swap (the earnings response coefficient test). The empirical results support the theoretical predictions.

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CHAPTER I

INTRODUCTION

Use of derivative securities has increased exponentially over the last 10 years. On July 17, 1997, the Wall Street Journal (page A2) quoted Arthur C. Levitt, chairman of the Securities and Exchange Commission as saying, "We are in a situation today in which the notional amount of derivatives outstanding has reached some $70 trillion".[1] The nature of derivatives contracts combined with highly individualized financial strategies across firms makes financial evaluation extremely complex. Currently, both the Securities and Exchange Commission (SEC) and the Financial Accounting Standards Board (FASB) are working towards providing appropriate accounting guidance for this dynamic class of financial instruments. This dissertation examines the most widely used derivative security, the interest rate swap, and investigates the effect of the firm's interest rate swap strategy on both the persistence of earnings and the earnings-return relation.[2]

While most of the prior research in this area has investigated usage of derivative securities by financial institutions (e.g., Schrand (1996), Riffe (1995),

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[1]Notional value is a contract's face value, but is not exchanged in cash in derivative transactions. Although these values are not "cash flows", the cash flows implied by the notional values is still very significant. For example, if all outstanding contracts were interest rate swaps and the average interest rate was 10 percent, then the gross cash flows associated with the notional value of $70 trillion would be approximately $7 trillion per year. In addition, the reported estimate of notional value does not include the value associated with contracts that are traded on exchanges (e.g., exchange traded futures and options).

[2]In response to The Wharton School/Chase survey of Derivatives Usage Among U.S. Non-Financial Firms (1995), firms responded that 67.2% used hedging strategies to manage cash flow exposure (survey question 5 response). In addition, question 3 of the survey asked firms which derivatives they used to manage interest rate risk and 62.8% of firms responded that interest rate swaps were used to manage interest rate risk.

Venkatachalam(1996)), this dissertation focuses on interest rate swaps and their effect on the persistence of earnings for a group of non-financial firms. Interest rate swaps alter the earnings pattern of the firm and thus, have implications for earnings persistence and earnings response coefficients (ERCs). In this study, a model is developed that describes the impact of interest rate swaps on earnings persistence and on ERCs.

The empirical predictions generated by the model are used to evaluate the positions taken by a group of non-financial firms. Evidence produced by this research is potentially relevant to assessing whether end users enter into such agreements for cash flow hedging purposes or for purposes inconsistent with cash flow hedging. The findings suggest that interest rate derivative strategies taken by firms are valuation relevant. Interest rate swaps that were part of an "effective" cash flow hedging strategy were found to increase earnings persistence and to increase ERCs while interest rate swaps that were not part of an "effective" cash flow hedging strategy were found to have no impact on either the earnings persistence or ERCs.

The evidence provided by this dissertation also adds additional support to the earlier work of Hentschel and Kothari (1995) who concluded that firms were not gambling on average with their derivative strategies. Using directional predictions for the impact on persistence and ERCs of effectively hedged cash flows, the results of this dissertation support a hedging strategy, thus strengthening the position that on average, non-financial firms are not speculating on cash flows with their interest rate swaps.

The dissertation proceeds as follows. Chapter II presents a review of the finance literature regarding the value relevance of a firm level hedging strategy. The purpose of

this literature review is to provide support for the underlying assumption made in this dissertation, that the firm value is increased by an effective hedging strategy. A discussion of the issues surrounding the reporting of derivative strategies and a description of potential cash flow impacts from an interest rate swap strategy are presented in Chapter III. In addition, an example is used to demonstrate the mechanics of an interest rate swap strategy and the accounting treatment under relevant reporting requirements. The purpose of Chapter III is to demonstrate the direct relation between the cash flow effects of an interest rate swap strategy and the reported financial position impact of the strategy. In Chapter IV, the possible effects of interest rate swaps on the earnings process are examined and specific predictions about how swaps will impact persistence and the earnings response coefficient are developed. These predictions are the bases for the empirical tests performed in Chapters VI and VII. The purpose of Chapter V is to provide a description of the sample selection process and to present descriptive statistics for the firms included in the empirical tests. An integral part of Chapter V is the description of the process used to categorize firms as effective or ineffective cash flow hedgers. Chapter VI presents the empirical model used to test the predictions regarding changes in persistence following implementation of an interest rate swap strategy and discusses the results of running the model using the sample described in Chapter V. Chapter VII presents the empirical model used to test the predictions regarding the earnings response coefficient response to an interest rate swap strategy and discusses the results of running the model. Chapter VIII concludes and discusses future research opportunities.

CHAPTER II

THE VALUE RELEVANCE OF HEDGING AT THE FIRM LEVEL

2.1 Introduction

This dissertation addresses the valuation relevance of a particular type of hedging strategy. However, the valuation relevance only becomes an issue after the firm has made the decision to hedge. Many theories have emerged in the finance literature explaining possible motives for firms to hedge and several of these are presented in this chapter. The theoretical predictions and empirical examinations of this dissertation start from the underlying assumption that firm owners benefit from an effective cash flow hedging strategy. This chapter provides support for this underlying assumption.

2.2 The possible value relevance of firm level hedging

Traditional finance theory (Modigliani and Miller (1958)) is inconsistent with a strategy to hedge cash flows. Risk management is not needed at the firm level because investors can diversify their risks. This traditional theory is based on assumptions that lead to capital structure irrelevance (i.e. the financing of an investment does not add to or lessen the value of the firm, only the quality of the investment itself affects firm value). Primary among these assumptions is the perfection of capital markets.[3] If, however, the market is allowed to have some imperfect qualities, a role emerges for firm level hedging.

Several theories have been put forth to support a role for hedging (or for

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[3]This proposition of capital structure irrelevance is presented in Modigliani and Miller (1958) as Proposition 1 and holds in the absence of any market imperfections (p. 268).

specifically using interest rate swaps) at the firm level and each depends upon certain market imperfections. These theories provide alternative motivations for hedging using asymmetric information scenarios, agency cost issues, progressive tax rate arguments, transactions costs issues and investment protection ideas. Each is discussed below along with a summary of the related empirical findings.

2.2.1 Asymmetric information and agency cost theories of firm level hedging

Within the asymmetric information scenarios and the agency cost theories, hedging allows firms to lower contracting costs while maintaining protection from interest rate risk. In the asymmetric information scenarios (Arak, Estrella, Goodman and Silver (1988), Titman (1992)), the firm's choice of debt contracts is used to signal private information about the firm's future credit premium . For example, the equilibrium reached in Titman's model has fixed rate long-term debt being used exclusively by firms with bad private information about their future credit quality. Firms with good private information (i.e., firms that expect to have better credit quality in the future) issue short-term debt. Hedging is used by these good private information firms to avoid the fluctuation in the short-term nominal interest rate.

One argument based on agency cost theory suggests that bondholders price protect against possible future underinvestment under a long-term fixed rate debt structure (Wall (1989)). This price protection decreases when shareholders have to go to the debt market often or when shareholders face variable rate debt (where the variable rate debt must include a variable credit quality premium). A combination of short-term debt or variable rate debt plus a hedge of the nominal rate changes acts as a substitute for

long-term fixed rate debt that allows for credit quality changes. Again, as in the asymmetric information story above, the hedge is valuable in this scenario because it allows for lower borrowing costs while maintaining protection from interest rate risk. Both theories predict that interest rate hedges should be used by firms with short-term debt.

The debt substitution theory has been examined empirically by Fenn, Post, and Sharpe (1996a) in their examination of debt maturity and the use of interest rate derivatives. The evidence indicates that the short-term debt/total debt is 10 to 15 percentage points higher for users of interest rate derivative users. This is interpreted as evidence supporting derivative use as increasing real cash flows (i.e., lowering borrowing costs), to the extent that short-term debt carries a lower credit risk premium than long-term debt. Fenn, Post, and Sharpe (1996a) note, however, that it is "difficult to distinguish empirically whether firms increase their use of short-term debt (leverage) *because* they use derivatives, or whether firms with greater short-term debt (leverage) are simply more likely to use derivatives." The authors further note that an examination of firms over time might provide a better test of the debt substitution hypothesis.

2.2.2 Manager compensation contracts and firm level hedging

A separate agency cost theory explanation for hedging focusses on managers' risk aversion. Smith and Stulz (1985) describe the case where hedging is valuable because it can remove fluctuations in performance-based compensation plans that are beyond the manager's control. The manager then does not have to be compensated for bearing these risks and the shareholders are better off (as long as the savings in compensation exceed

the costs of hedging). This theory, however, overlooks the potentially less costly alternative of hedging "on paper" only, an alternative that could accomplish the same goal as far as managers are concerned without increasing the number of actual hedging contracts used by firms.

Alternatively, one line of research offers that managers are motivated to hedge corporate earnings so that the capital markets can better judge the management's performance. Demarzo and Duffie (1991) use an information asymmetry model where managers have private information about the source and magnitude of the risks faced by the firm and may have private information about the hedging positions. The model develops an equilibrium where investors support managers' hedging because the decrease in the firms' expected profits is offset by the benefits of reduced noise in the investors' information sets regarding the variance of firm payoffs. In the model, the manager's incentive to hedge is negatively affected by the degree of disclosure required, thus explicitly including a role for accounting standards in shaping management's incentives to use derivatives.

Empirical evidence regarding the managerial risk aversion hypotheses has been mixed. As discussed by Fenn, Post, and Sharpe (1996b), conclusions are difficult to draw without knowing the managers' and shareholders' ex ante positions regarding managerial risk aversion. Geczy, Minton, and Schrand (1995) examined the relation between information asymmetry and derivative use and did not find support for the Demarzo and Duffie (1991) prediction that firms with higher information asymmetry would be more likely to hedge.

2.2.3 Tax savings as a motivation for firm level hedging

Within the previously described theories the value of the hedge comes primarily from its impact on future contracting costs, not from its direct impact on the risk being hedged. In contrast, the following theories propose that the reduction of variance achieved by the hedge adds value to the firm.

The progressive tax rate theory (Smith and Stulz (1985)) relies upon the intuition of taxes as a convex function of earnings. The convexity is due to two factors, as pointed out by Fenn, Post, and Sharpe (1996b), faced by corporations. One is the increasing statutory marginal tax rate (15% on the first $100,000 and 34% on all income beyond) and the other is the existence of tax preference items (such as investment tax credits and loss carryforwards). Reducing the variability of earnings through a hedging instrument leads to lower expected taxes, or higher expected future cash flows and thus a higher firm value. As discussed by Fenn, Post and Sharpe (1996b), the firms that could realize the largest tax benefit from hedging are those whose income is especially volatile and/or those who are near a shift in the marginal tax rate.

Using data on firms' tax preference items and their pre-tax income, empirical studies have investigated this tax rate theory. Nance, Smith and Smithson 91993) found no statistically significant relation between derivative use and tax preference items. They concluded that confidence in the tax hypothesis is reduced based upon their results.

2.2.4 Financial distress costs as a motivation for firm level hedging

There are exogenous costs associated with financial distress that create a concave expected profit function. Financial distress costs include not only the relatively small

direct costs of bankruptcy but also the potentially material indirect costs of being close to bankruptcy. Hedging reduces the expected costs of financial distress by reducing the likelihood of cash shortages and consequently reduces the cost of debt financing (Smith and Stulz (1985)).

Empirically, the hypothesized positive relation between derivatives and leverage has been investigated and a positive relation has been found. Generally, however, the relation has been statistically and economically insignificant (Fenn, Post, and Sharpe (1996b)). Therefore, financial distress does not seem to be the key motivator for the growth in derivative use.

2.2.5 Investment protection as a motivation for firm level hedging

A final theorized value-relevant role for hedging comes from the perspective of investment protection. Froot, Scharfstein, and Stein (1993) develop a model of optimal hedging at the firm level based on the Myers and Majluf (1984) "pecking order" model.

The Myers and Majluf model assumes managers make financing and investment choices to maximize the wealth of passive, existing ("old") shareholders and assumes managers have information that shareholders do not have.[4] The pecking order model suggests that old shareholders prefer to use internally generated funds for new projects when given a choice between internal funds or issuing new equity. This is because there is a cost to the old shareholders of issuing new equity. When new equity is issued to fund a project, the old shareholders give up part of the value of existing assets and gain only

[4]Passive in this context means a shareholder that does not rebalance his/her portfolio upon a new equity issuance by the firm.

part of the value of the new investment. If the value of the assets before any new investment exceeds the old shareholders' post-equity issuance share of the value of the assets plus the value of the new investment, the old shareholders are better off if no new equity is issued. However, this decision process results in some new projects being rejected only because internal funds are not available for an otherwise beneficial project. Myers and Majluf (1984) discuss "financial slack" as being cash, liquid assets, or unused borrowing power in addition to the existing productive assets and show that this "slack" has value because as the slack increases, the availability of internal funding increases, and the firm passes up fewer positive NPV projects without going to the equity market.[5]

Froot et. al. (1993) show that the value of hedging comes from the desire to protect the "slack". The optimal hedging strategy model developed provides for protection of internal funds (the "slack" in Myers and Majluf) when facing changing investment opportunity sets and changing financing opportunities. If internal funds are subject to external risks (such as changing interest rates), the cash flows associated with these funds will fluctuate. Hedging protects internal funds by removing the fluctuation. Relying on the assumption that profit is a concave function of internal wealth (because of the exogenous costs of financial distress), the protection of internal wealth increases the

[5]The pecking order model also is extended to rank debt financing between equity financing and internal funding. This theory appears to be empirically documented by the findings of an average decline in stock price after the announcement of new equity issues (Dann and Mikkelson (1984), Korwar (1982), Asquith and Mullins (1983)) and no apparent price reaction for the issuance of new debt securities (Dann and Mikkelson (1984)). In an experimental setting, Hopkins (1996) documents stock price predictions by analysts that also support the pecking order predictions.

shareholders' expectation of future profits and increases firm value.[6] The intuition from the model is that shareholders will benefit from hedging at the firm level because firms will be more likely to accept positive net present value projects if the cash flow is protected.

Empirical studies related to this theory have examined the hypothesis that high-growth firms should benefit the most from hedging if the benefit comes from protecting investment funds. The market-to-book ratio has been used as a proxy for the firm's investment demand and is predicted to be negatively related to derivative usage.

In terms of the Froot et al. (1993) intuition, the market-to-book ratio captures the likelihood that future positive NPV projects will be accepted by the firm. If this is the case, then the market value of the high market-to-book firm already includes acceptance of future positive NPV projects. If hedging adds value by increasing the likelihood that positive NPV projects will be accepted , then hedging should be associated with firms that have lower market-to-book ratios. This would logically follow because the market value of low market-to-book firms does not include the acceptance of future positive NPV projects. When examined alone, the evidence on the relation between derivative use and the market-to-book ratio does not support the investment protection hypothesis. Geczy, Minton, and Schrand (1995,1996) do find evidence that firms that are both highly leveraged and have low market-to-book ratios use derivatives more than other firms.

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[6]The concavity assumption means that as the variance in internal funds increases, the profits decrease or: $p=f(w)$; $p_w > 0$, $p_{ww} < 0$, where
p is defined as profit and w is defined as internal wealth. Froot et. al point out that this type of assumption is necessary for any model where hedging increases the value of the firm.

Their conclusion is that this finding supports the Froot et al. (1993) model of corporate hedging. This cited prior research looked at market-to-book ratios at one point in time (post-hedging in the case of Geczy, Minton, and Schrand (1995)). Perhaps a better test of the investment protection hypothesis would look for market-to-book ratio changes after derivatives are put in place to see if the value of the firm reflects a higher likelihood of future positive NPV project acceptance.

Another proxy for high growth firms is the firm's relative investment in research and development (R&D). Firms that invest heavily in R&D are predicted to be more likely to use derivatives to protect the internal funds necessary for R&D programs. In empirical studies, R&D usage is consistently significantly related to derivative usage (Nance, Smith, and Smithson (1993), Geczy, Minton, and Schrand (1995)). These results were especially strong for foreign currency derivatives but were weaker for interest rate derivatives, as noted by Fenn, Post, and Sharpe (1996).

