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A disaggregate approach to accounting based measures of systematic risk

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The University of Wisconsin - Madison, 1988

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submitted to the Graduate School of the
University of Wisconsin-Madison in partial fulfillment of
the requirements for the degree of Doctor of Philosophy

by

THOMAS ALAN BUTTARS

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A DISAGGREGATE APPROACH TO ACCOUNTING BASED MEASURES OF SYSTEMATIC RISK

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Table of Contents

List of Tables

List of Chart, Figure and Exhibit

Introduction

With the advent of the two-parameter portfolio model and efficient market theory in the mid to late 1960's, the perceived role of accounting information by the securities market changed. No longer, theoretically, should one use the information to search for over or undervalued securities, since these are unlikely to exist in an informationally efficient market. Rather a new role of accounting information should be to aid in assessing the systematic risk of the individual security and assessing its contribution to the systematic risk of the portfolio.

Can accounting information be useful in the assessment of market risk? Beginning with the seminal study by Beaver, Kettler, Scholes (1970) researchers have tried to answer this basic question phrased in slightly different ways. First through correlation analysis and later through various regression techniques, accounting information has been used to build models that will predict beta (β), the firm's systematic risk. While the results have been mixed, the research has shown that accounting numbers are associated with β. The purpose of this study is to approach the above question from a different point of view, correct what the author sees as problems with the past methodology and provide information on the usefulness of accounting data for the prediction of β. More specifically, the research question for the present study can be stated as follows: "Is accounting information alone sufficient for prediction of an individual firm's β over a short time interval?" If answered in the affirmative, it can be said that accounting data may have a very useful role in capital market decisions. If answered in the negative, accounting data would have proved to be less useful in the prediction of β.

Chapter 1 deals with the past approaches to the problem, what the author sees as problems with these past approaches and why the methodology of this study provides an improvement. Chapter 2 discusses problems of β estimation and how these problems may effect the present study. Chapter 3 deals with the research design, subsections include an overview of the methodology, descriptions of firm selection and data sources, and a detailed discussion of the methodology. Chapter 4 presents the results and Chapter 5 the analysis and conclusions.

Chapter 1

This chapter is composed of two major parts. The first part contains a discussion of past research on the association between beta (β) and accounting numbers. The second describes and evaluates some problems with those studies.

I. Past Research

The decade of the 1960's saw great development in the area of finance theory with the introduction of modern portfolio theory, the market model and the Capital Asset Pricing Model (CAPM). These advances in finance theory gave birth to market based empirical research in accounting. One of the first investigations into the role accounting numbers might play in the market using these financial models was the study by Beaver, Kettler, and Scholes (1970)(BKS). One implication of the CAPM is that the only variable which determines differential expected returns among securities is the systematic risk coefficient, β. BKS was the first study to investigate the relationship between a firm's β and accounting based measures of risk (Accounting Risk Measures, or ARM's). The author feels BKS is one of the best studies in the area, but its results are limited by the lack of data available in 1968-1970 when the study was performed.

BKS used all the data available on the CRSP tapes (monthly returns) and the COMPUSTAT tapes (annual report numbers) in their study. Two nine year periods were used to estimate β from the market model, 1947-56 and 1957-65. β was estimated for each period by using an ordinary least squares (OLS) regression of monthly returns against Fisher's link relative index, an equally weighted index of the market returns. The ARM's used were generated by, in essence, trial and error. The authors used ratios and other accounting data from the annual reports that they postulated were associated with risk, and kept trying data until they found what worked best. They finally choose seven accounting measures (those that worked best) that were generated as averages over each of the nine year periods. The first stage of the study associated β with the ARM's by contemporaneous correlation analysis. The second part of the study used a stepwise regression procedure to associate the ARM's from the first period with the β estimated from the second period. This analysis was done at the individual security level and with portfolios of 5 securities. It must be noted however that the regression analysis is cross-sectional in nature. For the individual firm level, each firm is a separate data point set, while for the portfolio level, each 5 firm portfolio is a separate data point. The

BKS results showed significant contemporaneous correlations for some of the ARM's, allowing securities and portfolios to be ranked essentially the same by either β or the ARM's. The final predictive regression model used only three of the ARM's and predicted better than a simple model of no change in β based on several error measures.

Gonedes (1973), in a study with a similar objective, used seven years[1] of monthly returns to generate β to test the association between it and selected ARM's. The ARM's in Gonedes were limited to measures of income variability with industry income and with economy wide income, especially the "accounting β."[2] While he found significant correlations between β and some income variability measures, especially the scaled difference in earnings, his results in regard to the "accounting β" were at odds with BKS. Gonedes found "no strong association"[3] between β and "accounting β." In contrast, "accounting β" was one of the ARM's for which BKS found significant correlation. Gonedes

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[1] Gonedes chose a seven year estimation period because he found β estimates over that time period to have the greatest predictive efficiency.

[2] The "accounting β" is the covariability of the firm or portfolio earnings with the earnings of the market, usually all COMPUSTAT firms.

[3] Gonedes (1973), p. 436.

attributed this difference to the scaling factor used by BKS, the market price per share. He felt that the use of a market factor to scale the data biased the results toward finding a correlation. Gonedes scaled with total assets.

A later study, Beaver and Manegold (1975), directly addressed the criticisms of Gonedes. Beaver and Manegold used multiple periods to estimate both OLS and Bayesian revised β's for the samples employed by both BKS and Gonedes. These were compared to "accounting β's," both OLS and Bayesian revised, by correlation analysis. The results confirmed the BKS findings of a high correlation between β and "accounting β," whatever the scaling factor. This study also introduced to the accounting literature Bayesian revision estimates as a way of lessening the errors in estimation of β within the market model.

During the same period of time, research on the market model coefficients was being published in the finance literature by Rosenberg and his associates. In Rosenberg and McKibben (1973) and Rosenberg and Marathe (1975) instrumental variables, consisting of accounting, market and economy wide variables, were used as independent variables in a two stage regression analysis with β as the dependent variable. The thrust of this line of research was the prediction of both the systematic component of risk, β, and the residual or nondiversifiable risk ($\alpha + \epsilon$ in the market model) of the firm. β was estimated with monthly data using the OLS estimation. The final model of Rosenberg and Marathe used 80 instrumental variables. The conclusions, in part, indicate that accounting variables significantly add to the predictive ability of the models.

Eskew (1979) performed a replication of the BKS study with extensions and some modifications. His set of accounting variables contained all those of BKS. In addition he included ARM's based on earnings variability and covariability ("accounting β") scaled by net worth. With the recent availability of a value weighted index, Eskew estimated β using this index for three estimation periods of 72 months each. He fitted several models, one of which was the regression model of BKS which measures the association between ARM's and β. In addition, he fitted models which impounded the mean reverting properties of the accounting numbers. The β predictions of these models were compared to the simple BKS models and more sophisticated financial models that incorporate the mean reverting properties of β and Bayesian revision estimates of β. As in the prior studies, Eskew found that the accounting based models slightly but consistently out-performed the market based models in prediction of β.