2.3 Summary

When considered in total, the empirical evidence to date seems most supportive of the investment protection hypothesis as the primary motivator for derivative usage. This hypothesis provides a value relevant role for hedging cash flows at the firm level. Therefore, it is assumed for the remainder of this dissertation that owners benefit from an effective hedging strategy. The chosen strategy impacts the earnings process and the earnings return relation, so in addition to being value relevant, the hedge is valuation relevant as well. The following chapter discusses the mechanics of using an interest rate swap as part of an interest rate risk hedging strategy.

CHAPTER III

INTEREST RATE SWAPS AS PART OF A HEDGING STRATEGY

3.1 Introduction

This chapter discusses the practical issues surrounding derivative strategies including the accounting treatment. An example of the mechanics of an interest rate swap is presented, followed by a discussion and example of the accounting treatment. Also discussed are the proposed changes in the generally accepted accounting treatment of interest rate swaps and their impact upon the predictions made in this dissertation.

3.2 Issues surrounding derivative strategies

A derivative instrument is any financial instrument that derives its value from the movement of some underlying asset or index (e.g., stock prices for stock option contracts, foreign exchange rates for currency derivatives, interest rates for interest rate derivatives, etc.). Derivative instruments can increase the exposure to the movement of the underlying index and are sometimes used to "speculate" or exploit expectations about the future direction of movement. Derivative instruments can also decrease the exposure to the movement of the underlying index and are sometimes alternatively used to "hedge" or eliminate the impact of any movement.

Accounting regulators and government officials currently are assessing accounting guidelines for the myriad of derivative strategies adopted by firms. The SEC has recently adopted expanded disclosures about derivative instruments in financial

statements, including qualitative and quantitative disclosures about the market risk of derivative instruments, details of accounting policies for derivative holdings, and the effects of derivatives on other positions.[7] The Financial Accounting Standards Board (FASB) continues its project on derivatives accounting.[8] The U.S. General Accounting Office (GAO) issued a report in May 1994 entitled "Financial Derivatives - Actions Needed to Protect the Financial System". The GAO report found that "accounting standards for derivatives, particularly those used for hedging purposes by end-users, were incomplete and inconsistent and have not kept pace with business practices. Insufficient accounting rules for derivatives increase the likelihood that financial reports will not fairly represent the substance and risk of these complex activities. In addition, the lack of rules for certain products makes it likely that accounting for these products will be inconsistent, thereby greatly reducing the comparability of financial reports." (GAO 1994, page 108, para.2) The SEC and GAO proposals highlight that current disclosure practices do not allow users to obtain clear signals about the extent and consequences of derivative use.

The delay in establishing accounting standards for derivative instruments has

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[7]The SEC rules are effective for filings after June 15, 1997 for banks, thrifts, and companies with market capitalization over $2.5 billion. The rules allow companies to choose from among three alternatives for presenting quantitative market risk information that has not previously been disclosed.

[8]Respondents to the 1995 Survey of Projects and Priorities of the FASB unanimously ranked the project on derivatives and hedging as the top priority for the Board (FASB, Financial Accounting Series, Feb. 26, 1996). The most recent approach discussed by the Board would classify all derivatives on the balance sheet as assets or liabilities and would measure all derivatives at fair value. The accounting for gains or losses on the derivatives would depend upon the reasons for holding the derivative. This approach is presented in an exposure draft dated June 20, 1996. The proposed accounting standards for derivatives would apply to fiscal years ending after December 1997.

occurred because of some fundamental controversial issues regarding the strategies taken by firms in the name of "risk management". The controversy can be broken down into the following three general categories.

First, there was controversy early on in the use of the term "hedging". Some took the view that hedging refers to the elimination of down-side risk only, while others regarded hedging as the elimination of both up-side and down-side risk. The second view, where hedging is the elimination of variance, has generally come to be the accepted definition used by regulators and standard setters.[9]

Second, there is the issue of whether firms are managing entity-wide risk or transaction risk. The managing of entity-wide risk potentially could increase exposure for individual transactions, but the managing of individual transaction risk could increase the exposure of the entity as a whole. For example, an entity-wide strategy of reducing the cash flow impact of interest rate changes may involve changing an existing fixed rate interest expense into a variable rate expense to match existing variable rate income. This action would increase cash flow exposure at the transaction level while reducing cash flow exposure for the entity. Likewise, protecting the interest income associated with a particular investment may increase exposure for the entity as a whole if interest expense is not protected as well.

Third, there is the mutually exclusive nature of cash flow risk management

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[9]The latest FAS exposure draft (June 20, 1996) does not explicitly define hedging but the language used ("This statement requires that changes in fair values (or cash flows) of the derivative and hedged item (or hedged transaction) be expected to offset substantially, both at inception and on an ongoing basis." paragraph 135) clearly implies that hedging eliminates both sides of movement.

versus market value risk management. The protection of one necessarily means the exposure of the other. For example, the market value of a variable rate instrument does not change when the interest rate moves but the cash flows associated with the instrument do change. Conversely, the market value of a fixed rate instrument changes when the interest rate changes but the cash flows remain constant. Because of these effects, a derivative strategy of hedging cash flows has opposing impacts on the exposure of market value and a strategy of hedging market values increases the exposure of cash flows.

The task of the regulators and standard setters has understandably been difficult because of these controversies. While most firm managers' report in survey data that hedging of cash flows is their primary reason for using interest rate swaps, the currently required financial statement disclosures may or may not make this clear.[10]

This study examines the sample firms' disclosed use of interest rate swaps. The definition of hedging to be used in the remainder of this study is as follows: hedging refers to the **reduction of variance** on an **entity-wide** level.[11] Because of the

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[10]In response to The Wharton School/Chase survey of Derivatives Usage Among U.S. Non-Financial Firms (1995), firms responded that 67.2% used hedging strategies to manage cash flow exposure (survey question 5 response). In addition, question 3 of the survey asked firms which derivatives they used to manage interest rate risk and 62.8% of firms responded that interest rate swaps were used to manage interest rate risk.

[11]The definition used above differs from the most recent FASB exposure draft. The exposure draft applies to *accounting* for hedging at the transaction level. "The board decided that any hedge accounting approach that adjusts the basis of the hedged item could not accommodate a portfolio of dissimilar items (a "macro" approach) because of the difficulties associated with allocating deferrals, changes in fair value,....." (paragraph 161). While the Board expressed a preference for effectiveness assessment (paragraph 163-164) at the entity-wide level, the concerns over the complexity needed to determine the effectiveness of entity-wide hedging activity outweighed the benefits at this time.

reported survey results noted above, the ex ante expectation is that firms are **managing cash flows** with interest rate swaps and the remainder of the paper evaluates the derivative strategies as cash flow management tools. Because the cash flow effects of interest rate swaps are reflected in earnings, this dissertation uses predictions about the earnings related concepts of persistence and earnings response coefficients to assess the strategy's effectiveness. The next section discusses the mechanics of an interest rate swap and describes how a swap can be used for hedging cash flows. Also described are scenarios where swaps increase the exposure of cash flows to interest rate risk.

3.3 Mechanics of Interest Rate Swaps and Potential Cash Flow Impacts

3.3.1 Example of Interest rate swap mechanics

Interest rate swaps are contracts used to change a variable (fixed) rate cash flow stream into a fixed (variable) rate cash flow stream. An example of the mechanics of a swap helps clarify the transaction.

Suppose Lizco, a solvent company, has variable rate debt (for example LIBOR + .50) but has assets which generate a fixed return (say 10%).[12] Further, suppose Lizco can get a fixed rate of 9.45% in a swap contract. If Lizco enters into the swap contract to swap "variable for fixed", the firm would be obligated to pay interest to the swap counterparty at the 9.45% fixed rate but would be entitled to receive interest from the swap counterparty at the variable rate based upon LIBOR.[13] As shown in exhibit

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[12]LIBOR refers to London Interbank Offer Rate. By convention this is the variable rate used in swap contracts.

[13]The interest to be paid would be calculated based upon an agreed upon "notional" principle, an amount equal to Lizco's variable rate debt if it was a "perfect" hedge. Notional principle is not exchanged

3.1, the net effect of this agreement is that Lizco would incur total net interest expense each period equal to the swap fixed rate of 9.45% plus the .50% spread between the debt variable rate and LIBOR.[14]

Exhibit 3.1
Lizco example of interest rate swap mechanics

Lizco example	Cash Flows in(out)
Variable rate on underlying debt	(LIBOR + .50)
Fixed rate in swap agreement	(9.45)
Variable rate in swap agreement	+LIBOR
Net fixed after swap rate	(9.95)
Asset return rate	10.00
Fixed cash spread between assets and liabilities	0.05

From exhibit 3.1, it is evident that Lizco has locked in its cash flow spread by locking the spread between its return on assets and its interest expense. This is one example of how firms can effectively hedge cash flows using interest rate swaps. The interest rate swap contract above insulates the firm's cash flows from changes in the interest rate when combined with the underlying debt contract. It is this combination of the derivative security and the underlying liability that makes the hedge. An interest rate swap could be used to alter the cash flows of either an asset or a liability, but in practice

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in cash. The amount is used strictly to compute the amount of interest owed/due under the swap contract.

[14]In this example, the original variable rate was based upon LIBOR plus X% and net after swap spread would be constant. If the original variable rate was based upon prime, there could still be some rate variance affected by the correlation of prime and LIBOR rates.

the swap is most often used on the liability side.[15] Therefore, the remainder of this section addresses swaps only on the liability side.

3.3.2 Definition of effective and ineffective cash flow hedging

The effectiveness of a cash flow hedging strategy depends upon the firm's net exposure position before the swap and upon the swap's pay and receive structure. In the prior example, Lizco was in a "net asset fixed" position, where "net asset fixed" means that Lizco's assets are greater than liabilities and that the assets generate a net fixed return. In this position, an effective cash flow hedge must result in fixed rate liabilities. Given the details regarding Lizco's debt, this can only be done with a swap that receives variable rate cash flows and pays fixed cash flows (hereafter referred to as a "swap to fixed" contract). There are four possible pre-swap positions and swap combinations, shown below in exhibit 3.2 along with the hedge effectiveness of each position.

Exhibit 3.2
Effective and Ineffective cash flow hedging

Swap structure: Pre-swap position:	liabilities swap to fixed	liabilities swap to variable
net asset fixed	**effective hedge** **CASE 1**	**ineffective hedge** **CASE 2**
net asset variable	**ineffective hedge** **CASE 3**	**effective hedge** **CASE 4**

[15]In the sample of only non-financial firms identified in this study, only one reported that the interest rate swap was used to change the interest rate on an asset and this firm was not used in the analysis due to an unrelated data availability issue.

The effective hedge cases are those where the impact of changes in the interest rate has been eliminated (or reduced) and the ineffective hedge cases are those where the impact of changes in the interest rate has been increased or is unchanged.

If the information necessary to categorize firms into one of these four cases was readily available, financial statement users could easily adjust their expectations of firm future cash flows. Current reporting requirements do not address the net asset position, however, so the categorization is not apparent from reading the financial statements. In order to empirically differentiate among these cells, a proxy for net asset position will be used to partition firms into two groups - one where the swap appears consistent with hedging interest rate risk and the other group where the swap does not appear to be consistent with hedging interest rate risk. The changes in earnings persistence and ERCs coincident with the use of interest rate swaps will be examined for each group.

As noted earlier, the earnings pattern of the firm will reflect the cash flow impact of an interest rate management strategy. The next section describes the current accounting treatment for interest rate swaps. It provides an understanding of how the swaps are recognized in the financial statements and then presents the disclosure requirements for swap activity.

3.4 Accounting treatment for interest rate swaps

3.4.1 Current accounting treatment

The accepted accounting treatment for interest rate swaps was developed by analogy to existing guidance for loosely related financial instruments. In 1984 and 1985, the Emerging Issues Task Force (EITF) discussed several issues relating to

interest rate swaps, thus forming the extent of the "authoritative literature" for these instruments. The issues discussed were hedge criteria and swap termination treatment. These discussions relied upon analogy to FAS Statement 80 and upon developing practice as the basis for comments on the accounting treatment.

FAS Statement 80 "Accounting for Futures Contracts" outlines the proper treatment for exchange-traded futures contracts. This statement sets up the criteria used to allow for hedge accounting, primarily that the contract be designated and effective as a hedge of certain entity-wide exposures. The effectiveness of a hedge is evidenced by the correlation between changes in market value of the hedging contract and the hedged item. If the hedge criteria are met, then changes in the market value of the hedging contract need not be recognized in the period of change. Rather, the change is an adjustment to the carrying amount of the hedged item (as an offset for the change in market value of the hedged item). Essentially this means no income statement effect for changes in market value of the hedging contract.

FAS80 also describes the accounting at termination for futures hedges where any gain or loss on the hedging contract at termination is deferred and recognized when the offsetting gain or loss is recognized on the hedged transaction. An odd result of this treatment is the recognition of an asset (deferred loss) or a liability (deferred gain) at the termination date relating to the hedging item that had not previously been recognized.

Using FAS80 as an authoritative backdrop, the Emerging Issues Task Force provided the following guidance for interest rate swaps in particular.

EITF 84-7 suggests that swap terminations follow the guidance of FAS Statement 80 if the swap had been accounted for as a hedge. The Task Force recognized that there was no consensus for treatment of swaps that had not been accounted for as a hedge.

EITF 84-36 suggests that where there is an underlying debt obligation on the balance sheet, the company should account for the swap as a hedge of the underlying debt and adjust interest expense accordingly. The Task Force recognized that there was diversity in practice in cases where there is no underlying debt or asset associated with the swap transaction.

This is the extent of authoritative guidance on the financial statement recognition of interest rate swaps. The disclosure requirements for interest rate swaps have evolved as part of the Financial Accounting Standard Board's continuing project on derivatives and hedging. Prior to fiscal years ending after June 15, 1990, there was no required disclosure for interest rate swap activity. The earliest statement , FAS 105 "Disclosure of Information about Financial Instruments with Off-Balance-Sheet Risk and Financial Instruments with Concentrations of Credit Risk" required a minimal amount of disclosure regarding a Company's involvement in derivative instruments. The requirements included disclosure of:

1) the notional amount of the swap agreement,

2) the nature and terms of the swap agreement, with discussion of credit risk, market risk, cash requirements, and related accounting policies,

3) the amount of any accounting loss that would occur as a result of

counterparty default,

4) the policy for requiring collateral and description of any collateral held in connection with the swap agreement.

The disclosure requirements were amended by FAS 107, "Disclosures about Fair Value of Financial Instruments". This statement requires that firms disclose the fair value of financial instruments, including those not recognized in the statement of financial position. This statement allows for a combined presentation of fair values (netting unrealized gains and losses across classes of derivatives).

FAS105 and parts of FAS107 were superseded by FAS 119 "Disclosure about Derivative Financial Instruments and Fair Value of Financial Instruments". FAS 119 specifies that the entity distinguish between derivatives held for trading purposes and those held for purposes other than trading. For derivatives held for trading purposes, the entity must disclose the average fair value and the net trading gains and losses over the reporting period. For derivatives held for other purposes (including interest rate swaps used for hedging) firms must disclose the purpose for holding the instrument and how the instrument is reported in the financial statements. FAS 119 amends FAS 107 to require that classes of derivatives be reported separately and that there be no netting of positions. FAS 119 encourages but does not require quantitative information about market risks.

3.4.2 Example of financial statement recognition and disclosure

Continuing with the Lizco example from exhibit 2.1, the accounting treatment for this particular swap is described below. Suppose that the underlying variable rate

debt has a face amount of $10,000 and that the notional principal specified in the four year interest rate swap agreement is $10,000 as well. For purposes of the example, assume that interest is paid annually on both the underlying debt and under the swap agreement and that the variable rate is set as of the beginning of each year. Interest rates over the life of the swap are as follows:

Exhibit 3.3
Lizco Interest Rates

	LIBOR	Debt variable rate(LIBOR + .50)
1/1/x1	9.45%	9.95%
1/1/x2	10%	10.50%
1/1/x3	11%	11.50%
1/1/x4	10%	10.50%

If the swap is entered into on **1/1/x1**, and is a fairly priced swap, then on **1/1/x1** there would be no cash exchanged and there would be no journal entry made because of the expectation of complete offset of future cash flows (i.e. the receivable completely offsets the payable).[16] Exhibit 3.4 presents the accounting entries that would be made at year-end to recognize the interest expense associated with the underlying debt and to record the interest rate swap activity.

[16]FASB Interpretation No. 39, "Offsetting of Amounts Related to Certain Contracts", describes the conditions that must be met to allow for offsetting of amounts in the statement of financial position. Specifically addressed is the applicability to interest rate swaps.

Exhibit 3.4
Accounting entries related
to Interest Rate Swaps

At 12/31/x1, interest payable on the debt would be recorded as follows:

Interest Expense	995	
Interest Payable		995
To record interest of LIBOR + .50% for the year.		

The entries necessary because of the swap agreement would be:

Interest Expense	945	
Interest Payable		945
To record the "pay fixed 9.45%" side of the swap.		
Interest Receivable	945	
Interest Income		945
To record the "receive LIBOR" side of the swap.		

As a result of these entries, the financial statements would be impacted in the first year as shown in Exhibit 3.5. As intended by Lizco, the net interest expense shown in the financial statements is at the effectively fixed rate of 9.95% of the debt face amount of $10,000. For each of the following three years, the accounting entries would be made in a manner as shown in Exhibit 3.4, based upon the rates shown in Exhibit 3.3.

Exhibit 3.5
Financial Statement Impact
12/31/x1

Income Statement dr(cr):	
Interest expense	1,840
Interest income	(945)
Net interest expense	995
Balance Sheet dr(cr)	
Interest receivable	945
Interest payable	(1,840)
Net balance sheet impact	(995)

Exhibit 3.6
Financial Statement Impact
Next three years

	12/31/x2	12/31/x3	12/31/x4
Income Statement dr(cr):			
Interest expense	1,995	2,095	1,995
Interest income	(1,000)	(1,100)	(1,000)
Net impact	995	995	995
Financial Statement dr(cr):			
Interest receivable	1,000	1,100	1,000
Interest payable	(1,995)	(2,095)	(1,995)
Net impact	(995)	(995)	(995)
On 1/1/X following:			
Net cash dr(cr):	(995)	(995)	(995)

For the next three years, the financial statement impact would be as shown in Exhibit 3.6. It is clear from this example that the swap has successfully changed the

interest expense to a fixed amount. As shown in Exhibit 3.6, the cash is also a fixed net outflow over the life of the swap.

The disclosure made by Lizco under FAS 105 would be similar to that shown in Exhibit 3.7.[17] After adoption of FAS 107 and FAS 119, the disclosure would include the fair value at year-end of derivative instruments. In accordance with these statements, the fair value would be based upon a quoted price of a similar instrument or a current replacement cost.

Exhibit 3.7
Lizco Disclosure

During 19X1 Lizco entered into a four-year interest rate swap agreement with a commercial bank which effectively fixes the interest rate on its outstanding variable rate debt. Under the agreement the Company pays interest on a $10,000 notional principal amount based on a fixed rate of 9.45%. The company receives interest based on LIBOR. The interest rate swap was designated as a hedge contract against interest rate fluctuations and accordingly, the differential to be paid or received is accrued as interest rates change and is recognized over the life of the agreement as an adjustment to interest expense. The company has limited exposure to credit loss for the differential between interest rates in the event of nonperformance by the other parties.

[17]The wording of this example is based upon the wording found in the disclosures used in this study.

3.4.3 Proposed changes to accounting treatment of interest rate swaps

The example above describes the accounting treatment in place during the time period of the current study. The accounting treatment changes dramatically for interest rate swaps under the exposure draft currently being deliberated[18]. The most important change is a requirement that all derivative instruments be recognized on the balance sheet at fair value. If the derivative is a hedge of the fair value of a particular asset or liability, then that asset or liability is also adjusted to fair value at the balance sheet date. The FASB has also decided that the accounting hedge criteria applies at the transaction level and that the treatment of unrealized gains and losses differs according to the type of hedge designated by management.

For the first time, this exposure draft treats a hedge of market value of an existing asset/liability differently than a hedge of cash flows for a projected transaction. This is important in the area of interest rate swaps because the board has applied this difference such that a swap-to-pay-fixed contract is treated as a hedge of cash flows while a swap-to-pay-variable contract is treated as a hedge of market value.

For hedges of cash flows, the unrealized gains and losses flow through comprehensive earnings until the actual date of the underlying projected transaction. If the hedge is effective then recognition of the swap gain or loss at the date of the transaction should be offset by the gain or loss on the actual transaction.

For hedges of market value, the unrealized gains and losses on the swap contract

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[18]The exposure draft is dated June 20, 1996. A final statement is expected to be released in June of 1997.

flow through earnings in the current period. If the hedge is effective, these unrealized gains and losses should be offset by the changes in the market value of the underlying asset or liability. Exhibit 3.8 summarizes the treatment for Lizco under the proposed standard. These new rules make the accounting more transparent but do not change the financial statement net effect for successful hedges.

Exhibit 3.8
Financial Statement Impact
Next three years
Proposed accounting treatment

Income Statement dr(cr):	12/31/x2	12/31/x3	12/31/x4
Variable rate debt:			
Interest expense	1,050	1,150	1,050
Interest rate swap:			
Deferred gains from other comprehensive income	(55)	(155)	(55)
Net impact	995	995	995
Balance Sheet dr(cr):			
Variable rate debt	$10,000	$10,000	$10,000
Interest rate swap	137	265	50
Net payable	(955)	(955)	(955)
Other comprehensive income	(137)	(265)	(50)
On 1/1/Xfollowing:			
Net cash dr(cr):	(995)	(995)	(995)

3.5 Summary

This dissertation examines one type of derivative instrument, the interest rate swap, as a tool for management of cash flow exposure to interest rate changes. The economic impact of the interest rate swap agreement on the firm's cash flows has been demonstrated through an example of the interest rate swap mechanics. This chapter has also demonstrated that the accounting for interest rate swaps used by firms during the period of the current study allowed for a matching of the economic consequences of a hedging strategy with the reported accounting earnings since the cash flow effects (i.e., the fixing of cash flows in the example) were identical to the earnings effects (i.e., the fixing of interest expense).

This chapter provides the background for understanding the valuation relevance of a particular type of hedging strategy. The earnings pattern of the firm is altered by the hedging strategy and accordingly, the financial statement users' reaction to earnings news is affected. The following chapter develops predictions regarding the valuation relevance of an interest rate swap strategy.

CHAPTER IV

THE IMPACT OF A DERIVATIVE STRATEGY ON THE EARNINGS PROCESS

4.1 Introduction

This chapter develops predictions regarding the impact of an interest rate swap strategy on the earnings process. Predictions are made regarding the persistence of surprises in the earnings process and regarding the earnings/return relation.

4.2 The valuation relevance of the earnings stream

Cash flow hedging impacts the earnings stream of the firm and the relation between stock returns and earnings has been the focus of many studies. One conclusion of this literature is that investors use earnings information to update their expectations of future cash flows.[19] A theoretical model used in many of these studies is the traditional formulation of price as the present value of expected future cash flows. Assuming that the present value of revisions in expected future cash flows is equivalent to the present value of revisions in the expected future earnings, Kormendi and Lipe (1987) show that the unexpected change in price is a function of unexpected earnings. When unexpected returns are regressed on unexpected earnings, the coefficient on the unexpected earnings is the "earnings response coefficient" or ERC.

Kormendi and Lipe (1987) provide empirical evidence that ERCs vary cross-

[19]The work of Miller and Rock (1985) first described the earnings announcement effect. Other works in this area include Kormendi and Lipe (1987), Easton and Zmijewski (1989), Collins and Kothari (1989), Salamon and Stober (1994), and others.

sectionally depending upon the earnings process of the firm. The earnings process is a function of the nature of the business, the operating environment, investments made, and the form of contracts with third parties (such as suppliers, managers, debt investors, employees, etc.). Actual earnings is generally modeled as a process that has an expected change and a variance around the change (due to risk in investments and business contracts and due to unexpected changes in the operating environment). Earnings surprise is the difference between the actual earnings change and the expected earnings change. Earnings persistence captures the extent to which earnings surprises persist into future periods. Prior research implies that if persistence is higher, then investors should update their estimate of expected future cash flows more for a dollar of earnings surprise than if persistence is lower.[20] Within the framework of Kormendi and Lipe (1987) and other prior research, the persistence of innovations in earnings depends upon the form of the model of the actual earnings process. Most prior studies have modeled the persistence of the annual earnings process, but because short-term interest rates are used in interest rate swap contracts, a model of the persistence in the quarterly earnings process is more useful for generating empirical predictions in this study.

4.3 A model of persistence in the quarterly earnings process

Earnings is exposed to various risks (for example, interest rate risk, exchange rate

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[20]Miller and Rock (1985) model the effect of earnings announcements upon prices and the model includes an earnings persistence parameter. Kormendi and Lipe (1987) use the Miller and Rock model to develop an earnings persistence measure that is used to explain cross-sectional differences in earnings response coefficients (ERCs). Kormendi and Lipe provide empirical evidence that cross-sectional differences in ERCs are related to cross-sectional differences in earnings persistence. Easton and Zmijewski (1989) and Collins and Kothari(1989) also find evidence that ERCs are positively related to earnings persistence.

risk, product supply and demand risk, etc.) and earnings is correlated with measures that capture these risks. This study focuses on one type of risk - interest rate risk. If some component of earnings is correlated with short-term interest rates, then that earnings component will be described by the time series of interest rates.

Suppose C_t is the component of net earnings that is dependent upon interest rates. C_t includes not only those items explicitly dependent upon interest rates such as variable rate interest income and expense (A_t) but also includes the portion of all other income and expense items implicitly related to the short-term structure of interest rates (B_t).

$$C_t = A_t + B_t , \quad (1)$$

$$A_t = DR_t , \text{ where} \quad (1.1)$$

D = the carrying value of the net assets that are explicitly interest sensitive, and

R_t = the short-term interest rate;

$$B_t = \gamma_t + KR_t , \text{ where} \quad (1.2)$$

γ_t and K describe the linear relation between the implicitly interest sensitive earnings components and the short-term interest rate . Then the realization of C_t can be described with the following model:

$$C_t = DR_t + \gamma_t + KR_t, \text{ or} \quad (1.3)$$

$$C_t = \gamma_t + (D+K)R_t$$

The short-term interest rate is examined by Brenner, Harjes, and Kroner (1996) (BHK)

who present the following model[21,22] :

$$R_t = R_{t-1} + \alpha - \beta R_{t-1} + \epsilon_t$$

$$= \alpha + (1-\beta)R_{t-1} + \epsilon_t , \qquad (2)$$

where R_t is the short-term interest rate at time t,

α is a constant drift term,

$(1-\beta)$ is an autoregressive parameter, and $\beta \geq 0$, and

ϵ_t is the realization from a random process with $E(\epsilon_t)=0$ and $Var(\epsilon_t) = \sigma^2_\epsilon$.

This model describes a process that is autoregressive in levels, with $(1-\beta)$ as the autoregressive parameter. The size of the coefficient β determines the speed of the decay of R_{t-1} in future levels of R.[23] For example, if $\beta=0$ in the above process, then R_{t-1} remains fully in the future levels of R and the process would be a random walk with drift. If $\beta=1$ then R_{t-1} has no impact on future levels of R and the process could be described as completely reverting to the drift term, α. Substituting the model of R_t from equation (2) into equation (1.3),

$$C_t = \gamma_t + (D+K)(\alpha+(1-\beta)R_{t-1} + \epsilon_t) \qquad (3)$$

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[21]This model is the discrete analogy to the continuous time models of Cox, Ingersoll, and Ross 1980) and others.

[22]BHK are primarily concerned with modeling the volatility of rates through specification of the conditional variance of ϵ_t , which is not examined here. They point out that the model above is useful because of its generality and that other models exist that may better describe the quarterly path of interest rates. The model above is used here because of its familiarity and because it is adequate for creating insights about the possible behavior of earnings before and after the initiation of interest rate swaps.

[23]BHK examined weekly rate changes and did not find significance for the β parameter over these short intervals, but the reversion of rates around a long-term mean level is an accepted premise in the term structure literature. For example, Chan, Karolyi, Longstaff, and Sanders (1992) empirically estimate parameters over 1 month intervals for the above discrete model under 9 alternative specifications and find that the parameter estimates for β range from .1779 to .5921 for models that explain up to 20% (when β=.5921) of the volatility of changes in interest rates (table 3, pg.1218).

where all items are as described above.

The C_t process follows the same AR process as the interest rates. Again the size of the β coefficient in the AR parameter $(1-\beta)$ determines the speed of decay of prior realizations in future levels of the series. It is this property of decay in future levels that is key in evaluating the persistence of surprises in this component of earnings relative to the other earnings component discussed below.

The portion of earnings that is **not** correlated with interest rates is assumed to follow the quarterly seasonal Brown and Rozeff (1979) model[24]. The following standard form of the model applies:

$$S_t = S_{t-4} + \phi(S_{t-1} - S_{t-5}) + \theta_4 a_{t-4} + a_t , \qquad (4)$$

where S_t is the quarterly level for the present period, t, of the earnings component not correlated with the interest rate process,

ϕ is an autoregressive parameter and $0<\phi<1$,

θ_4 is a moving average parameter and $-1<\theta_4<0$,

a_t is the realization from a random process with $E(a_j) = 0$ and $Var(a_j) = \sigma^2$, and

$corr(S_t,C_j) = 0$ for all t,j .

The quarterly earnings for the firm, QE_t, is a combination of the C and S series :

$$QE_t = C_t + S_t. \qquad (5)$$

Substituting from equations(3) and (4) into equation (5) yields

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[24]Brown and Rozeff(1979) find that the movement in quarterly earnings is reasonably well explained by a seasonal time series model of the form (1,0,0)x(0,1,1). This model was found to explain roughly 75% of the variation in quarterly earnings in their sample of firms. This model was also used by Bernard and Thomas(1990) as a model for the quarterly earnings process.

$$QE_t = \gamma_t + (D+K)(\alpha + (1 - \beta)R_{t-1} + \epsilon_t) + S_{t-4} + \phi(S_{t-1} - S_{t-5}) + \theta_4 a_{t-4} + a_t, \quad (5.1)$$

where all terms are as described above[25].

As described by Enders (1995), equation 5.1 can be decomposed into a deterministic trend in the γ_t and $(D+K)\alpha$ terms and a stochastic trend in the $\{(D+K)((1- \beta)R_{t-1} + \epsilon_t)+S_{t-4}+ \phi(S_{t-1}-S_{t-5})+ \theta_4 a_{t-4}\}$ term. If thought of as the permanent portion of the $(\boldsymbol{D+K})\epsilon_t$ and $\mathbf{a}_t$ realizations, the stochastic trend can show how the earnings surprises ($(\boldsymbol{D+K})\epsilon_t$ and $\mathbf{a}_t$) are carried into the future periods beyond t.[26] Splitting the QE_t series into its independent component parts, C_t and S_t, the permanence factor, Ψ_{ct}, for the C_t series (the expectation at time t of how the realization of $(\boldsymbol{D+K})\epsilon_t$ is carried forward j periods) can be expressed as:

$$\Psi_{ct} = (1 - \beta)^j (D+K)\epsilon_t, \text{ for all } j \quad (6)$$

where the terms are as described above.[27] As noted earlier, the size of the β parameter determines how the current period surprise decays in future periods. It is apparent from equation (6) that the impact of $(D+K)\epsilon_t$ approaches zero over subsequent future periods.