Elgers (1980) carried the model building further and introduced a new method to evaluate prediction errors. This study used two five-year periods of monthly return data and the CRSP value weighted index to estimate β by OLS and two Bayesian methods. All three of these β's were used as dependent variables for model fitting. The independent variable set consisted of 28 accounting variables and stepwise regression was performed on the variables themselves and on a set of components generated from them by principal components analysis (PCA). The result was six accounting based models, three with the ARM's alone and three with PCA variables. For each of these variable sets β was estimated using OLS and each of the two Bayesian methods. The predictions from these models were compared to those of a simple model predicting no change in β for each of the three estimation methods. Rather than using a simple error metric to evaluate the predictions, however, the mean square error was decomposed into bias, inefficiency, and random error. While the simple models showed higher mean square error, the accounting based models showed consistently higher random error. Elgers used this result to conclude that if simple models are adjusted with Bayesian methods, accounting numbers will not significantly improve the prediction of β; rather they will introduce random error into the forecasts.

These studies constitute the major empirical work seeking to estimate β by use of accounting numbers. For purposes of the evaluation to follow, it should be noted that each of these studies (and all studies of which the author is aware) have used: (1) monthly security returns to estimate β, (2) annual accounting reports to calculate the ARM's, (3) cross-sectional regressions for the model fitting process, and (4) some form of "accounting β" as one of the ARM's.

II. Problems With Prior Research

There are several problems with employing the designs used in previous studies to address the research question of this study. In addition, several problems exist for all research of this kind. These problems are: the length of the estimation period to be used, timing issues, cross-sectional regression model issues, collinearity of the ARM's, and the theoretical justification for use of the ARM's. This subsection addresses these problems in the context of the research objective of this study.

A. Length of the Estimation Period for Beta

The use of monthly returns to estimate β requires that a relatively long period of time be used. The above studies used periods of five to nine years in order to estimate from a large enough number of observations to avoid errors in the estimates. Unfortunately, the use of such a long time period causes serious problems in the use of the models. When the above studies test their β predictions against the observed β for the future period, that future period is also five to nine years long. Since β must be estimated over such a long time period, what is observed is really the average β over that period. What the above studies really state is, "Given the accounting information at a point in time, I will tell you what the average β will be over the next five to nine years." This author maintains that if the accounting information is to be useful to the investor in assessing risk, a much shorter horizon for prediction must be used. This is not meant to be critical of the prior research whose major thrust was to demonstrate an association between accounting numbers and the firm's β. Further, when many of the above studies were performed, monthly data was the only data available. Nevertheless, when an investor receives an accounting report and wants to decide on a trading strategy, that investor is interested in the exposure to risk of his/her portfolio during the period up to the next data release, at which time he/she will update the trading strategy again, and potentially adjust the portfolio.

B. Timing Issues

Timing considerations are also important in regard to the above research. Several of the studies use contemporaneous association measures. If the objective of the model is the prediction of β, then an association is needed between the ARM's at their release date and the β for the period following that date. If we state that the accounting data at time t is associated with the observed β in period t, and therefore the accounting data at time t will predict the β in period t+1, we are relying on β stationarity. If β is stationary, then there is no reason to conduct this line of research. Measure β now and that is what it will be next period. This is the naive model of no change in β that is typically used as a benchmark to test predictive ability of more sophisticated models in most studies. If β is not stationary, models must be built by associating the ARM's with the β in the following period to be a valid prediction.

Another timing issue is the availability of the data at the point when the prediction is made. Some of the above studies have assumed that the accounting data is instantly available. For example, balance sheet data is assumed available at the balance sheet date, usually December 31. Of particular note in this regard are the Rosenberg studies. Commenting on Rosenberg and McKibben, Beaver and Manegold state,

> The variable forecasted was future conditional return (i.e., conditional upon the beta forecast and perfect knowledge of future return on the market portfolio), and their beta forecast assumed perfect knowledge of the accounting variables in the forecast period.[4]

In a similar vein, Foster observes,

> It is important to note that Rosenberg and Marathe assumed foreknowledge of the `fundamental descriptors' in the period being forecast. In practice, the forecasting ability of their techniques would be jointly dependent on the structural model and the ability to forecast the "fundamental descriptors" in the structural model.[5]

The Rosenberg studies were not the only ones to assume the existence of data that was not yet available. Each of the above studies adopted as an ARM some form of earnings covariability with the market earnings, i.e. "accounting β."

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[4] Beaver and Manegold, p. 235.

[5] Foster (1978), p. 286, note 17.

Six of Elger's 28 accounting variables were some form of accounting earnings covariability. It should be noted that this variable cannot be calculated at the release date of the accounting report. Since earnings for all firms in the market are needed, this data does not become fully available until the last firm in the market releases its report. The above studies used the earnings of the COMPUSTAT firms in computing the "accounting β." However, the researcher must wait even longer for COMPUSTAT type data to become available, as it is not available at the release date of the last firm's accounting report and certainly not at the balance sheet date.

C. Cross-sectional Regression Models

Problems are also caused by the use of cross-sectional models for two reasons. First, if the significance of an accounting ratio's value in predicting β is sought, using a cross-sectional model may lead to coefficients that reflect the average relationship between the ARM and β across the sample of firms rather than the individual firm's sensitivity to changes in the ARM. Also, since the same level of a ratio may mean different things in different industries, coefficients estimated using cross-sectional models may be distorted by the nonhomogeneity in the information reflected by an individual variable across firms and across industries. For example, if leverage is used to reflect an accounting measure of the operating risk of a firm, cross-sectional differences in leverage may not appropriately reflect cross-sectional differences in firm risk if the average leverage ratio varies across industries.

In addition, differing interpretations occur within the same ARM if we are at the individual firm level versus the aggregate level. For example, an ARM which is used by BKS, Beaver and Manegold, Eskew, and Elgers is firm size. This variable is also addressed by Bowman (1979), discussed later. It has been found at the aggregate level that the bigger the firm, the smaller the β. At the individual firm level, size could show how β is affected when the size of the firm changes. Does the β necessarily decrease as the firm expands or is size proxying for some other variable that has been omitted from the model? The individual firm level analysis allows different questions to be asked.

Second, if the objective of β prediction is to update β estimates at the time of the release of new accounting information, then cross-sectional models may be impossible to implement since each firm in the cross-section will not release new accounting information at the same time. Therefore, in the extreme, if only firm A releases accounting information at time A and all other firms in the cross-sectional model release information at other times, then the firms other than firm A will be useless in providing information to update the model's prediction of risk for firm A. Again, individual firm models estimated with data across time do not suffer from this problem. While these models suffer from other problems, individual firm models are employed in this study.

D. Collinearity Between ARM's

In order to form the optimal predictive model, as many variables as will improve the predictions should be used. The early studies in this area (BKS) used as few as three variables in their regression predictive model. Though more variables could improve the predictive ability of the models, large numbers of accounting variables will cause problems of multicollinearity. Note that the Rosenberg and Marathe study settled on a model using 80 "fundamental variables" with no correction for potential collinearity problems. BKS discussed this problem in their study and decided to omit correlated variables, which is one reason they used only seven candidates and so few variables in the final model. Elgers' use of the PCA technique allows many variables to be used without the problems of multicollinearity. In any case, the design employed by any study in this area must address collinearity problems or be cognizant of its effects on the estimation of regression model coefficients. This study will utilize the PCA technique.

E. Theoretical Justification for Inclusion of ARM's

A final problem in β prediction research deals with the lack of theoretical work delineating variables to be included in these models. The perfect accounting based prediction model would include only accounting variables that are associated with β on both an empirical and theoretical level. Bowman (1979) addresses the theoretical relationship between some of the ARM's used in the above studies and β. Bowman finds theoretical support for only two of the ARM's, leverage and earnings covariability (the "accounting β"). These two ARM's are flawed, however. In order to derive the theoretical relationship for leverage, the market price of the firm's debt and the market price of the firm's equity must be known. These are not accounting numbers. Thus, Bowman's study adds no theory to the analysis of pure accounting risk measures. In addition, as discussed above, the "accounting β" is itself a market concept. So, if market variables are included in the model, there is theoretical support for some of them, but there is still no theoretical support for any of the accounting variables having an association with β.

F. Summary

Several problems exist with the prior research associating β with ARM's. These problems as discussed above are: the length of the estimation period to be used, timing issues, cross-sectional regression model issues, collinearity of the ARM's, and the theoretical justification for use of the ARM's. To avoid these problems to the greatest extent possible, this study will use daily return data, estimate β quarter by quarter, use only accounting report data for ARM's, employ individual firm modeling, and utilize principal components analysis. The complete research design is presented in Chapter 3.

Chapter 2

Beta and Beta Estimation

The definition and estimation of the value of β is open to controversy depending on the use to be made of the estimate. Most of this controversy results from the fact that β is not observable. We observe the last trade on the New York Stock Exchange to obtain the closing price of a particular security. From this and dividend data, the return on the security is computed. Indices reflecting the return on the market portfolio can be calculated by various aggregations of the returns on the individually traded securities. From these security returns and the market return indices, the β can then be estimated. Both the method of estimation and the index chosen must be addressed when designing research of this type.

I. Beta Estimation Procedure

The market model and the Capital Asset Pricing Model (CAPM) define the β of security n as follows:

$$\beta_n = \frac{\text{covariance}(r_{n,t}, r_{M,t})}{\text{variance}(r_{M,t})}$$

Where $r_{n,t}$ = the return on security n at time t and

$r_{M,t}$ = the return on the market at time t, the index.

The theoretical derivation of β and the two parameter model is explained in Fama and Miller (1972) and Fama (1976). Early studies in finance and accounting estimated this value by ordinary least squares (OLS) regression of the portfolio return against the return on the market portfolio. Possible problems with the OLS estimation of β exist, however, and are addressed by Vasicek (1973) in the following:

> To illustrate this point, assume that the estimated beta of a stock traded on the New York Stock Exchange is b=.2. In the absence of any additional information, this value is taken by sampling theory as being the best estimate of the true beta <u>because</u> any given true beta is equally likely to be overestimated as underestimated by the sample b. This, however, does not imply that given the sample estimate b, the true parameter is equally likely to be below or above the value .2. In fact, it is known from previous measurements that betas of stocks traded on the New York Stock Exchange are concentrated around unity, and most of them range in value between .5 and 1.5. Thus, an observed beta as low as 0.2 is more likely to be a result of underestimation than overestimation. The question of whether the estimate b is equally likely to lie below or above the true beta is irrelevant, since the true beta is not known. What is desired is an estimate such that given the sample information (which is available), the true beta will with equal probability lie below or above it.
>
> To pursue this example further, assume that there are 1000 stocks under consideration, the betas of which are known to be distributed approximately normally around 1.0 with standard deviation of .5. Each of the true betas is equally likely to be underestimated or overesti-

> mated by b. Therefore, there are 500 stocks with true beta higher than the observed estimate, and 500 with true beta lower than the estimate. If an estimate of b = .2 is observed, the stock might be any of the approximately 500 X .945 = 473 stocks with β larger than .2 and underestimated, or any of the approximately 500 X .055 = 27 stocks with β smaller than .2 and overestimated. Apparently, given the sample and our prior knowledge of beta distribution, the former is much more likely, and thus, it is not correct to take .2 for an unbiased estimate.[6] (underline in original)

From this point, Vasicek goes on to develop a Bayesian process for estimating β.

While OLS estimation provides the minimum variance estimate for β for the given sample of returns, the above or similar arguments have been used to draw the conclusion that OLS estimated β's are biased. This is a recurring issue in both the accounting and finance literature. Because of this bias, Bayesian estimations introduced by Vasicek (1973) and Maier et. al. (1977) have become common. However, the only way to prove an estimator is biased is to measure it against the true value when known, or show that the procedure itself creates bias. As to the former, this is impossible since β is unobservable. As to the latter, if the assumptions of the regression model are met, the OLS procedure produces unbiased estimates. It may well be that

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[6] Vasicek (1973), p. 1234.

OLS estimation produces biased estimates through violation of the statistical assumptions, but without a "true β," it is impossible to know the size and direction of the bias.

The above arguments of Vasicek also stress the "true beta," in the sense of an unchanging attribute of the firm. Most of the early research in accounting and finance estimated "true β" using models that assume β stationarity. If β is stationary, then estimates over different time periods, or with different data should produce an unbiased estimate of the "true β" hindered by sampling error only. If β is stationary, as Vasicek seems to assume, then his arguments are much more persuasive. Yet, if β is stationary, then the research in this and many other studies is futile. The best estimate of next period's β is the measured β of this period, sampling error or not. The problem of the most appropriate method of measuring this period's β would remain, however. If β is not stationary, but varies widely from period to period (or if the stocks come from a distribution with a mean NOT equal to 1.0), then the arguments of Vasicek do not seem relevant. In his example, the observed value of .2 could have equal probability of over or underestimation if β varies widely. Thus, for any one security, the OLS estimated β could be unbiased, by Vasicek's standards of bias, if β is nonstationary.