In a similar way, the permanence factor, Ψ_{st}, for the S_t series can be shown (the expectation at time t of how the realization of $\mathbf{a}_t$ is carried forward j periods into the future) as:

$$\Psi_{st} = \phi^j a_t, \qquad j<4, \quad (7)$$

---

[25]The simple combination of the two series relies upon two attributes:: the additive property of normally distributed random variables and the assumed independence of the two series.

[26]The expression of the permanence factor is similar to those found in Table 1 of Collins and Kothari(1989), who summarize permanence factors of various annual earnings time series models.

[27]Appendix A shows the derivation of the permanence factor Ψ_c.

$$\Psi_{st} = \phi^{j-4}a_t + \phi^{j} a_t + \phi^{j-4}\theta_4 a_t \qquad 4 \le j < 8,$$

$$\Psi_{st} = \phi^{j-8}a_t + 2\phi^{j-4}a_t + \phi^{j} a_t + \phi^{j-8}\theta_4 a_t + \phi^{j-4}\theta_4 a_t \qquad 8 \le j < 12, \text{ etc..}^{28}$$

The moving average and seasonal autoregressive parameters in the S_t series cause the current period surprise, a_t, to be carried to future periods.

The persistence for each of these series, C_t and S_t, is the present value of the sum of the Ψ_{ct} and Ψ_{st} over all future j periods.[29] The persistence for the Ψ_{ct} series is described as:

$$PV\Psi_{ct} = (D+K)\epsilon_t \sum_{j=1}^{\infty} \frac{(1-\beta)^j}{(1+b)^j} = (D+K)\epsilon_t \frac{(1-\beta)}{b+\beta}, \qquad (8)$$

where b is the assumed discount rate and all other terms are as described. The persistence for the Ψ_{st} series is more complicated because of the seasonality, but basically can be described as:

$$PV\Psi_{st} = a_t \sum_{j=1}^{\infty} \frac{(1+\phi^j+\phi^j\theta_4)}{(1+b)^j} = a_t\left(\frac{1}{b} + \frac{\phi+\phi\theta_4}{1+b-\phi}\right), \qquad (9)$$

where all terms are as described earlier[30]. The persistence of QE_t is dependent upon the proportions of C_t and S_t and the relative persistence of Y_{ct} versus Y_{st}.. Comparing the persistence in terms of the time series parameters only:

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[28]Appendix A shows the derivation for Ψ_s.

[29]This definition of persistence is analogous to that used by Kormendi and Lipe (1987), "the present value of the revisions in expected future earnings induced by a $1.00 innovation in current earnings, is our measure of persistence".

[30]Equation 9 is a simplification of the S series where all of the 4th quarter effects are combined.

$$\frac{1-\beta}{b+\beta}<\left(\frac{1}{b}+\frac{\phi+\phi\theta_4}{1+b-\phi}\right), \qquad (10)$$

or $$PV\Psi_{ct} < PV\Psi_{st},$$

where $0<\beta<1$, $0<\phi<1$, $-1<\theta<0$, and $0<b<1$.

The total persistence for QE_t is a weighted average of the persistence of the two series, with the weights coming from the absolute magnitude of the errors. This total can be described as:

$$PV\Psi_{ct}\left(\frac{(|D+K|)|\epsilon_t|}{|(D+K)||\epsilon_t|+|a_t|}\right)+PV\Psi_{st}\left(\frac{|a_t|}{(|D+K|)|\epsilon_t|+|a_t|}\right), \qquad (11)$$

Examination of equations (10) and (11) indicates that the persistence of the QE_t earnings stream is a weighted average of the persistence of the C_t and S_t series and is dependent upon the β, ϕ, θ, and $(D+K)$ parameters. As noted earlier, the β parameter comes from the interest rate series and is exogenous to the firm. The ϕ and θ parameters in the QE_t series described above are combinations of exogenous risks and management choices not specified in this study. The $(D+K)$ parameter is the amount of explicitly interest sensitive net assets (D) and the amount of implicitly interest sensitive net assets (K). Referring back to the example of the mechanics of an interest rate swap in Chapter 3, it is clear that the variable rate side of the swap follows the same short term interest rate process, R, described above. The mechanics of the swap by design lead to a change in the amount $(D+K)$ of interest sensitive net assets (because of the use of the notional amount). It is then the $(D+K)$ parameter that is impacted when the firm implements an interest rate derivative strategy and it is through the $(D+K)$ parameter that the derivative

strategy affects the persistence of the earnings stream. Exhibit 4.1 shows the persistence of the total earnings under a range of values for the *(D+K)* parameter.

Exhibit 4.1
Values of Persistence under different $|D+K|$ parameter values

Total Persistence	$PV\Psi_t$	$PV\Psi_c$	b discount rate $0 \le K \le 1$	β int. rate speed $0 \le \beta \le 1$	ϕ seasonal ar $0 < \phi < 1$	θ seasonal ma[31] $-1 < \theta < 0$	$\|D+K\|$ value	$\|\epsilon_t\|$ value[32]	$\|a\|$ value
9.29	82.0	0.75	0.10	0.50	0.50	-0.70	90.00	0.01	8.00
9.49	82.0	0.58	0.10	0.50	0.50	-0.70	70.00	0.01	8.00
9.69	82.0	0.42	0.10	0.50	0.50	-0.70	50.00	0.01	8.00
10.13	82.0	0.08	0.10	0.50	0.50	-0.70	10.00	0.01	8.00
10.25	82.0	0.00	0.10	0.50	0.50	-0.70	0.00	0.01	8.00

4.4 Interest rate derivative strategies and persistence

From an inspection of equation (11) and exhibit 4.1 , it is evident that as $|D+K| \to 0$, the weight of the C_t series decreases. Eliminating the less persistent earnings component leads to an increase in the persistence (because the more persistent series has a greater weight in the weighted average). If interest rate derivatives are viewed as altering *(D+K)* then when $D+K=0$ the firm has completely hedged its cash flows against the interest rate risk. If the firm took a position inconsistent with cash flow hedging, then the interest sensitivity would not be decreased and interest rate changes would remain (or

[31]The parameter values of .5 for ϕ and -.7 for θ come from an example in Brown and Rozeff (1979).

[32]The value of $(D+K)\epsilon$ is chosen arbitrarily but within reason relative to the a value chosen, given that the interest rate sensitive component of most non-financial firms is material but is dominated by the non-interest rate sensitive component.

be magnified) in earnings changes and the $|D+K|$ value would not move towards zero. Thus, the impact of alternative derivative strategies upon persistence in the aggregate earnings stream differs for each type of strategy.

Referring back to Exhibit 3.2 from Chapter 3, the four cases can be examined in light of this persistence discussion. In both Cases 1 and 4, where there is an effective cash flow hedge, the strategy reduces the amount $(D+K \to 0)$ of interest sensitive net assets. This leads to an increase in the permanence of the earnings surprises for Case 1 firms and Case 4 firms.

On the other hand, consider cases 2 and 3 where the strategy is inconsistent with effective cash flow hedging. The ineffective interest rate strategy maintains or increases the amount (*$D+K$ does not go to 0*) of interest sensitive net assets. This leads to no change or a decrease in the permanence of the earnings surprises for Case 2 firms and Case 3 firms.

The conflicting implications for persistence from swaps that effectively hedge versus those that do not highlight the mutually exclusive affects of the different strategies on earnings persistence. The discussion above leads to the prediction that persistence will increase after an effective cash flow hedge of interest rate risk and will not increase after a position is taken that is inconsistent with an effective cash flow hedge. The first part of this dissertation's empirical tests investigates whether interest rate swaps are material enough to change the earnings persistence of a group of firms that are believed to enter into swaps as part of a cash flow hedging strategy. Furthermore, the direction of change in persistence is used as an indicator of whether the consequences of the swaps for this

group are more consistent with the stated cash flow hedging strategy or with a strategy that is inconsistent with cash flow hedging.

4.5 Interest rate derivative strategies and earnings response coefficients

The second part of this dissertation investigates whether ERCs are impacted by the change in earnings persistence that comes about from initiation of an interest rate derivative strategy. Prior research has documented that ERCs are directly related to the earnings persistence. However, ERCs are affected not only by the persistence, but also by the shareholder's perceived riskiness of the firm (Easton and Zmijewski (1989)), growth rates and interest rate levels (Collins and Kothari (1989)), and the perceived quality of the reported earnings (Collins and Salatka (1993)) among other factors.

The riskiness of the firm has been found to be inversely related to ERCs (see Easton and Zmijewski (1989), Collins and Kothari(1989)). While the preceding model focuses upon persistence and no predictions are made about the strategy's impact upon the riskiness of the firm, prior research in the area of derivatives has not found a significant change in market betas for firms following the implementation of a derivative strategy (Hentschel and Kothari 1995). Hentschel and Kothari (1995) interpreted this finding of no change as support for the use of derivatives as a risk management tool rather than as a gamble by managers because the riskiness did not increase significantly for firms in their sample. The intuition of their hypothesis is that a speculative derivative strategy should be associated with an increase in riskiness. Because changes in risk are inversely related to ERCs, a(n) decrease (increase) in the perceived riskiness of the firm following the implementation of a derivative strategy would be expected to be associated with

increased (decreased) ERCs. Therefore, the Hentschel and Kothari intuition regarding riskiness would result in predictions about ERCs identical to the predictions based upon the ERC/persistence relation described above. This dissertation therefore attempts to control for risk as a possible confounding factor in the empirical analysis.

Growth rates have been identified as having a direct relation to ERCs (Collins and Kothari (1989)). This dissertation makes no predictions about the relation between growth rates and persistence. If the implementation of a derivative strategy coincides with a change in the growth rate of the firm, then changes observed in ERCs may be attributable to the growth rate changes. Therefore, growth rates represent another possible confounding factor that is controlled for in the empirical analysis of this study.

Interest rate levels have been found to be inversely related to ERCs (Collins and Kothari (1989)) over time. This dissertation makes predictions based upon the correlation between the earnings stream and the term structure of interest rates, an issue separate from the relation between ERCs and the level of interest rates across time. In the formulation of the earnings stream found in equation (5.1), the changes in interest rate levels over time would be captured by the α and β parameters, both exogenous to the firm. Persistence would be impacted not by a change in the level of the interest rate, but only by a change in the size of the β parameter (the speed of decay parameter). Such an exogenous change would have a market wide impact, not only for firms with interest rate strategies but also for firms with no strategies in place. The theory behind the interest rate level/ERC relation stems from the discount rate used to capitalize earnings changes over time. This rate is theorized to move intertemporally but is not expected to vary

cross-sectionally. In this dissertation, a control firm sample is used to capture macro changes across time, beyond the treatment effect, and the interest rate level movement represents one such macro change.

Collins and Salatka (1993) find an inverse relation between ERCs and the perceived quality of the earnings report. The impact on the ERC from the current accounting practices of reporting derivatives activity is difficult to predict ex ante. Therefore, the part of this research that attempts to discover whether the initiation of interest rate derivatives is associated with changes in ERCs assumes that there is no significant change in perceived quality of the earnings report upon implementation of an interest rate derivative strategy.

Specifically, the second part of this research investigates whether the earnings response coefficients change for a group of firms believed to have implemented an interest rate hedging strategy. The direction of change in the ERCs is predicted to be the same as that predicted for the persistence and is used as an indicator of whether the consequences of the swaps for this group are more consistent with the stated cash flow hedging strategy or with a strategy that is inconsistent with cash flow hedging. Exhibit 4.2 re-creates exhibit 3.2 and adds the persistence and ERC predictions discussed above.

Exhibit 4.2
Predictions for persistence and ERCs following implementation of strategy

Swap structure: Pre-swap position:	Liabilities swap to fixed	Liabilities swap to variable
Net asset fixed	**effective hedge** **CASE 1** **ΔPersistence >0** **ΔERC > 0**	**ineffective hedge** **CASE 2** **ΔPersistence ≤ 0** **ΔERC ≤ 0**
Net asset variable	**ineffective hedge** **CASE 3** **ΔPersistence ≤ 0** **ΔERC ≤ 0**	**effective hedge** **CASE 4** **ΔPersistence >0** **ΔERC >0**

4.6 Summary

This chapter developed predictions for persistence and ERCs following implementation of an interest rate swap strategy. These predictions are modeled and tested empirically in Chapter VI (Empirical tests of the persistence predictions) and Chapter VIII (Empirical tests of the ERC predictions). The following chapter describes the sample used for the empirical tests.

CHAPTER V

SAMPLE SELECTION, CATEGORIZATION OF FIRMS, AND DESCRIPTIVE STATISTICS

5.1 Introduction

This chapter describes the process used to select the treatment and control samples. It also includes information about the classification of firms into groups of "effective cash flow hedging" firms and "ineffective cash flow hedging" firms. Finally, descriptive statistics are presented for the firms used in the empirical tests of persistence and ERC changes after implementation of an interest rate swap strategy.

5.2 Sample selection

The National Automated Accounting Research System (NAARS) was accessed for all years 1972 through the present.[33] A search was made on the string "interest rate swap" for each year, starting with 1992 and working backwards until there were no items found. The earliest reports found were in 1982 when four firms reported the use of interest rate swap agreements. The number of reports identified each year increased rapidly in the subsequent years with 590 firms reporting interest rate swap activity in 1992.

Because this study does not address the derivative strategies of financial institutions, all financial institutions were eliminated from the sample. This was done by

[33]The search was made using Lexis/Nexis database.

deleting all firms with four digit SIC codes between 6000 and 7000.

Using the 1992 reports as a starting point, the firms were traced back through NAARS to their earliest disclosure year, which was designated as the identification year. Because of the small number of firms disclosing in pre-1989 years and because of the limited data availability after 1992, the analysis includes only firms that first disclosed swap activity in 1989, 1990, and 1991. Because it is unknown how long the swaps were in place during the identification year, the first month of the year immediately following the identification year was used to divide a quarterly time-series of firm quarterly earnings forecast errors, earnings forecast revisions, and abnormal returns into a pre-disclosure and a post-disclosure period.

The 1994 Compustat Industrial Quarterly P-S-T and Research files were searched to find the following for each firm quarter available for five years before the identification year and up to 4.5 years after the identification year: book/market ratio, total market equity, operating income before depreciation, depreciation, SIC code, fiscal quarter, fiscal year end month, and quarterly earnings announcement date.

Using the earnings announcement date from Compustat, the quarterly earnings per share forecast, actual quarterly earnings per share, and quarterly earnings per share forecasts of quarter t+1 were extracted from the Value Line Investment Survey. To be included in the sample, Value Line data must be available for the entire time period (1984-1994). This requirement insured that a continuous time series of observations could be used in the revision test and in the ERC test.

In order to examine cross-sectional differences in the pre- and post-disclosure

periods, control firms were chosen for each treatment firm from Value Line based upon industry and size.

Table 5.1
Sample Selection Details

Sample Selection - Treatment firms:	
NAARS Search of 1992 annual reports[34]	590
Eliminate financial services firms	-167
Eliminate firms first swapping in years other than 1989,1990,1991	-155
Eliminate firms not covered by Compustat	-137
Eliminate firms with incomplete data from CRSP or Compustat over the sample period[35]	-20
Eliminate firms not covered by Valueline	-19
Total treatment firms	92
Sample selection - Control firms:	
Firms selected by matching on size and industry[36,37]	89
Eliminate firms not covered by CRSP or Compustat for the required sample period	-8
Total Control firms	81

A search of annual reports for all control firms insures that no control firm was

[34]This is the number of firms from the NAARS search for which cusip numbers were found using the following sources: Standard and Poor's CD Corporate data base, CRSP flat file.