Some recent research in finance has addressed the process by which β is generated, and therefore the appropriate method of measuring it, when β is assumed to be nonstationary. Fabozzi and Francis (1978) state the following as an overview:

> Econometricians assign models with changing regression parameters to essentially one of the following four categories:
> (i) random coefficients model (RCM hereafter)...,
> (ii) the model of shifting regimes...,
> (iii) models with sequentially varying coefficients obeying a Markov process (Kalman filter techniques)..., and
> (iv) models with systematic parameter variation....
>
> The literature suggests that instability of beta systematic risk coefficients ... in the single-index market model...may result from any of the four processes outlined above.[7] (citations deleted)

In addition, they provide some evidence in support of the use of a random coefficients model when estimating β within the Single Index Market Model for some New York Stock Exchange firms. They conclude..."the true beta is moving randomly while the OLS beta is a point estimate which is invariant over the sample period."[8] Garbade and Rentzler (1981) extend the above research by introducing a test to

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[7] Fabozzi and Francis (1978), p. 101.

[8] Ibid. p. 111.

determine whether β follows a random coefficients or a random walk process. However, they provide no empirical test to assess which form of nonstationarity exists in the Fabozzi and Francis sample.

Other research has provided evidence of the nonstationarity of β and some have introduced alternative methods to alleviate this problem. For example, Chen and Lee (1982) provide evidence that, using a derived Bayesian estimator, β is random (nonstationary) over time for firms in the Dow 30. Fisher and Kamin (1985) introduce an improved Kalman-Filter (weighted least squares) technique to predict β with the assumption that β follows a random-walk process for overlapping periods of monthly data. Hays and Upton (1986) investigate β estimation from a shifting regression regimes approach and found that regime shifts were large and frequent, implying that both α and β should be corrected for these shifts.

The above studies were concerned with the prediction of β from past return data and the improvement of β estimation procedures based on an empirically derived or assumed process of β change. All these studies used monthly returns for long time periods, generally five years, and in some instances, used overlapping time periods to estimate β. If β changes suddenly, as in the shifting regimes approach (or as in a time series intervention), use of data prior to the change can only force the estimate away from the value that would be obtained by using only data subsequent to the change. This would argue against using overlapping periods and is contrary to Fisher and Kamin (1985) which recommended using as many data points as possible when estimating β. However, even they recognize the inappropriateness of using very old data to obtain high quality estimates of β. It would seem that if daily data is available, the appropriate time period to use when estimating β for period t+1 is a quarterly interval. This will assure that enough data is available to estimate β and will avoid the problem of overlapping periods. When successive β are estimated using overlapping periods, each computed β shares observations with the β before and after it in the series. This means that β will change slowly, or drift, and the estimate becomes essentially a moving average. This would create problems for this study, since the prediction of β with ARM's seeks to associate immediate changes in β with the release of accounting data directly prior to the change.

In regard to the β estimation procedure, the change in β is important to the present study, but the process of this change, whether RCM, random walk, shifting regimes, etc., is not. Since the present study seeks to predict the average β over the next quarter through the use of Accounting Risk Measures (ARM's), in estimating, fitting and testing the model, the average β during each interval over the experimental period is all that is needed. Fisher and Kamin (1985) criticized OLS with the following statement: "To forecast beta under OLS assumptions, we actually estimate the average value of beta during the sample period."[9] But this is what is desired for the present study. Thus, what is of concern to this research is that the estimation technique adopted captures the central tendency or average β for each interval in question. Whether this procedure is simple OLS or some other OLS based procedure is next to be addressed.

A real source of potential bias in OLS estimates of β is the nonsynchronous trading of securities on the major exchanges. With the availability of daily security returns, more frequent estimation of β within shorter intervals becomes possible. Daily data, however, is more susceptible than monthly data to the problems resulting from non-continuous trading. Securities trade on the exchanges at discrete intervals and the closing price is based on the last trade of the day. For less actively traded stocks, the last trade of the day might be in the morning of that day or even

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[9] Fisher and Kamin (1985), p. 134.

several days before. For infrequently traded stocks, there might be several days of no trading activity. For a no trade day, the listed return would be zero rather than the true return on the security. The mismatching of the individual security trading time with the market trading time "introduces into the market model the common econometric problem of errors in variables."[10] "With errors in variables in the market model, ordinary least squares estimators of both alphas and betas for almost all securities are biased and inconsistent."[11] While the firms used in this study are all actively traded, the market indices are composed of all stocks, including those infrequently traded. This results in the bias mentioned above. Scholes and Williams (S&W) show information on the distribution of this bias for both high and low β firms as opposed to the median β firms. Because of this bias, simple OLS procedures will not be used in this study. The S&W procedure to adjust for the nonsynchronous trading of securities will be the one employed to estimate β from daily data. This procedure, detailed in Chapter 3, provides "computationally convenient consistent estimators"[12] of β using OLS based procedures.

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[10] Scholes and Williams (1977), p. 311.

[11] Ibid., p. 310.

[12] Ibid., p. 316.

II. Index Measure Chosen

A final potential problem in β estimation is choosing which index to use. The theoretical market index is a weighted average return on all investment assets. This market portfolio would include stocks, bonds, options, gold, real estate, and anything else held, bought or sold. That should also include works of art, stamps, and even, lately, comic books. Clearly such an index is not available and accounting and finance research has commonly assumed that adequate β estimates can be derived with indices made up of stock returns only. But which stock index? Roll states:

> ...corresponding to every index, there is a beta for every individual asset (and thus for every portfolio); but these betas can be different for different indices and will be different for most. To consider the beta as an attribute of the individual asset alone is a significant mistake. For every asset, an index can be found to produce a beta of any desired magnitude, however large or small...[13]

Roll wrote this as part of his criticism that the securities market line is an inappropriate way to judge the performance of portfolio managers. Fortunately, the choice of an index may not be effected by this criticism for this study. Empirical research in accounting and finance has indicated that the values of β obtained using different

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[13] Roll (1978), p. 1056.

broadly based indices are highly correlated. Since this study is not particularly concerned with the absolute value of β or its relative ranking across a sample of firms, but rather with a model's ability to predict the future β value (i.e. the change in β), the choice of an index, as long as it is broadly based, is not subject to these concerns. What is needed is an index measure that derives β estimates that accurately reflect the change in β over time for an individual firm. No evidence exists to help with this selection process. Thus, for this study the CRSP value weighted index was chosen since it is broadly based and more theoretically correct than the equal weighted index.

For this study, the β computed using the S&W procedure and the CRSP value weighted index will be the benchmark upon which to measure the performance of the generated model. It is hereafter referred to as the observed or measured β.

Chapter 3

The Research Design

This chapter consists of four parts. First the research question is reviewed. This is followed by a section describing the procedures used to select the sample and a section on the definition, computation and selection of the accounting risk measures. The chapter ends with a discussion of the methodology used in the study.

I. Overview

The release of quarterly and annual financial reports to the investors allows the opportunity for the revision of expectations about the risk and return of an individual security. Portfolio theory would suggest, and this study proposes, that when this information is received by the individual investor, the investor trades or holds the particular security based on its new expected risk and how that risk contributes to the overall risk of the investor's portfolio. The result of this trading activity on the market as a whole should result in a relationship between the accounting data in the reports and the β observed for that security in the period following the release of the reports. It is this relationship which allows the building of the predictive models that have been used in past research and in this study. Because of this orientation, only accounting risk measures generated from data actually available were associated through a predictive model with the β observed in the quarter following the date of the report.