[35]Coverage was necessary over the time period before and after swapping.

[36]The industry categorization was based upon Valueline's groupings of firms.

[37]In three cases, two treatment firms were matched to the same control firm. This was necessary due to limits imposed by the matching criteria and by Valueline's coverage of the industry.

disclosing the use of interest rate swaps during the test period. All treatment and control firms must have daily price and return data available on the 1994 version of the Daily CRSP tape for the entire testing period.

5.3 Categorization of firms

5.3.1 Model of interest rate sensitivity

In order to make directional predictions about the persistence and ERCs following the implementation of a hedging strategy, the treatment firms need to be categorized according to the 4 cases shown in Exhibit 4.2 . As noted earlier, the financial statements do not explicitly provide the net asset interest rate sensitivity, so a reasonable proxy must be chosen. Because the Exhibit 4.2 cases are differentiated by the sensitivity of net assets to interest rate changes, a proxy based upon the interest rate sensitivity of operating income was deemed appropriate.

For each firm in the treatment group, the following model was used to determine the extent of the relation between changes in operating income and changes in short-term interest rates:

$$Opinc_{qj} = d_0 + d_1\ Chgrates_q + d_2 Chgrates_{q-1} + e_q, \text{ where} \qquad (12)$$

$Opinc_{qj}$ = the change in operating income after depreciation for firm j for quarter q, before interest income or interest expense,

$Chgrates_q$ = the change in the 3 month T-bill rate over quarter q,

$Chgrates_{q-1}$ = the change in the 3 month T-bill rate over quarter q-1.

5.3.2 Pre-period interest sensitivity

The model was first run for each treatment firm over the time period before the disclosure of interest rate swap activity. The individual regressions were evaluated to

determine the interest sensitivity of each treatment firm. The results, as shown in Table 5.2 under the "Pre-swapping" column, indicated that for 14 firms the operating income was found to be interest sensitive, as evidenced by a significant coefficient estimate on either the $Chgrate_q$ or $Chgrate_{q-1}$ variable. Significance for this test was determined at the two-tailed 5% level. For these 14 firms, the model was able to explain on average roughly 36% of the change in operating income from quarter to quarter during the pre-swapping period, indicating a strong relation between changes in interest rates and changes in operating income.

For the remaining 78 firms, the individual regressions indicated no systematic relation between the changes in short-term interest rates and changes in operating income from quarter to quarter. For this group of firms, the model was not able to explain the change in operating income as evidenced by the average adjusted R^2 of -6% and the low average model F statistic of .5795. The operating income of these firms was therefore designated as interest insensitive over the time period before disclosure of interest rate swap activity.

5.3.3 Post-period interest sensitivity

The model was also run for each treatment firm over the time period after the disclosure of interest rate swap activity. The interest sensitivity of the operating income was evaluated in the same manner and again 14 firms were found to be interest sensitive, as shown in Table 5.2 under the "Post-swapping" column. For these 14 firms, the model was able to explain on average roughly 31% of the change in operating income from quarter to quarter during the post-swapping period.

In the "Post-swapping" period, the individual regressions for the remaining 78 firms indicated no systematic relation between the changes in short-term interest rates and changes in operating income from quarter to quarter. The average R^2 of -4.3% and the low average model F statistic of .7253 reflect the model's inability to explain the change in operating income for these firms. These firms were accordingly classified as having operating income that was insensitive to changes in short-term interest rates over the period after disclosure of interest rate swap activity.

5.3.4 Decision rule for grouping firms

Table 5.2 summarizes the results for the individual regressions over each of the two time periods. Of the 14 firms found to be interest sensitive in the "Post-swapping" period, only 3 of these 14 are included in the "Pre-swapping" category of interest sensitive. This means that there are 11 firms in the "Pre-swapping" interest sensitive category that become interest insensitive in the "Post-swapping" period. Likewise, there are 11 firms in the "Post-swapping" interest sensitive category that were interest insensitive in the "Pre-swapping" period. For these 22 firms, something happened that was unrelated to the firm's interest rate swap activity.

Because of the inability to isolate the impact of interest rate swap activity from the impact of this unknown operating change, these 22 firms and their matching control firms were eliminated from the empirical tests. After elimination of the 22 firms from the interest sensitive category, there remained 3 treatment firms that were categorized as interest sensitive in both the "Pre-swapping" period and in the "Post-swapping" period. For the empirical tests, these firms were classified as "net asset variable" firms.

Table 5.2
Summary of Categorization Regression results
based upon the interest sensitivity in the pre-swapping quarters and
in the post-swapping quarters
Model: $Opinc_{qj} = \alpha_0 + \alpha_1 Chgrate_q + \alpha_2 Chgrate_{q-1} + \epsilon$

Number of treatment firms in total	Pre-swapping	Post-swapping
	92	92
Average number of observations per regression	14.3	14.2
Panel A: Firms where operating income was found to be interest sensitive[a]		
Number of interest sensitive treatment firms	14	14
Average number of observations per regression	13.9	14.07
Average adjusted R^2	36.52%	31.08%
Average F statistic	5.428	4.195
Number of times $Chgrate_q$ coefficient positive and significant (negative and significant)[b]	6(4)	1(4)
Number of times $Chgrate_{q-1}$ coefficient positive and significant (negative and significant)[b,c]	6(3)	9(4)
Panel B: Firms where operating income was found to be interest insensitive[a]		
Number of interest insensitive treatment firms	78	78
Average number of observations per regression	14.56	14.35
Average adjusted R^2	-6.008%	-4.306%
Average F statistic	.5795	.7253
Number of times $Chgrate_q$ coefficient positive and significant (negative and significant)	0(0)	0(0)
Number of times $Chgrate_{q-1}$ coefficient positive and significant (negative and significant)	0(0)	0(0)

$Opinc_q$ = the change in operating income after depreciation for quarter q, before interest income or interest expense,
$Chgrate_q$ = the change in the 3 month T-bill rate over quarter q,
$Chgrate_{q-1}$ = the change in the 3 month T-bill rate over quarter q-1.
[a]Firms were determined to be interest sensitive if the estimated coefficient on $Chgrate_q$ or $Chgrate_{q-1}$ was significantly positive or negative.
[b] Significance was determined at the two-tailed 5% level.
[c]There were 5 pre and 4 post cases where both $Chgrate_q$ and $Chgrate_{q-1}$ were significant, totaling 14 firms.

After elimination of the 22 firms from the interest insensitive category, there were 67 firms that had no evidence of interest sensitivity in either time period. For the empirical tests, these firms were classified as "net asset fixed" firms.

The finding that operating income for most treatment firms is insensitive to changes in the short-term interest rate is not surprising. It is consistent with a sample which does not include financial services industries and is made up primarily of capital intensive industries.

5.3.5 Disclosure

The direction of the interest rate swap was determined for each treatment firm. The disclosures typically provide an indication of the direction of the swap cash flows. If the firm discloses that the swap agreement calls for payments based on a fixed rate, then the swap was classified as a "swap-to-fixed" interest rate swap. In this case, cash outflows and interest expense are fixed by the agreement. If the firm disclosed that the swap agreement called for payments based upon a variable index, then the swap was classified as a "swap-to-variable" interest rate swap. Exhibit 1 provides an example of the wording from an actual disclosure.

5.3.6 Final Grouping

Once all treatment firm disclosures had been classified as "swap-to-fixed" or "swap-to-variable", the treatment firms were grouped according to the four cases shown in Exhibit 4.2. This grouping is necessary to test the predictions made for the impact of effective cash flow hedges upon firm persistence and upon the firm's ERC. Table 5.3 shows the final grouping of the treatment firms for the empirical tests. The control

firms were assigned to the same cell as their matching treatment firm.

Exhibit 5.1
Disclosure example
"Swapping to fixed"

NOTE-10: [DEBTAC COMMT]

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The company has entered into interest rate swap agreements whereby the *company pays interest on the notional amount based on a fixed rate.* (italics added) At January 30, 1991, the company had two interest rate swap agreements outstanding with commercial banks, having a total notional principal amount of $ 150 million. The variable rate is a calculated bond equivalent based on the rate for 30-day commercial paper. These agreements expire during fiscal years 1992-1995. The weighted average effective interest rate on these agreements during 1990 was 7.4%. The company has limited exposure to credit loss for the differential between interest rates in the event of nonperformance by the other parties.

Principal payments on long-term debt for five years subsequent to 1990, in millions, are: 1991-$ 51; 1992-$ 37; 1993-$ 140; 1994-$ 55; 1995-$ 233.

NOTE-11: [DEBTAC]

Table 5.3
Categorization of Treatment Firms
to hedging strategy cases
Total number of Treatment Firms = 70

Categorization of Treatment firms[a]		
Swap structure: Pre-swap position:	swap to fixed	swap to variable
net asset fixed	**effective hedge** **CASE 1** **56 firms**	**ineffective hedge** **CASE 2** **11 firms**
net asset variable	**ineffective hedge** **CASE 3** **3 firms**	**effective hedge** **CASE 4** **0 firms**

[a]The control firms were grouped into the corresponding treatment firm's cell.

5.4 Statistics for categories

The final sample to be used in the persistence test includes 4,389 quarterly observations, representing 70 treatment firms and 60 control firms. The difference between total treatment and total control is due to 7 control firms that did not have complete information on Compustat or CRSP and 3 control firms acting as the match for more than one treatment firm.[38] The total number of quarterly observations excludes quarters where the forecasted earnings was zero, due to the formulation of the variables as percentages of forecasted earnings. Also eliminated from the final sample are quarters where a restructuring charge was taken, since revisions of future earnings was

[38]Because of the necessity to be followed by Value Line, some control firms represented the only suitable match for more than one treatment firm. Also, because of the need for daily price information, 7 of the control matches chosen were not used. As shown in tables 5.4 and 5.5, the final control and treatment samples were well matched even after the elimination of these 7 firms.

likely for these quarters due to the restructuring, regardless of the derivative strategy. The total firm quarters used in the ERC test is 4,476, with the increase due to inclusion of the zero forecasted earnings quarters.

5.4.1 Univariate statistics across all time periods

Table 5.4 provides information on the sample on the following dimensions: total assets, market equity, book equity/market equity ratio, book debt/book equity ratio, and β. The statistics were run over all quarters available for each firm. There are no unusual items noted from examination of this table. It appears, by comparison of total assets and market equity, that Case 2 and 3 firms (the ineffective cash flow hedging firms) are significantly larger than the Case 1 and 4 group (the effective cash flow hedging firms), although size appears to be the only significant difference between the two. The impact of this size difference between groups is discussed in the conclusion of this dissertation in Chapter VIII.

5.4.2 Test of means between treatment and control

The matching was effective as evidenced in the comparative statistics for the treatment and control firms. Table 5.5 shows the result of tests of differences in means between the treatment and control firms for size (measured as total equity), book equity/market equity ratio, and β. For this test, the individual firm means were calculated first and then the firm means were used to compute treatment and control firm means for comparison. The t-statistics were calculated assuming unequal variances in all cases where an F-test for equality of variances indicated a rejection of the null hypothesis of equality. The means were equivalent with regard to size and there was no

significant difference between the book equity/market equity ratio or β.

5.4.3 Tests of differences between pre- and post-swapping time periods

Table 5.6 provides an analysis of differences between the pre- and post-swapping time periods for treatment and control firms for the following variables: variance of earnings, variance of forecast errors, market equity/book equity ratio, and β. For each firm, the average level of the differencing variable was determined for the pre-swapping period and for the post-swapping period and the difference was calculated as : pre-mean - post-mean. Table 5.6 presents a test of the mean difference for each group against a null hypothesis of zero. For the difference in variance of earnings, the effective hedging treatment firms and the ineffective hedging control firms show a significant decrease, while the other groups have no significant change. A change in variance of earnings could signal a change in the predictability of earnings (i.e., a change in the level of earnings surprises) or it could signal a change in persistence (i.e., a change in the time series parameters of earnings). By examining the difference in the variance of forecast errors, the change in predictability can be tested. For all groups, there is no significant change in the variance of forecast errors, providing some evidence that the earnings were not easier to predict in the post-swapping period for any group of firms. Knowledge of this evidence is useful in drawing conclusions from the empirical tests of persistence and ERC changes.

Table 5.4
Univariate statistics on quarterly observations across all time periods

Panel A: Case 1 and 4 firms only: Effective cash flow hedging										
	Treatment firms (56)					Control firms (50)				
	Median	Mean	Std. Dev.	Min.	Max.	Median	Mean	Std. Dev.	Min.	Max.
Total assets	3315.2	5719.9	6496.6	101.5	36186.0	2146.4	4153.6	5922.7	101.6	33146.1
Market equity	2371.4	4745.8	5654.5	23.4	38891.1	1613.8	4099.4	7534.1	25.0	74878.4
Mk/Bk	1.664	2.107	1.613	.347	20.440	1.629	2.361	2.532	.039	44.052
Debt/equity	.733	1.047	1.243	.0601	15.660	.656	1.213	2.140	.055	30.501
β	1.174	1.193	.544	-.902	3.580	1.141	1.197	.588	-.836	3.670
Firm quarters	1,976					1,723				
Panel B: Case 2 and 3 firms only: Ineffective cash flow hedging										
	Treatment firms (14)					Control firms (10)				
	Median	Mean	Std. Dev.	Min.	Max.	Median	Mean	Std. Dev.	Min.	Max.
Total assets	4269.5	18056.5	22200.3	526.7	87707.0	2002.0	12494.4	16434.9	263.8	63859.0
Market equity	4893.4	12110.8	16980.4	139.0	82120.6	3269.0	8997.8	10772.6	223.1	55952.7
Mk/Bk	1.457	2.052	1.596	.429	11.074	1.627	2.348	2.447	.399	19.047
Debt/equity	.790	1.167	.983	.056	6.393	.564	.669	.501	.018	2.449
β	1.123	1.156	.583	-.165	2.753	1.028	1.113	.597	.056	3.316
Firm quarters	494					309				

Table 5.5
Tests of means for selected variables between Treatment and Control firms in each time period (pre- and post-swapping)

Panel A: Case 1 and 4 firms only: Effective cash flow hedging						
	Treatment firms (56)		Control firms (50)		h_0:means are equal	
	Mean	Std. Dev.	Mean	Std. Dev.	t-stat.	prob>|t|
Size -pre	4093	4360	3158	4702	1.0574	.2929
Size -post	6135	6948	5575	9900	.3333	.7397
Mk/Bk -pre	.684	.274	.851	.908	-1.2437	.2187
M-/Bk -post	.6235	.361	.714	.571	-.9605	.3397
β -pre	1.307	.382	1.317	.416	-.1350	.8929
β -post	.921	.365	.944	.473	-.2701	.7877
Panel B: Case 2 and 3 firms only: Ineffective cash flow hedging						
	Treatment firms (14)		Control firms (10)		h_0:means are equal	
	Mean	Std. Dev.	Mean	Std. Dev.	t-stat.	prob>|t|
Size -pre	9631	14656	10464	11661	-.1549	.8783
Size -post	14527	20654	15039	17273	-.0659	.9480
Mk/Bk -pre	.767	.321	.683	.289	.6690	.5109
Mk/Bk -post	.582	.204	.597	.213	-.1863	.8542
β -pre	1.35	.373	1.261	.326	.6211	.5412
β -post	.874	.434	.806	.405	.3913	.6997

Table 5.6
Tests of mean differences between pre- and post-swapping time periods for selected variables within Treatment and Control firm groups

Panel A: Case 1 and 4 firms only: Effective cash flow hedging								
	Treatment firms (56)				Control firms (50)			
Differencing variable	Mean	Std. Dev.	t-stat.	prob>|t|	Mean	Std. Dev.	t-stat.	prob>|t|
Variance of earnings	.085	.050	1.700	.0947	.174	.363	.478	.6344
Variance of forecast errors	-11.93	12.00	-.993	.3247	-.067	.225	-.302	.7639
Mk/Bk	.060	.034	1.764	.0832	.136	.116	1.175	.2454
β	.385	.039	9.643	.0001	.373	.049	7.581	.0001
Panel B: Case 2 and 3 firms only: Ineffective cash flow hedging								
	Treatment firms (14)				Control firms (10)			
Differencing variable	Mean diff.	Std. Dev.	t-stat.	prob>|t|	Mean	Std. Dev.	t-stat.	prob>|t|
Variance of earnings	.151	.107	.141	.1819	.091	.037	2.456	.0364
Variance of forecast errors	.060	.091	.654	.5244	-28.76	28.78	-.999	.3438
Mk/Bk	.185	.054	3.394	.0048	.085	.061	1.392	.1973
β	.476	.057	8.27	.0001	.454	.126	3.603	.0057

The significant decrease in β for all groups indicates a need to include a control for β in the empirical tests. Likewise, the significant decrease in the Market equity/Book equity ratio for both treatment groups indicates a need to control for this difference.