The observed β for each period was estimated from daily returns starting the day the report was issued and ending the day prior to the release of the next report. The estimation technique used was that of Scholes and Williams (S&W)(1977). This technique adjusts daily returns for the problems encountered because of the nonsynchronous trading of securities on the exchanges, and provides consistent estimates of β. Daily return data was used since quarterly β estimates were needed and only daily data provided a sufficient number of observations to fit the predictive model. In addition, the use of daily data allowed the association of β with each release of quarterly accounting data.

The accounting numbers contained in the quarterly and annual reports were used to form the accounting risk measures (ARM's). These ARM's were subjected to a principal components analysis (PCA) to reduce the volume of data for the final regression and to provide a data set more in keeping with the statistical assumptions of the regression technique. PCA reduces the data set by forming a set of components, each of which is a linear aggregate of the standardized individual accounting variables (ARM's). The advantage of the technique from a statistical point of view is that each of the principle components is orthogonal to all the others. By construction, the components have no problem with collinearity that most certainly exists among the ARM's prior to the PCA.

The entire process of estimation, analysis and model building was done on an individual firm basis over time. Most of the work in this area has been done across firms at a point in time or across firms and across time. The individual firm approach allows different questions to be asked and answered (see Chapter 1) and controls for potentially disruptive effects, such as lack of data availability, industry effects, and the differing definitions of the ARM's due to different accounting methods.

The specific research question addressed is as follows: "Is accounting information alone sufficient for prediction of an individual firm's β over a short time interval?" The question was operationalized by comparing the experimentally created model with two naive models on a mean absolute error basis. The naive models were; β=1.0, and no change in β. Specifically, the β computed by the S&W procedure (the observed β) was compared to the β predicted by both the naive and experimental models. If the experimental model had a consistently lower error than the naive models, then the experimental model was judged to be successful and accounting data alone was proven useful in prediction of β.

II. Firm Sample Selection

The sample of firms used in this study are a subset of all firms listed on the CRSP daily data tapes. The sample was also constrained by the following selection characteristics: (1) industry group membership, (2) listed exchange of trading, (3) continuity of return data, (4) absence of large number of zero return days, (5) degree of association with the market index, and (6) the firms standard deviation of β in the estimation period.

The procedure used to select the sample firms required inputting the entire data for the firms on the CRSP tape into a FORTRAN program that contained screens to reject firms that did not meet the following criteria. First, a screen for industry group was used to exclude firms with SIC codes below 2200 and above 3990. Firms with SIC codes below 2200 are classed as agriculture, mining, oil exploration, food production, and tobacco. Firms with numbers above 3990 fall into regulated areas such as transportation, communications, utilities and banking, or into the wholesale and retail sales and service areas. It was felt that, for this study, the sample should be restricted to the industrial manufacturing firms that fall in the specified range. It was feared that including regulated firms in the sample would create problems due to their special reporting requirements. Also, since the research hoped to find a single group of ARM's for all the firms in the sample, some degree of homogeneity was desired. For example, it is hard to believe that the inventory turnover ratio would be associated with risk for a service firm whose inventory is immaterial.

The second screen eliminated firms that were not listed on the New York (NYSE) or American Stock Exchanges. It was felt that the larger, more actively traded firms listed on these exchanges would provide more reliable results. However, due to additional selection criteria, all firms in the final sample were NYSE firms.

The screen for continuity of return data was a two stage process. First the firm was tested to determine if it had returns available on the CRSP tape for the period beginning with January 2, 1971 and ending with December 31, 1982. This interval corresponds to the estimation period needed to fit the individual firm β prediction models. The second part of the screen was a check for missing data. Since CRSP enters missing data as a large negative number, the data must be corrected by setting this number to zero. While setting the missing returns to zero, a counter was included to delete any firm with more than 605 missing daily returns. 605 is an arbitrarily chosen cutoff representing 20% of the daily returns over the 12 year estimation period. Of the final sample of firms only 4 firms had missing data; one had three missing returns and three other firms had only one missing return each.

Since the study seeks to find a predictive model for β by using accounting numbers, β must vary. If one assumes that β is stationary, then the best predictor of β_{t+1} is β_t. Furthermore, since the dependent variable in the final regression model is the observed Scholes and Williams β, it was necessary to identify firms with a high variability of this β. The more β varies, the more likely the experimental model will identify the association between the variance of β and the variance of the ARM's. If a random sample were to select firms where the regression dependent variable, β, did not vary at all, it would then be impossible to find any association between the dependent variable and the independent variables, the ARM's. If this were to be the case, the study would certainly fail.

In addition, firms were chosen that had a high association (R^2) between the market return and the individual firm's return since if this association (R^2) is low, little of the variance in the individual firm's return is explained by the market return. Therefore, a low R^2 implies that the market model does not hold for this firm in this time interval. As β is a coefficient in the market model, its usefulness as a risk measure is suspect since it is difficult to impart a risk interpretation to a parameter in a model that has no association with the variance in the dependent variable, β. In this sense the model is suspect for firms and intervals with very low R^2.

Therefore, to choose these firms, quarterly β's were computed for 48 consecutive 63-trading-day quarters using the CRSP value-weighted index. Over the twelve year estimation period, the average number of trading days per quarter was 63.125 so for calculations related to this screen, a quarter was assumed to include observations for 63 trading days. No attempt was made to insure that the 63 days actually fell on the break of a quarterly reporting period but the 12 year period was segmented into 63-day periods to facilitate the implementation of this screening process. It should be noted that for this screen, the β computed for firm selection was the simple OLS β and not that used by the S&W procedure. Roll (1978) has pointed out that if a firm has a high β using one efficient index, it will have a high β with other efficient indices as well. It might be inferred that if one procedure computes a high β, then a similar procedure would also compute a high β. The OLS β is the central component of the S&W β. It was felt that for a first pass computation of β this procedure would be adequate to identify firms with high β variability even though the β's would not be corrected for problems of non-synchronous trading. In addition, this procedure reduced the complexity introduced in the β estimation process by the S&W procedure. See section 4 of this chapter for more on the S&W β estimation procedure.