5.4.4 Statistics for eliminated firms

Tables 5.7, 5.8, and 5.9 provide descriptive statistics for the firms eliminated by the interest rate sensitivity analysis. These statistics are provided to demonstrate that there is no obvious characteristic that distinguishes these firms from the rest of the sample.

5.4.5 Industry representation

Table 5.10 presents information on the breakdown of industries represented in the sample. It is clear that the sample is not heavily dominated by one industry. Therefore, it is not expected that the results of the empirical tests will be driven by industry effects.

5.4.6 Economic significance of interest rate swaps

Table 5.11 presents descriptive information about the economic significance of the interest rate swaps for the effective cash flow hedging firms and for the ineffective cash flow hedging firms. Economic significance is measured with two ratios: the notional principal to long-term debt ratio and interest expense to sales ratio. Both measures are imperfect proxies for economic significance but both provide some descriptive level of swap activity. The notional principal to long-term debt ratio is imperfect because firms must disclose the total amount of notional principal and this total sometimes includes offsetting positions. For instance, one firm in the sample had a notional principal to long-term debt ratio of 16.84. Because this firm did not disclose the number of swaps or the

direction of individual swaps, it is not possible to determine how much of the long-term debt is covered on a net basis. Therefore, this ratio should only be used as a gauge of swap activity and can not really be meaningfully compared across the groups.

The interest expense to sales ratio is an attempt to determine whether or not changes to interest expense patterns would be significant enough to impact the valuation process. Because the interest expense related to swaps is not broken out separately in the income statement, the interest expense number may overstate the significance of the swap activity. This ratio does provide enough information to conclude that there is a slightly higher impact likely for the effective cash flow hedging firms (interest expense is approximately 3.5% of sales) than for the ineffective cash flow hedging firms (interest expense is approximately 2.9% of sales). This difference between groups is discussed in Chapter VIII as a possible limitation of the results.

Table 5.7
Univariate statistics on quarterly observations
Across all time periods
Firms eliminated after interest sensitivity analysis

Firms eliminated after interest sensitivity tests										
	Treatment firms (22)					Control firms (21)				
	Median	Mean	Std. Dev.	Min.	Max.	Median	Mean	Std. Dev.	Min.	Max.
Total assets	2854.1	9613.5	28582.2	116.2	198938	2133.54	10933.1	32227.4	134.7	197279
Market equity	1579.3	3271.7	4472	149.1	32121	1568.1	5561.2	9172.4	89.8	64352.2
Bk/Mk	1.493	1.761	1.115	0.376	8.643	1.594	2.089	1.75	0.506	12.361
Debt/equity	0.858	1.641	2.232	0.105	14.221	0.612	0.922	1.15	0.057	8.688
β	1.161	1.203	0.568	-0.337	3.286	1.321	1.304	0.541	-0.015	2.972
Firm quarters	716					670				

Table 5.8
Tests of means for selected variables between eliminated Treatment and Control firms

	Treatment firms (22)		*Control firms (21)*		h_0:*means are equal*	
	Mean	Std.Dev.	Mean	Std.Dev.	t-stat.	prob>|t|
Size -pre	2792	3960	4262	6858	-0.8558	0.3985
Size -post	3782	4887	6273	11247	-0.9346	0.3583
Mk/Bk -pre	0.807	0.369	0.738	0.341	0.6368	0.5278
M-/Bk -post	0.735	0.394	0.606	0.302	1.209	0.2338
β -pre	1.349	0.324	1.421	0.421	-0.7095	0.482
β -post	0.931	0.461	1.063	0.418	-0.9969	0.3247

Table 5.9
Tests of mean differences between pre- and post-swapping time periods for selected variables within eliminated Treatment and Control firm groups

	Treatment firms (22)				Control firms (21)			
Differencing variable	Mean	Std.Dev.	t-stat.	prob>|t|	Mean	Std.Dev.	t-stat.	prob>|t|
Variance of earnings	0.013	0.1	0.137	0.8923	0.107	0.067	1.582	0.1294
Variance of forecast errors	0.041	0.045	0.909	0.3732	-0.01	0.018	-0.72	0.4807
Mk/Bk	0.071	0.05	1.412	0.0832	0.132	0.05	2.639	0.0157
β	0.419	0.071	5.946	0.0001	0.357	0.065	5.482	0.0001

Table 5.10
Industry breakdown for treatment and control firms, including Case 1 and 4 firms, Case 2 and 3 firms, and the eliminated firms

SIC #	Industry	Case 1 and 4		Case 2 and 3		Switchers	
		treat	control	treat	control	treat	control
100-1999	Agricultural production,Oil and Gas extraction, Mining	5	4				
2000-2799	Food and paper products	10	9			7	5
2800-2999	Chemicals and allied products	6	6	6	5	5	4
3000-3999	Machinery, computer equipment, electronics, transportation equipment	19	16	6	3	5	8
4000-4999	water transportation, communication	4	5	1	1		
4900-4999	utilities	6	5			3	2
5000-5999	wholesale and retail merchandising	3	3	1	1	2	2
7000-7999	hotels, business services, entertainment	3	2				
	Total firms	56	50	14	10	22	21

Table 5.11
Economic significance of interest rate swaps

	notional amount/ long-term debt	interest expense/ sales
Effective cash flow hedging firms	0.3935	0.0355
Ineffective cash flow hedging firms	0.282	0.0286

5.5 Summary

This chapter has provided information about the sample selection process and the categorization of firms for testing. In addition, descriptive statistics have been presented for a number of variables. The results of these analyses indicate that the selected control firms provide a successful match for the treatment firms and provide confidence that the empirical tests will not be adversely impacted by sample selection biases. The following chapter presents the empirical model and results for the test of the impact of interest rate swap activity on earnings persistence.

CHAPTER VI

EARNINGS PERSISTENCE: EMPIRICAL MODEL AND REGRESSION RESULTS

6.1 Introduction

This chapter presents the empirical model for testing the impact of implementing a derivative strategy on earnings persistence. Also presented are results of running the empirical model using the sample of firms described in Chapter V.

6.2 Earnings persistence model

As in prior research, this study uses analysts' forecast errors to proxy for the surprise in earnings. Analysts' forecast errors have been shown to be related to abnormal returns and analysts' forecasts have been shown to be an effective proxy for market expectations (Abarbanell 1991). This study uses the Value Line Investment Survey as the source of analyst forecasts.[39] The primary prediction examines the persistence of earnings, based upon a model from Easton and Zmijewski(1989). They use an analysts' revision model of the following form:

$$REV_{jt}=\theta_{j0}+\theta_{j1}FE_{jt}+\theta_{j2}PVLVL_{jt}+u_{jt}, \qquad (13)$$

[39]Value Line forecasts were deemed more appropriate in this context than were the consensus forecasts found on IBES. Revisions of forecasts are difficult to isolate and understand in a consensus format due to the various reasons analysts may have for updating. Forecasts from one source may be biased, but the bias is likely to be constant across treatment and control firms and should not impact the interpretation of the results.

where

REV_{jt} = the revision in analyst forecast for period t+1 following the earnings announcement in quarter t.

FE_{jt} = the forecast error for quarter t,

$PVLVL_{jt}$ = the change in stock price for firm j from the earnings forecast date preceding the earnings announcement date through the earnings forecast date immediately after the earnings announcement date, excluding the three days before, the day of, and the three days after the earnings announcement date.

The coefficient, θ_{j1} ,on the forecast error is the revision coefficient in Easton and Zmijewski's model. This coefficient captures all factors that influence a revision in the analyst's forecast beyond those captured by θ_{j2}, including but not limited to the information contained in the earnings announcement.[40] In the current study, the revision coefficient is used to proxy for the earnings persistence. Two slope indicator variables are added to the Easton and Zmijewski model: one to designate the post-hedging periods and one to allow for treatment and control firm differences in the pre-hedging period. The resulting empirical model is of the following form:

MODEL 1:

$$REVP_{jq} = \alpha_0 + \alpha_1 FEP_{jq} + \alpha_2 FEP_{jq} * Post_{jq} + \alpha_3 FEP_{jq} * Treat_j + \alpha_4 FEP_{jq} * Post_{jq} * Treat_j + \epsilon_{jq}, \quad (14)$$

[40]The $PVLVL_{jt}$ variable was weakly significant in Easton and Zmijewski's tests and is not used in the current model.

where

$REVP_{jq}$ = The percentage revision in the quarter q+1 earnings forecast for firm j following the announcement of firm j quarter q earnings where revision is measured as the difference between the quarter q+1 forecast after announcement of quarter q earnings and the last quarter q+1 forecast preceding the announcement of quarter q earnings as reported in the Value Line Investment Survey.[41]

FEP_{jq} = The percentage forecast error for firm j for quarter q, measured as the difference between the actual earnings per share and the latest forecasted earnings per share for quarter q where forecasts and actual earnings per share were taken from the Value Line Investment Survey.

$Post_{jq}$ = 1 if quarter q is in firm j's post-disclosure period and 0 otherwise.

$Treat_j$ = 1 if firm j is a treatment firm and 0 otherwise.

Exhibit 6.1 shows how the coefficients in the model relate to the effect of interest rate swaps on earnings. In Exhibit 6.1, α_4 is the coefficient of primary interest. This coefficient shows the change in treatment firm persistence after controlling for the change in all firms over time and after controlling for any difference between treatment and control firms. The prediction made in the first part of this research is that α_4 will be positive if firms are hedging cash flows with interest rate swaps or α_4 will be zero or negative if firms' strategies are inconsistent with cash flow hedging.

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[41]The percentage revision and percentage forecast error are used in this study to scale for size differences across firms. Easton and Zmijewski ran the model for individual firms and accordingly, used the nominal revisions and forecast errors.

Exhibit 6.1
Coefficients in Model 1

	Time period	
Type of Firm	Pre-swapping period	Post-swapping period
Control Firms	α_1	$\alpha_1 + \alpha_2$
Treatment Firms	$\alpha_1 + \alpha_3$	$\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4$

6.3 Test of persistence response

6.3.1 Regression results for Model 1

Table 6.1 provides the estimation results of running Model 1. Panel A presents the results of the model using all firms.[42] Panels B and C present the results for the effective cash flow hedging firms (case 1 and 4 firms) and the ineffective cash flow hedging firms (case 2 and 3 firms), respectively. In Panel A, the revision coefficient which proxies for persistence increased for treatment firms in the period after disclosure after controlling for differences between treatment and control firms and controlling for general differences in the time periods, as evidenced by the significant positive coefficient on α_4 , the FEP_{jq}*$Post_{jq}$*$Treat_j$ variable.[43]

As expected, the FEP_{jq} coefficient was significantly positive, establishing the base

[42]The total number of firm quarters tested, 5752, is made up of the 3595 case 1 and 4 firm quarters, the 794 case 2 and 3 firm quarters, and the 1363 firm quarters for firms eliminated from the case categories.

[43]Upon a review of influential observations, it was noted that approximately 10 quarterly observations were substantially affecting the coefficient estimates. Therefore, these extreme forecast error percentages and extreme revision percentages were winsorized to the values at the 1 and 99 percentile. This maintains the direction but dampens the relative magnitude of the effect for these extreme observations.

relation between the forecast errors and the forecast revisions. Panel A shows that the treatment firms had lower revision coefficients than the control firms in the pre-disclosure period, as evidenced by the negative coefficient on the treatment indicator variable, FEP_{jq}*$Treat_j$. In the post-disclosure period, panel A shows that all firms had lower revision coefficients as shown by the negative coefficient on the post-disclosure period indicator variable, FEP_{jq}*$Post_{jq}$. The significant positive coefficient on the post-disclosure treatment indicator, FEP_{jq}*$Post_{jq}$*$Treat_j$, is consistent with the prediction for effective cash hedging when all firms are included. Therefore, if no differentiation is made between firms' net asset position before swapping, it appears that firms, on average, effectively hedge cash flows with their interest rate swaps. However, in order to provide a stronger test of the predictions, Panel B presents the results of running Model 1 for the effective cash flow hedging firms (Cases 1 and 4) and panel C presents the results for the ineffective cash flow hedging firms (Cases 2 and 3). The coefficient on the post-disclosure period treatment indicator, FEP_{jq}*$Post_{jq}$*$Treat_j$, remains significantly positive in panel B, as predicted, and all other coefficients are consistent with Panel A. In panel C, however, the coefficient on FEP_{jq}*$Post_{jq}$*$Treat_j$ is insignificant, while all other coefficients are consistent with panels A and B. The results in Table 6.1 are consistent with the prediction that an effective cash flow hedging strategy (as predicted for cases 1 and 4 in panel B) will increase persistence while a strategy that is inconsistent with cash flow hedging (as predicted for cases 2 and 3 in panel B) will not increase earnings persistence.

Table 6.1: Model 1 - Test of persistence response

$$REVP_{jq} = \alpha_1 FEP_{jq} + \alpha_2 FEP_{jq} * Post_{jq} + \alpha_3 FEP_{jq} * Treat_j + \alpha_4 FEP_{jq} * Post_{jq} * Treat_j + \epsilon_{jq}$$

Panel A: All Firms			
variable	coefficient estimate	White's t-statistic	two-tailed prob. >|t|
FEP_{jq}	0.23636	14.908	.0001
$FEP_{jq}*Post_{jq}$	-0.026371	-2.238	.025
$FEP_{jq}*Treat_j$	-0.010244	-1.855	.0636
$FEP_{jq}*Post_{jq}*Treat_j$	0.061558	3.341	.0008
# of observations	5752		
Adjusted R^2	.1947		
Panel B: Firms categorized as cases 1 or 4: Effective cash flow hedging			
variable	coefficient estimates	White's t-statistic	one-tail prob.>t
FEP_{jq}	0.252519	12.98398	.0001
$FEP_{jq}*Post_{jq}$	-0.0359	-2.5589	.0054
$FEP_{jq}*Treat_j$	-0.01032	-1.9718	.0244
$FEP_{jq}*Post_{jq}*Treat_j$	0.086354	3.9264	.0001
# of observations	3595		
Adjusted R^2	.2444		
Panel C: Firms categorized as cases 2 or 3: Ineffective cash flow hedging			
FEP_{jq}	0.35523	5.5266	.0001
$FEP_{jq}*Post_{jq}$	-0.14472	-1.9325	.0268
$FEP_{jq}*Treat_j$	-0.09166	-2.1221	.017
$FEP_{jq}*Post_{jq}*Treat_j$	0.052216	.6502	.2578
# of observations	794		
Adjusted R^2	0.1814		

6.3.2 Regression results for Model 1 with firm-specific and time-specific indicators

Any test of cross-sectionally pooled time-series data is subject to measurement error resulting from the forcing of firm and time specific influences into one intercept term.[44] The appropriate solution for this problem depends upon the assumptions made about the firm and time specific intercept terms and can take the form of a fixed effects model or an error components model. A fixed effects model does not make any specific assumptions about the distribution of the firm and time specific terms and can accordingly be used for a wider range of problems than can an error components model.[45]

Herein, the least restrictive assumption is made so that the firm and time specific influences are assumed to be fixed and a fixed effects model is then appropriate. Therefore, Model 1 was augmented to incorporate an indicator variable for each firm and for each quarter, to control for both firm-specific and time-period specific influences. The augmented model is as follows:

$$REVP_{jq} = \alpha_1 FEP_{jq} + \alpha_2 FEP_{jq} * Post_{jq} + \alpha_3 FEP_{jq} * Treat_j + \alpha_4 FEP_{jq} * Post_{jq} * Treat_j + \sum_{j=1}^{175} \alpha_{4+j} Dfirm_j + \sum_{q=1}^{44} \alpha_{179+j} Dtime_q + \epsilon_{jq} \quad (15)$$

where Dfirm is an indicator variable for each firm j, and

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[44]The ideas presented in this paragraph are based upon the discussion presented by Judge, Hill, Griffiths, Lutkepohl, and Lee (1982)in Chapter 16 of "Introduction to the Theory and Practice of Econometrics" .