The previously mentioned FORTRAN program performed all the computation of β and R^2 for each firm passing the above screens. A β and R^2 value was computed for each of the 48 63-day periods. When these values were examined, the necessity of another screen became apparent. Individual firms had variability in the R^2 value from period to period. It was decided that the chosen firms should have high, or relatively high, R^2 values in all 48 periods. If a chosen firm had a zero R^2 value for a particular period, and some were so low as to essentially be zero, then the corresponding β would be suspect (in the sense discussed above). It was noticed in examining the output of the selection program that a high correlation existed between firms with a large number of zero return days and low R^2 values for that period. Therefore an additional screen was introduced to reject firms that had more than 18 daily returns of zero in any 63-day quarter. This 30% figure was chosen arbitrarily. Several explanations are available for a zero return. (1) The return was missing and set to zero. (2) The firm was not traded that day and so the return was zero. (3) The firm traded but the closing price was unchanged from the previous day. And (4), the firm traded and the closing price was insufficiently different from the previous day to be picked up in a four significant digit return for the CRSP tape. Missing returns and lack of active trading will lower the association with the market and make the study less reliable. This screen, therefore, provides a within quarter test for low R^2 values.

When the above procedures were performed for all firms on the CRSP daily return tape, 176 firms remained. For each of these firms, a β and R^2 value were computed for each quarter, along with an average β and R^2 value across all quarters. In addition, the standard deviation of β across the 48 quarters was computed. The firms selected were those that had the highest average R^2 value and a standard deviation of β above .20. The 34 firms selected, their identification numbers, their average β and R^2 values, and the standard deviation of β along with a summary of industry classifications appear in the Appendix as Table 2.

Note that the above procedures do not result in choosing a random sample of firms, but if a predictive association is to be found and the research is to be given the best chance of finding positive results, the firms must meet the above criteria. Because of the non-random sample of firms, if the experimental model proves successful, its generalizability would be limited, but if the model fails for these firms, it is unlikely it would succeed for other firms.

III. Accounting Risk Measures

For each of the chosen 34 firms, accounting data was collected for the period from 1971 through 1983. Annual data was selected from the COMPUSTAT annual industrial tape. The source of quarterly information was 10Q data filed with the Securities and Exchange Commission (SEC). Since these data are only available after the first quarter of 1971, all data collection efforts began at this point. The SEC stores the 10Q's on microfiche in several of its offices. Data was collected from SEC offices in Chicago and Washington, D.C.

The Chicago office only contains the more recent filings, since 1979, and the complete data set is only available in Washington, D.C.

The data reported in 10Q reports were crucial to this study for two reasons. First, the study requires that β be estimated over each period between quarterly and annual report release dates for the chosen firms. Second, the only source of reasonably complete quarterly data is the 10Q filings at the SEC.

When the SEC receives a filing, be it 10Q, Annual Report, 10K or other, it's receipt is date stamped by the mail room. These date stamps are the most reliable source for the release date of the total information set. Because these dates are not compiled in any place other than on the 10Q or Annual filings during the years of this study, the only source for these dates is the individual microfiche itself. In addition to duplicating the quarterly reports and writing down the dates, the receipt dates for annual reports were also recorded. In determining the appropriate date for the release of the annual report, it was found that the 10K filing date with the SEC was generally two to five weeks later than the date stamped on the annual report. Because of this, the annual date was chosen to be that stamped on the annual report by the SEC. When a date stamp was missing or totally illegible, the average date for the corresponding quarter for the prior and succeeding years was used. Patell and Wolfson (1979) found for their study that firms have a strong tendency to release their quarterly and annual financial reports on or about the same date each year. Because of this, the averaging procedure should provide no major problems for this study. In addition, perusal of the timing of legible stamp release dates confirmed their observation of the same release date for the great majority of firms in this study.

Although 10Q reports are the best source for quarterly data, the information provided therein is not complete. For the period from 1971, when the first filings occur, through the third quarter of 1975, the reports do not contain complete balance sheet information. Instead only a complete listing of stockholders' equity, short-term notes and long-term debt is presented. In addition, no statement of changes in financial position data is disclosed. A sample quarterly filing for 1972 appears in the Appendix and is rather typical of 10Q presentation during these early years. Relatively complete reports start with the first quarter of 1976, including data on assets and a statement of changes in financial position. For all periods, complete income statement data is available.

The lack of full quarterly reports for the period prior to 1976 may not be as great a problem as it first appears. For data that is presented only in the annual report, the last reported figure can be used. It is true that this data is nine months old for the third quarter reports, but this is still the most recent data available to the market and presumably that upon which the investors trade. In addition, APB Opinion No. 28 on "Interim Financial Reporting" requires that if there are significant changes in financial position in the interim period, they must be disclosed in the interim report. If there are no updates of these numbers in the interim reports, the market must presume that there have been no significant changes and trade on this information.

The data collected from the quarterly reports for the 34 firms was entered into a Lotus 123 template for calculation of the ARM's. Since these ARM's are defined similarly across firms and years in the study, and since multiple ARM's share either numerator or denominator, the spreadsheet calculation of these numbers was simple and time saving. The ARM's used in this study were a compilation of those used in either the prior research mentioned in Chapter 1 or those suggested by research predicting failure or bankruptcy [Beaver (1966), Altman (1968), Beaver (1968), Deakin (1972) and Libby (1975)]. Of course, consistent with the objective of this study, only the ARM's that use accounting data alone were selected from these prior studies.

It must be noted that one of the ARM's that has been found to have a high association with β, both empirically and theoretically, could not be used in this study. The calculation of "accounting β" requires knowledge of both the individual firm's earnings and the earnings of all the firms in the market (usually the earnings of all COMPUSTAT firms). Since the earnings of all firms in the market are not usually available at the release of each firm's accounting reports, the "accounting β" must be considered a market variable and excluded from this study. Also, several prior studies used market data such as market value of the firm or price data to scale the accounting numbers. These variables were not used either since the emphasis in this study is on accounting data only. The ARM's and their definitions appear in the Appendix as Table 1.

During the computation of the quarterly ARM's, it was discovered that several firms had to be deleted from the sample due to missing data. Sperry had no 10Q reports available for an entire year. Control Data changed its method of reporting in 1982. The change was so radical that it proved impossible to relate past numbers to the current data to allow restatement to a common basis. Finally, the oil companies presented a great problem. Much time was spent trying to reconcile the numbers from the 10Q with the annual numbers selected from the COMPUSTAT tape. Since this failed, the oil companies were also deleted from the sample. The final sample consisted of 27 firms. See Table 3 in the Appendix for a list of these firms.

Summary of Sample Selection Criteria and Firms Chosen

All firms with return data listed on the CRSP tape, NYSE or AMEX membership, with daily data for the proper interval, and industry codes between 2200 and 3990	= 746
Less: Firms with more than 605 returns missing	= 10
Firms with more than 18 zero return days per quarter	= 560
	176
Less: Firms whose R^2 was less than .325	= 142
	34
Less: Oil Companies	= 5
Control Data and Sperry Corporations	= 2
Total Final Sample	= 27

IV. Methodology

The final model used to predict the one-step-ahead β for this study was fitted by stepwise regression and can be represented as follows:

$$\beta_{n,d}+1 = f\ (\ \text{PCA}\ [\text{ARM's}_{d_1}\ ]\ )$$

where the dependent variable, $\beta_{n,d^{+1}}$ is the S&W β for firm n for the interval d^{+1} which runs from the date of the disclosure release, day d_1, to the day prior to the date of next disclosure release, d_2;

and the independent variable set, PCA [ARM's$_{d_1}$], consists of the principal components of the ARM's disclosed on day d_1.

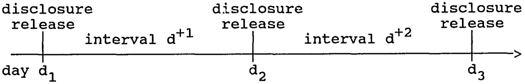

Figure 1

The remainder of this section is composed of four parts discussing dependent variable estimation, independent variable determination, the model fitting procedure, and assessing the fit of the prediction model.

A. Dependent Variable Estimation

The dependent variable (β) for the final regression model was estimated by the S&W technique. For each firm and for each period between report release dates, the following technique was applied to derive a single observation of β.

According to the S&W model, the observed β is calculated as:

$$\beta_n = \frac{b^- + b^0 + b^+}{1 + 2\rho_M}$$

where

$$\rho_M = \frac{\mathrm{cov}(r_{M,t}\ , r_{M,t-1})}{\sqrt{\mathrm{var}(r_{M,t})}\ \sqrt{\mathrm{var}(r_{M,t-1})}} \ ,$$

the simple lag-1 autocorrelation of the market returns; b^-, b^0 and b^+ are the sample values of β^-, β^0, and β^+ respectively; and β^-, β^0, and β^+ are defined as follows:

$$\beta^- = \frac{\mathrm{cov}(r_{n,t}\ , r_{M,t-1})}{\mathrm{var}(r_{M,t-1})} \ ,$$

$$\beta^0 = \frac{\mathrm{cov}(r_{n,t}\ , r_{M,t})}{\mathrm{var}(r_{M,t})} \ ,$$

$$\beta^+ = \frac{\mathrm{cov}(r_{n,t}\ , r_{M,t+1})}{\mathrm{var}(r_{M,t+1})} \ .$$

Finally, the sample values, b^-, b^0 and b^+, were estimated by the following three regressions:

$$r_{n,t} = a + b^- r_{M,t-1} + \epsilon$$

$$r_{n,t} = a + b^0 r_{M,t} + \epsilon$$

$$r_{n,t} = a + b^+ r_{M,t+1} + \epsilon$$

where: r_n = the daily return on firm n,

r_M = the daily return on the market portfolio,

t = a time index in days.

Thus, each observation of β requires three regressions and one calculation of the market index lag-1 autocorrelation. This procedure was applied to the data between release dates of the quarterly or annual reports starting with the first quarter of 1971 and ending with the first quarter of 1984. For most firms, this generated 52 observations of β_n for the quarterly intervals. Day zero was defined as the date the report was released. Each of the three regression models used to fit b^-, b^0 and b^+, were estimated using as many daily observations as possible prior to the next release date. This provided a range of observations that varied from a low of 19 data points to a high of 118 data points. The large difference in available returns between release dates for some firms was caused by the late release of the annual report. The 10Q's, being unaudited, were generally released promptly after the date of the report. This was not so for the audited annual reports. The higher number of returns per regression usually resulted for the interval between the third quarter 10Q and the annual report; the low number usually resulted for the interval between the annual and the first quarter 10Q. The maximum and minimum intervals for the 27 firms in the final sample are listed in the Appendix as Table 3.

For the daily return on the market portfolio, r_M, the CRSP value-weighted index was used. This index is broadly based and being value-weighted, is theoretically correct. The problems in cross-sectional studies with this index have resulted from the sample portfolio comprising too large a percentage of the index. Since the portfolio in this study consists of only a single firm, these types of problems should not result, even if the firm is one of the larger ones on the exchange.

The S&W β's were computed using a technique based on the above regression equations. The appropriate sums of squares needed to calculate b^-, b^0, b^+, their respective R^2's and ρ were generated; these numbers were calculated; and the S&W β's were computed from the CRSP tapes using a special purpose FORTRAN program. A summary of the S&W β's appears in the Appendix as Table 4.

B. Independent Variable Determination

The independent variable set for the final regression model was formed from the 40 ARM variable set computed from the 52 quarterly and annual reports. These variables are listed in the Appendix as Table 1. The original data matrix contained the 40 variables and 52 observations. This data is highly correlated as many of the risk measures have either the same numerator or denominator, or represent different measures of a similar relationship. Because of this correlation problem, the ARM's were subjected to a principal components analysis (PCA) to reduce the size of this data matrix and at the same time assure that the resulting components are orthogonal. After PCA each component is a linear aggregation of the individual standardized ARM's in the original data matrix.

The PCA was performed on a CMS system using the Statistical Analysis System (SAS) software package. In particular, the ARM's for the first 46 (47 through 51) observations were used to calculate the correlation matrix of the input variables, means and standard deviations of the input variables, as well as the eigenvalues, and the eigenvectors of the PCA. The eigenvectors, along with the original data matrix were used to compute the principal component scores for the first 47 (48 through 52) observations based on the means and standard deviations of the first 46 (47 through 51) observations.[14] The result of the PCA was therefore a 40x47 (40x48 through 40x52) matrix of derived variables, the principal component scores, of which the first 46 (47 through 51) were the independent variable

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[14] The SAS routines used for the model fitting were PRINCOMP with the OUTSTAT option to save the eigenvectors and SCORE to compute the principal component scores.

set for the final regression model. The 47th (48th through 52nd) set of principal component scores was not used in the model fitting but became the set used for testing the experimental model's predictions.

C. Model Fitting Procedure

Stepwise regression was used to fit the final model with the first 46 (47 through 51) observations of β from the S&W procedure as the dependent variable and the 30x46 (30x47 through 30x51) matrix of principal component scores as the independent variable set. The last 10 principal components were dropped from the regression since their eigenvalues were less than or equal to .0001, and to five decimal places, 100% of the variance was explained by the first 30 components. SAS was used for the model fitting with default values.[15] These defaults set the significance required for a variable to enter or exit the stepwise model equal to .15. The decision as to whether a variable should exit the model is irrelevant in this study since the input variables are orthogonal. Since the entering component is not statistically related to any component already in the model, it cannot change the significance level of those already there. Hence, once a component enters, it stays. Also, since these

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[15] The SAS routine used was STEPWISE.

components are statistically unrelated, the coefficients of the regression for each component are also unaffected by the presence of additional components.