[45]This methodology is applied in recent studies by Loudder, Boatsman, and Khurana (1996) and Abody (1996) where cross-sectional, time-series data is used.

Dtime is an indiator variable for each quarter t.

Table 6.2 presents the results of running Model 1 using all firms(panel A), firms in cases 1 and 4 (panel B) - the effective cash flow hedgers, and firms in cases 2 and 3 (panel C) - the ineffective cash flow hedgers. The table suppresses the coefficients on individual firms and time periods (significant coefficients found for: 19 firms/0 quarters in panel A, 14 firms/0 quarters in panel B, 4 firms/3 quarters in panel C). In panel A of table 6.2, the revision coefficient which proxies for persistence increased for treatment firms in the period after disclosure after controlling for differences between treatment and control firms and controlling for general differences in the time periods, as evidenced by the significant positive coefficient on α_4 , the $FEP_{jq}*Post_{jq}*Treat_j$ variable.[46] The significant positive coefficient on $FEP_{jq}*Post_{jq}*Treat_j$ is consistent with the prediction for effective cash hedging when all firms are included. Therefore, if no differentiation is made between firms' net asset position before swapping, it appears that firms, on average, effectively hedge cash flows with their interest rate swaps.

When firms' net asset position before swapping is considered, the revision coefficient increased for effective cash flow hedgers as evidenced by the significantly positive coefficient on the $FEP_{jq}*Post_{jq}*Treat_j$ variable in panel B. For the ineffective cash flow hedgers shown in panel C, the coefficient on $FEP_{jq}*Post_{jq}*Treat_j$ is positive but insignificant.

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[46]Once again, the extreme forecast error percentages and extreme revision percentages were winsorized to the 1 and 99 percentile. This procedure dampened the level of significance for all coefficients but had no impact on the direction of the coefficients in the model.

Table 6.2: Model 1 - Test of persistence response with indicator variables for each firm and each quarter

$$REVP_{jq} = \alpha_1 FEP_{jq} + \alpha_2 FEP_{jq} * Post_{jq} + \alpha_3 FEP_{jq} * Treat_j + \alpha_4 FEP_{jq} * Post_{jq} * Treat_j + \sum_{j=1}^{175} \alpha_{4+j} Dfirm_j + \sum_{q=1}^{44} \alpha_{179+j} Dtime_q + \epsilon_{jq}$$

Panel A: All Firms			
variable	coefficient estimate	White's t-statistic	two-tail prob. >|t|
FEP_{jq}	.223193	14.404	.0001
$FEP_{jq}*Post_{jq}$	-0.030214	-2.677	.0074
$FEP_{jq}*Treat_j$	-0.006906	-1.275	.2023
$FEP_{jq}*Post_{jq}*Treat_j$	0.060472	3.584	.0004
# of observations	5752		
Adjusted R^2	.2775		
Panel B: Firms categorized as cases 1 or 4: Effective cash flow hedging			
variable	coefficient estimates	White's t-statistic	one-tail prob.>t
FEP_{jq}	0.245336	12.9648	.0001
$FEP_{jq}*Post_{jq}$	-0.040287	-2.9585	.0018
$FEP_{jq}*Treat_j$	-0.008142	-1.4535	.0695
$FEP_{jq}*Post_{jq}*Treat_j$	0.084184	4.1655	.0001
# of observations	3595		
Adjusted R^2	.3109		
Panel C: Firms categorized as cases 2 or 3: Ineffective cash flow hedging			
FEP_{jq}	0.322290	5.0253	.0001
$FEP_{jq}*Post_{jq}$	-0.120492	-1.7301	.0416
$FEP_{jq}*Treat_j$	-0.063156	-1.8335	.0325
$FEP_{jq}*Post_{jq}*Treat_j$	0.029368	.3992	.3474
# of observations	794		
Adjusted R^2	.2853		

As expected, the FEP_{jq} coefficient was significantly positive in all panels, establishing the base relation between the forecast errors and the forecast revisions. Table 6.2 shows that there was no significant difference in panels A and B between the treatment firms and the control firms in the pre-disclosure period, as evidenced by the insignificant coefficient on the treatment indicator variable, FEP_{jq}*$Treat_j$, while the Panel C treatment firms had significantly lower revision coefficients in the pre-disclosure period. In the post-disclosure period, each panel of table 4 shows that all firms had lower revision coefficients as shown by the significantly negative coefficient on the post-disclosure period indicator variable, FEP_{jq}*$Post_{jq}$. Again, these collective results are consistent with the predictions for effective cash flow hedging and ineffective cash flow hedging. The inclusion of the firm and time specific indicator variables did not change the interpretation of the model's results.

6.4 Summary

In summary, the tests performed in this chapter support the predictions presented in Chapter 4 for the firm-specific impact of effective cash flow hedging and ineffective cash flow hedging on the persistence of earnings. For this study, persistence is proxied by the relation between revisions of analysts forecasts of future earnings and current earnings surprise, described as a revision coefficient. An increase in the revision coefficient in the period following disclosure of interest rate swap activity is interpreted as an increase in the persistence of the earnings. The findings support the prediction that effective cash flow hedging of interest rates will increase the persistence of earnings while ineffective cash flow hedging will not.

CHAPTER VII

EARNINGS RESPONSE COEFFICIENT EMPIRICAL MODEL AND REGRESSION RESULTS

7.1 Introduction

This chapter presents the empirical model for testing the impact of implementing an interest rate hedging strategy on the earnings response coefficient. Also presented are the results of running the empirical model using the sample of firms described in Chapter V.

7.2 The earnings response coefficient model

The second prediction made in this study addresses the change in ERC following the implementation of the hedging strategy. This prediction is tested using a model similar to that found in Collins and Salatka (1993). The empirical model is as follows:

MODEL 2

$$\begin{aligned} AR_{jq}/p_{jt-2} &= \beta_1 FE_{jq}/p_{jt-2} + \beta_2 FE_{jq} * Post_{jq}/p_{jt-2} + \beta_3 FE_{jq} * Treat_j/p_{jt-2} \\ &+ \beta_4 FEP_{jq} * Post_{jq} * Treat_j/p_{jt-2} + \beta_5 FE_{jq} * EBETA_{jq}/p_{jt-2} \\ &+ \beta_6 FE_{jq} * MK/BK_{jq}/p_{jt-2} + \sum_{j=1}^{175} \beta_{6+j} Dfirm_j/p_{jt-2} + \sum_{q=1}^{44} \beta_{181+j} Dtime_q/p_{jt-2} + \epsilon_{jq} \end{aligned} \quad (16)$$

where AR_{jq} = The abnormal return, measured as the prediction error from a market model run over day t-1 and day t where t is the quarterly earnings announcement date for quarter q. The parameters of the market model are estimated using a 200 day trading interval from

day t-100 to day t+100[47],

Fe_{jq} = The nominal forecast error where forecast error is as defined in equation 10 above. This specification follows that of Collins and Salatka(1993),

$Beta_{jq}$ = The market model beta for firm j for quarter q where the parameters of the market model are estimated using a 200 day trading interval from day t-100 to day t+100,

MK/BK_{jq} = The market equity to book equity ratio for firm j for quarter q where market equity and book equity are measured at the end of the fiscal quarter,

p_{jt-2} = The price of firm j stock two days prior to the quarterly earnings announcement date, and all other variables are as described previously.

Based upon the findings of prior research regarding cross-sectional determinants of ERCs, the model includes a proxy for risk ($Beta_{jq}$) and a proxy for growth (Mk/Bk_{jq}). These are included as control variables and are expected to have the signs found in prior research, where ERCs are found to be associated negatively with risk and positively with growth. The model does not include a control variable for interest rate levels, as this intertemporal ERC determinant is controlled via the control sample. Exhibit 7.1 summarizes the coefficient combinations necessary to evaluate the ERC's of the treatment

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[47]In estimating the market model parameters, daily returns were examined for extreme market return days and these were eliminated from the estimation model. Excluded due to extreme returns were most of the days in October 1987 subsequent to the 15th as well as days in other years where the market return for the day was more than 5 standard deviations away from the average return for the estimation period. These days were also eliminated as abnormal return dates, resulting in the loss of several firm quarter observations and these dates were eliminated as scaling days for the regression model. Bowen, Johnson, and Shevlin (1989) examine the return-earnings relation during the market crash of October 1987 and find that the relation is maintained in their tests except for the days Oct. 19-20. However, the inclusion of these extreme return observations distorts the estimated coefficients in a pooled cross-sectional setting such as the current study.

and control samples in the pre- and post-swapping period.

Exhibit 7.1
Coefficients in Model 2

	Time period	
Type of Firm	Pre-swapping period	Post-swapping period
Control Firms	β_1	$\beta_1 + \beta_2$
Treatment Firms	$\beta_1 + \beta_3$	$\beta_1 + \beta_2 + \beta_3 + \beta_4$

The coefficient of interest for the tests of the second model is β_4. Analogous to the persistence model, this coefficient captures the change in ERC after implementation of the derivative strategy beyond any general time trend and controlling for differences between the treatment and control firms. The prediction is that β_4 will be positive if a cash flow hedging strategy is used and that β_4 will be zero or negative if the strategy is inconsistent with cash flow hedging.

7.3 Test of ERC response

7.3.1 Regression results for Model 2

Turning to tests of the ERC response to firms' hedging strategies, Table 7.1 presents the results of running Model 2 for all firms (panel A), for the effective cash flow hedging firms (panel B), and for the ineffective cash flow hedging firms (panel C). Each panel is discussed below.

Panel A is presented as a base result that does not control for differences in the effectiveness of the hedging strategy. The signs on the control variables of market beta (-) and market/book ratio (+) were consistent with prior research although neither

variable was significantly different from zero. As expected, the FE_{jq} coefficient was significantly positive, establishing the base relation between unexpected earnings and abnormal returns. In table 7.1 and consistent with the findings in the persistence tests, the coefficient on Fe_{jq}*$Post_{jq}$ was significantly negative, indicating that ERCs in the post-disclosure period were lower across all firms in the sample. The treatment indicator, FE_{jq}*$Treat_j$ was not significantly different from zero, indicating that the treatment firms and control firms were not significantly different in the pre-disclosure period. The insignificantly positive FE_{jq}*$Post_{jq}$*$Treat_j$ coefficient indicates that for the sample of all firms, there is no significant impact on the ERC from the implementation of the hedging strategy. However, a more powerful test of the predictions can be performed by partitioning the data according to the expected effectiveness of the hedging strategies as described in Chapter V.

Panel B provides results from running Model 2 for the combination of cases 1 and 4 - the effective cash flow hedging firms. The results in panel B are consistent with those in panel A, with one interesting exception. For this group of effective cash flow hedging firms, the coefficient on the hedging strategy effect, FE_{jq}*$Post_{jq}$*$Treat_j$, is significantly positive. This finding is consistent with the prediction for an effective hedging strategy.

The results in panel C are interesting as well. All coefficients are consistent with those in panel A except that the FE_{jq}*$Post_{jq}$ coefficient is no longer significant, indicating that for this group of ineffective cash flow hedging firms there was no systematic decline in ERCs across time. The insignificant coefficient on the hedging strategy effect,

Table 7.1: Model 2 - Test of the ERC response

$$AR_{jq}/p_{jt-2} = \beta_1 FE_{jq}/p_{jt-2} + \beta_2 FE_{jq} * Post_{jq}/p_{jt-2} + \beta_3 FE_{jq} * Treat_j/p_{jt-2} + \beta_4 FE_{jq} * Post_{jq} * Treat_j/p_{jt-2} + \beta_5 FE_{jq} * EBETA_{jq}/p_{jt-2} + \beta_6 FE_{jq} * MK/BK_{jq}/p_{jt-2} + + \epsilon_{jq}$$

Panel A: All Firms			
variable	coefficient estimate	White's t-statistic	two-tailed prob.>|t|
FE_{jq}	0.810421	6.945	.0001
FE_{jq}*$Post_{jq}$	-0.143757	-2.947	.0032
FE_{jq}*$Treat_j$	-0.026194	-0.223	.8258
FE_{jq}*$Post_{jq}$*$Treat_j$	0.183598	1.040	.2984
FE_{jq}*$Beta_{jq}$	-0.02029	-1.477	.1388
FE_{jq}*MK/BK_{jq}	0.048549	1.376	.1691
# of observations	5851		
Adjusted R^2	.0381		
Panel B: Firms categorized as cases 1 or 4: Effective cash flow hedging			
variable	coefficient estimate	White's t-statistic	one-tailed prob. >t
FE_{jq}	0.661361	4.456	.0001
FE_{jq}*$Post_{jq}$	-0.1397	-2.602	.0047
FE_{jq}*$Treat_j$	-0.12852	-1.092	.1379
Fe_{jq}*$Post_{jq}$*$Treat_j$	0.271769	1.431	.0764
FE_{jq}*$Beta_{jq}$	-0.01919	-1.420	.0778
FE_{jq}*Mk/Bk_{jq}	0.07296	1.0117	.1562
# of observations	3673		
Adjusted R	.0256		

Panel C: Firms categorized as cases 2 or 3:Ineffective cash flow hedging			
variable	coefficient estimate	White's t-statistic	One-tailed prob. > t
FE_{jq}	0.833709	1.073	.1423
FE_{jq}*$Post_{jq}$	-0.79789	-1.246	.1056
FE_{jq}*$Treat_j$	-.02577	-.05232	.4801
FE_{jq}*$Post_{jq}$*$Treat_{j4}$	1.116835	1.249	.1056
FE_{jq}*$Beta_{jq}$	-.05429	-.1513	.4404
FE_{jq}*Mk/Bk_{jq}	0.1102	.3372	.3669
# of observations	803		
Adjusted R^2	.0305		

Note:

AR_{jq} is the abnormal return, measured as the prediction error from a market model run over day t-1 and day t where t is the quarterly earnings announcement date for quarter q.

FE_{jq} is the forecast error for quarter q for firm j,

$Post_{jq}$ is an indicator variable taking the value of 1 for quarters after disclosure of swap and 0 otherwise,

$Treat_j$ is an indicator variable taking the value of 1 for treatment firms and 0 for control firms,

$Beta_{jq}$ is the market model beta for firm j estimated using a 200 day period around t.

MK/BK_{jq} is the market equity/book equity for firm j for quarter q,

DFirm is an indicator variable for each firm,

Dtime is an indicator variable for each quarter,

and

p_{jt-2} is the price for firm j at day t-2 and is used as a scalar in the above model.

FE_{jq}*Post $_{jq}$*Treat$_j$, can be interpreted as consistent with the predictions for an ineffective hedging strategy.

7.3.2 Regression results for Model 2 with firm-specific and time-specific indicators

Finally, similar to the method described in chapter VI, Model 2 was run as a fixed effects model, with indicator variables added for each firm and for each quarter. The indicator variables control for firm-specific and time period-specific omitted variables that weaken the power of the simpler test presented in Table 7.1. The augmented model is shown below:

$$\begin{aligned} AR_{jq}/p_{jt-2} = {} & \beta_1 FE_{jq}/p_{jt-2} + \beta_2 FE_{jq} * Post_{jq}/p_{jt-2} + \beta_3 FE_{jq} * Treat_j/p_{jt-2} \\ & + \beta_4 FEP_{jq} * Post_{jq} * Treat_j/p_{jt-2} + \beta_5 FE_{jq} * EBETA_{jq}/p_{jt-2} \\ & + \beta_6 FE_{jq} * MK/BK_{jq}/p_{jt-2} + \sum_{j=1}^{175} \beta_{6+j} Dfirm_j/p_{jt-2} + \sum_{q=1}^{44} \beta_{181+j} Dtime_q/p_{jt-2} + \epsilon_{jq} \end{aligned} \quad (17)$$

where Dfirm is an indicator variable for each firm and Dtime is an indicator variable for each quarter.

Table 7.2 presents the results from this model for all firms (panel A), case 1 and 4 firms (panel B), case 2 and 3 firms (panel C). The coefficients on the indicator variables are suppressed (significant coefficient found for: 2 firms/0 quarters in panel A, 10 firms/4 quarters in panel B, 1 firm/5 quarters in panel C). Results across all panels are consistent with those in Table 7.1. The hedging strategy impact variable, FE_{jq}*Post $_{jq}$*Treat$_j$, is positively significant in panel B (consistent with the categorization of these firms as "effective cash flow hedgers") and is negative in panel C (the firms

categorized as "ineffective cash flow hedgers"). Therefore, the results are considered to be consistent with the predictions for effective versus ineffective cash flow hedging of interest rate risk. The firms that were categorized as effective cash flow hedging firms experienced an increase in ERCs following the implementation of the interest rate swap strategy while those firms that were categorized as ineffective cash flow hedging firms did not experience a change in ERC corresponding to the implementation of the interest rate swap strategy.

7.4 Summary

This chapter presented the empirical model and results for the tests of the ERC response to implementation of an interest rate swap strategy. The results, based upon a model augmented to include firm-specific and time period-specific indicator variables, support the predictions made in Chapter IV. The implementation of the interest rate swap strategy was associated with an increase in the ERCs of firms categorized as effective cash flow hedgers. For firms categorized as ineffective cash flow hedgers, there was no significant change in the ERCs. The following chapter concludes this dissertation and offers ideas for future research based upon the findings and conclusions herein.

Table 7.2: Model 2 - Test of the ERC response with indicator variables for each firm and each quarter

$$AR_{jq}/p_{jt-2} = \beta_1 FE_{jq}/p_{jt-2} + \beta_2 FE_{jq} * Post_{jq}/p_{jt-2} + \beta_3 FE_{jq} * Treat_j/p_{jt-2} + \beta_4 FE_{jq} * Post_{jq} * Treat_j/p_{jt-2} + \beta_5 FE_{jq} * EBETA_{jq}/p_{jt-2} + \beta_6 FE_{jq} * MK/BK_{jq}/p_{jt-2} + \sum_{j=1}^{175} \beta_{6+j} Dfirm_j/p_{jt-2} + \sum_{q=1}^{44} \beta_{181+j} Dtime_q/p_{jt-2} + \epsilon_{jq}$$

Panel A: All Firms			
variable	coefficient estimate	White's t-statistic	two-tailed prob. >|t|
FE_{jq}	0.821060	7.189	.0001
FE_{jq}*$Post_{jq}$	-0.114238	-1.846	.0651
FE_{jq}*$Treat_j$	0.001578	.0119	.9840
FE_{jq}*$Post_{jq}$*$Treat_j$	0.254534	1.375	.2023
FE_{jq}*$Beta_{jq}$	-0.020873	-1.726	.0845
FE_{jq}*MK/BK_{jq}	0.031368	.8587	.3926
# of observations	5851		
Adjusted R^2	.0491		
Panel B: Firms categorized as cases 1 or 4: Effective cash flow hedging			
variable	coefficient estimate	White's t-statistic	one-tailed prob. >t
FE_{jq}	0.683708	4.9151	.0001
FE_{jq}*$Post_{jq}$	-0.122228	-1.7369	.0400
FE_{jq}*$Treat_j$	-0.136286	-1.0568	.1444
FE_{jq}*$Post_{jq}$*$Treat_j$	0.415752	2.1415	.0175
FE_{jq}*$Beta_{jq}$	-0.020593	-1.778	.0375
FE_{jq}*Mk/Bk_{jq}	0.053507	.715	.2347
# of observations	3673		
Adjusted R	.0398		

Panel C: Firms categorized as cases 2 or 3:Ineffective cash flow hedging			
variable	coefficient estimate	White's t-statistic	One-tailed prob. > t
FE_{jq}	0.832746	1.004	.1587
FE_{jq}*$Post_{jq}$	-0.433499	-.6791	.2505
FE_{jq}*$Treat_j$	-0.378418	-.7593	.2269
FE_{jq}*$Post_{jq}$*$Treat_{j4}$	1.06539	1.2631	.1025
FE_{jq}*$Beta_{jq}$	-0.033405	-.09527	.4645
FE_{jq}*Mk/Bk_{jq}	0.146835	.4347	.3328
# of observations	803		
Adjusted R^2	.0503		

Note:

AR_{jq} is the abnormal return, measured as the prediction error from a market model run over day t-1 and day t where t is the quarterly earnings announcement date for quarter q.

FE_{jq} is the forecast error for quarter q for firm j,

$Post_{jq}$ is an indicator variable taking the value of 1 for quarters after disclosure of swap and 0 otherwise,

$Treat_j$ is an indicator variable taking the value of 1 for treatment firms and 0 for control firms,

$Beta_{jq}$ is the market model beta for firm j estimated using a 200 day period around t.

MK/BK_{jq} is the market equity/book equity for firm j for quarter q,

DFirm is an indicator variable for each firm,

Dtime is an indicator variable for each quarter,

and

p_{jt-2} is the price for firm j at day t-2 and is used as a scalar in the above model.

CHAPTER VIII

CONCLUSION AND SUGGESTIONS FOR FUTURE RESULTS

8.1 Interpretation of results

The results of the empirical tests in this dissertation are generally consistent with the predictions concerning the valuation relevance of interest rate swap strategies. Firms that (1) disclose the use of interest rate swaps and (2) swap to hedge based on net asset classification demonstrate changes in persistence and ERCs consistent with effective cash flow hedging. However, firms that (1) disclose the use of interest rate swaps as a tool to manage interest rates but (2) swap to a position inconsistent with hedging based on net asset classification demonstrate changes in persistence and ERCs that are inconsistent with effective cash flow hedging.

What do these results mean for regulators and standard setters? One could interpret these findings as evidence that even though derivative strategies are not transparent within the financial statements, the financial statement users are apparently able to correctly infer the valuation relevance of the strategies. The results for the group of "effective cash flow hedge" firms are consistent with the predictions even though the financial statements do not present the "effective cash flow hedge" positions explicitly. The lack of a significant result for firms in the "ineffective cash flow hedge" group is consistent with the findings by Collins and Salatka (1993) concerning the ERC/reporting quality relation. Firms in this group disclosed an interest rate swap as an interest rate

risk management tool but the direction of the swap, given the interest rate sensitivity of the firm, was inconsistent with an effective cash flow hedge, and the ERCs did not change in response to the strategy. [48]

8.2 Limitations and suggestions for future research

One potential limitation of these results is the size difference between the firms effective cash flow hedging firms and ineffective cash flow hedging firms. As discussed in Chapter V, the ineffective cash flow hedging firms were larger on average than the effective cash flow hedging firms as shown in Table 5.4. Therefore, it is possible that the lack of significance for the swap activity is because for the larger firms the swap activity is not economically significant enough to impact the persistence or ERC. Table 5.11 also indicates that the interest expense to sales ratio is smaller for the ineffective cash flow hedging firms, another possible indicator of economic significance. Future research will need to address the size differential to rule out this limitation.

Another potentially limiting factor is the self-selection issue for the treatment firms. While attempts have been made to control for a variety of firm characteristics, there could still be omitted variables that are not captured in this dissertation.

This dissertation makes predictions about changes in persistence and ERCs. It

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[48]Some interesting implications of these findings concerning the most recently proposed accounting guidelines are as follows:

(1) firms may be hedging cash flows effectively through case 4 but this case would be reported as a fair value hedge under the latest FAS exposure draft, without cash flow effect transparency, and

(2) a case 2 strategy would be accounted for as a cash flow hedge but firm-wide cash flow exposure would not be decreased by this strategy.

These contradictory disclosures underscore the board's desire to eventually require firm-level assessment of hedging strategies as stated in paragraphs 161-164 of the FAS exposure draft dated June 20, 1996.

does not address changes in predictability, a concept discussed by Lipe (1990). The data gathered for this dissertation could also be used in an examination of predictability of earnings following implementation of a derivative strategy.

The findings suggest that the interest rate management strategies taken by firms are valuation relevant. The results add empirical evidence to the mostly theoretical-based literature on the role and impact of hedging at the firm level. An interesting empirical question for future research will be to see how the persistence and ERC impacts are affected by changes in the reporting requirements.

The sample used in this study can also be used in future research of finance related value relevance hypotheses. For example, the investment protection hypothesis implies that market-to-book ratios should change for firms that successfully hedge. Data gathered for tests in this dissertation could easily be used to test this hypothesis.

Finally, the evidence provided by this study also adds additional support to the earlier work of Hentschel and Kothari(1995) who concluded that firms were not gambling on average with their derivative strategies. This study makes directional predictions for the impact on persistence and ERCs of effectively hedging cash flows and finds support for an average hedging strategy, thus strengthening the position that on average, firms are not speculating on cash flows with their interest rate swaps.

APPENDIX A

Following the method of decomposing a sequence presented by Enders (1996) using the methodology of Beveridge and Nelson (1981), the stochastic trend of the interest-rate sensitive series, C_t, is found below.

First, stating the model at C_t:

$$C_t = \gamma_t + (D+K)(\alpha + (1-\beta)R_{t-1} + \epsilon_t) \text{ or}$$

$$C_t = \gamma_t + (D+K)\alpha + (D+K)(1-\beta)R_{t-1} + (D+K)\epsilon_t$$

where ϵ is the realization from a random process with $E(\epsilon_t) = 0$ and

$$Var(\epsilon_t) = \sigma^2_{\epsilon},$$

and recognizing $\gamma_t + (D+K)\alpha$ as a permanent deterministic drift in C_t, the stochastic trend of the series is derived by taking the expectation at time t of future C levels:

$$E_tC_{t+1} = (1-\beta)C_t,$$

$$E_tC_{t+2} = (1-\beta)(1-\beta)C_t,$$

$$E_tC_{t+3} = (1-\beta)(1-\beta)(1-\beta)C_t$$

.

$$E_tC_{t+j} = (1-\beta)^jC_t.$$

Now, restating the last expression in terms of the surprise at period t, $(D+K)\epsilon_t$, the permancence factor, Ψ_c, for the series can be summarized as:

$$\Psi_c = (1-\beta)^j (D+K)\epsilon_t \; t, \quad \text{for all periods } t+j.$$

Again, following the method presented by Enders (1996) using the methodology of Beveridge and Nelson (1981), the stochastic trend of the seasonal series, S, is found below.

First, stating the model at S_t:

$$S_t = S_{t-4} + \phi(S_{t-1}-S_{t-5}) + \theta_4 a_{t-4} + a_t ,$$

where a_t is the realization at time t from a random process with

$E(a) = 0$ and

$Var(a) = \sigma^2_a$,

and taking the expectation at time t of future S levels, the stochastic trend of the series is derived as follows:

$$E_t S_{t+1} = S_{t-3} + \phi(S_t - S_{t-4}) + \theta_4 a_{t-3}$$

$$E_t S_{t+2} = S_{t-2} + \phi((S_{t-3} + \phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) - S_{t-3}) + \theta_4 a_{t-2}$$

$$= S_{t-2} + \phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2}$$

$$= S_{t-2} + \phi^2 (S_t - S_{t-4}) + \phi\theta_4 a_{t-3} + \theta_4 a_{t-2}$$

$$E_t S_{t+3} = S_{t-1} + \phi(S_{t-2} + \phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2} - S_{t-2}) + \theta_4 a_{t-1}$$

$$= S_{t-1} + \phi(\phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2}) + \theta_4 a_{t-1}$$

$$= S_{t-1} + \phi^3(S_t - S_{t-4}) + \phi^2\theta_4 a_{t-3} + \phi\theta_4 a_{t-2} + \theta_4 a_{t-1}.$$

Expressed in terms of the surprise at period t, a_t, the permanence of the shock for j periods into the future is found in the term that carries S_t into the future:

$$\Psi_s = \phi^j a_t \qquad \text{for } j<4,$$

and for periods t+4 through t+7, the expectation at t is:

$$E_t S_{t+4} = S_t + \phi(\phi(\phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2}) + \theta_4 a_{t-1}) + \theta_4 a_t$$

$$= (1+\phi^4)S_t - \phi^4 S_{t-4} + \phi^3\theta_4 a_{t-3} + \phi^2\theta_4 a_{t-2} + \phi\theta_4 a_{t-1} + \theta_4 a_t$$

$$E_t S_{t+5} = S_{t-3} + \phi(S_t - S_{t-4}) + \theta_4 a_{t-3} +$$

$$\phi(S_t + \phi(\phi(\phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2}) + \theta_4 a_{t-1}) + \theta_4 a_t - S_t)$$

$$= S_{t-3} + \phi(S_t - S_{t-4}) + \theta_4 a_{t-3} + \phi^5(S_t - S_{t-4}) + \phi^4\theta_4 a_{t-3} + \phi^3\theta_4 a_{t-2}$$

$$+\phi^2\theta_4 a_{t-1} + \phi\theta_4 a_t$$

$$E_t S_{t+6} = S_{t-2} + \phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2} + \phi(\phi^5(S_t - S_{t-4})$$

$$+\phi^4\theta_4 a_{t-3} + \phi^3\theta_4 a_{t-2} + \phi^2\theta_4 a_{t-1} + \phi\theta_4 a_t)$$

$$= S_{t-2} + \phi^2(S_t - S_{t-4}) + \phi\theta_4 a_{t-3} + \theta_4 a_{t-2} + \phi^6(S_t - S_{t-4}) + \phi^5\theta_4 a_{t-3}$$

$$+\phi^4\theta_4 a_{t-2} + \phi^3\theta_4 a_{t-1} + \phi^2\theta_4 a_t$$

$$E_t S_{t+7} = S_{t-1} + \phi(\phi(\phi(S_t - S_{t-4}) + \theta_4 a_{t-3}) + \theta_4 a_{t-2}) + \theta_4 a_{t-1} +$$

$$\phi(\phi^6(S_t - S_{t-4}) + \phi^5\theta_4 a_{t-3} + \phi^4\theta_4 a_{t-2} + \phi^3\theta_4 a_{t-1} + \phi^2\theta_4 a_t)$$

$$=S_{t-1} + \phi^3(S_t - S_{t-4}) + \phi^2\,\theta_4 a_{t-3} + \phi\,\theta_4 a_{t-2} + \phi^7(S_t - S_{t-4})$$

$$+\phi^6\theta_4 a_{t-3} + \phi^5\,\theta_4 a_{t-2} + \phi^4\,\theta_4 a_{t-1} + \phi^3\,\theta_4 a_t$$

which in terms of the surprise at period t, a_t, (found by gathering terms for S_t and a_t) is as follows for these four periods:

$$\Psi_s = \phi^{j-4} a_t + \phi^j a_t + \phi^{j-4}\,\theta_4 a_t \qquad \text{for } 4 \le j < 8,$$

and the process continues likewise for periods beyond j+8.

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