D. Assessing the Fit of the Model

Several ways are available to judge the "best" model generated by a stepwise regression procedure. The above significance level required for a variable to enter or exit will result in PROC STEPWISE outputting a final model that may not be thought of as the "best" model since it will necessarily include components with a significance of .15 which is higher than traditional significance levels of .05 or .10. Alternately, Mallows' C_p statistic[16] can be used to choose the "best" model. When C_p is at its minimum value, or at a value closest to the number of independent variables in the model plus one for the intercept, this model could be selected as the best stepwise regression model. The R^2 statistic could also be used to evaluate alternative models. However, since the R^2 statistic always increases as

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[16] The C_p statistic was proposed by C. L. Mallows in 1964 as a way of assessing the best fitting model for the all possible regressions or the stepwise regression methods. In addition to the SAS User's Guide: Statistics (1985)(pp. 765 & 6) it is cited in Neter, Wasserman, Kutner (1985)(pp. 426-8) and as the C_k statistic in Miller & Wichern (1977)(pp. 294 & 5).

variables enter the model, adjusted R^2 is a better evaluative statistic. The SAS procedure doesn't produce an adjusted R^2 statistic for the stepwise regressions so the best model was judged to be the last stepwise regression model that added a component with a significance level which was less than .10. The C_p value was also observed to assure that the "best" model didn't vary across these two procedures. In no case were contradictory models selected using these two alternative criteria.[17]

It should be noted that the model fitting process was redone in its entirety for each one-step-ahead forecast. This means re-estimation of the principal components with updated mean and variance standardization were used to compute the new principal component scores inputted when refitting the regression model. Therefore, for each quarter, all available information was used in the generation of a new experimental prediction model for β.

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[17] It may be noted that the stepwise procedure used the default level of .15 for a variable to enter the model even though the selection criteria rejected models containing variables with significance levels above .10. It was necessary to generate these later models to identify the model where Mallows' C_p statistic reached its minimum value and to make sure that a model that would otherwise be the "best" was not ignored if it happened to have a variable enter with a significance level of .1001.

The coefficients from the "best" stepwise regression model were used along with the holdout observations of the principal components for the next disclosure period to compute the predicted β. The predicted β from the experimental model was then compared to the observed β computed by the S&W technique as were the β's predicted by the two naive models for that same forecast period. If the experimental model is deemed successful, the fitted β from the experimental model will better predict the observed β than will the naive models. The performance of the alternative prediction models was evaluated by determining the mean absolute error between the predictions of the models (experimental and the two naive) and the observed β over the six holdout periods for which an experimental β was forecasted. If the experimental model has a lower mean absolute error than the naive models over the six holdout periods, then accounting data alone is useful in prediction of β. The naive models were: (1) β=1.0, the β of the market portfolio, the most naive model but one that has performed as well as others; (2) $\beta_t=\beta_{t-1}$ or no change in β based on the observed value. If the experimental model cannot outperform these very naive models, it has no usefulness in prediction of β. Other naive models used in previous research, such as Bayesian adjusted estimates of Vasicek

(1973) and Maier et. al. (1977) were not used because they require the use of cross-sectional data which is contrary to the design and objectives of this study.

Chapter 4

Results

This chapter is divided into three sections. The first section reports the performance results of the experimental model as compared to the naive models. These are the main results of the study. The latter two sections report the results of research extensions dealing with: (1) combined models and (2) correlations between individual ARM's and the observed β.

I. Performance Results of the Experimental Model

As discussed in the last chapter, the independent variable set was derived by a principal components analysis from ARM's computed from quarterly data. The dependent variable for the stepwise regression procedure was the S&W β estimated from daily returns. This model was estimated using from 46 to 51 quarterly periods to allow calculations of predicted β for the 47th through 52nd quarters, respectively. This section reports the results of that prediction of β.

The experimental predictive model was compared to the naive models of β=1.0 and $\beta_{t+1}=\beta_t$ (that of no change in β) by computing the absolute error of each of the predictive models (the two naive models and the experimental model) for each of the 6 holdout periods. This error was defined as the difference between the predictive model and the benchmark β for this study, the observed S&W β computed for the corresponding period. The better predictive model was determined to be the model with the smaller mean absolute error over the 6 holdout periods.

The results were not as hoped. For only seven out of the 27 sample firms were the predictions of the experimental model better than the naive model of $\beta=1.0$. These firms were Digital Equipment, Ford Motor, General Motors, Merck, Motorola, NCR Corporation, and National Semiconductor. The naive model of $\beta=1.0$ assumes that the best prediction of β is the theoretical β of the market portfolio. A model that cannot outperform this very naive model is of no practical use. It was hoped that this naive model, at least, could be outperformed.

The results were even worse when comparing the experimental model with the other naive model. In this case, the predictions from the experimental model were better than prediction of no change in β from the prior period for only six of 27 firms. These firms were Ford Motor, General Electric, Honeywell, Motorola, NCR Corporation, and National Semiconductor. It is interesting to note that five of these six are electronics firms that share the same two-digit SIC code of 36. However, this should not be interpreted as providing evidence that the experimental model outpredicts this second naive model for this 2-digit SIC code industry because for 10 other firms in this industry, this naive model provided better predictions than the experimental model.

On the mildly positive side, four of the 27 firms had experimental models that outperformed the predictions of both of the naive models. Those firms were Ford Motor, Motorola, NCR Corporation, and National Semiconductor. Yet, there are no apparent reasons why the accounting data of these firms should provide more information for predicting β than the other 23 firms. Table 5 in the Appendix summarizes the results comparing the predictions of the experimental model and the two naive models, the raw data for which is reported in Table 7.

II. Combined Models

In the prior section, evidence is provided that, in general, the experimental model does not outperform the naive models when predicting β. Yet, one would hope superior models using accounting data could be constructed. One potentially fruitful approach is to combine predictions from individual models to assess whether this aggregated prediction outperforms each of the individual model predictions. Previous research in the social sciences[18] provides evidence that combined models may outperform individual models when making human and statistical judgments. In particular, Winkler (1967 & 1971) found that the consensus generated by a simple average outperformed the average of the individual predictors.[19] Thus, it was felt that the averaging of individual prediction models might be useful in generating a more reliable forecast of β. To that end, combined models were investigated to determine if accounting data might be useful in making predictions about the β of a firm.

The combined models used were generated by simple averages of the β's predicted by the experimental model and either one <u>or both</u> of the above naive models. In the absence of any reason to weight any model more than another, equal weights were used. This might not result in the ideal combined model but should provide some indication of their usefulness. The predictions based on these models were evaluated using the same criteria as was used for the experimental model. The β's calculated were used to compute

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[18] See, for example, Beaver (1981), Winkler (1967 & 1971), and Einhorn, Hogarth, and Klempner (1977).

[19] For further exposition and underlying theory, see Einhorn, Hogarth, and Klempner (1977).

absolute errors from the observed β for the final six periods. If the combined model generated a smaller mean absolute error than the naive model, it was deemed to be successful in comparison to that naive model. A success in this setting would be an indication of the usefulness of accounting data in combined financial models for the prediction of β.

The results of this analysis are summarized in Table 6 of the Appendix. In addition, an actual listing of the combined, experimental, and naive predictions and their absolute errors are reported in the Appendix as Table 7.

As a benchmark for understanding the improvement provided by using combined models, Table 6 in the Appendix first summarizes the results of the individual model analysis alone. Recall from the prior section that for only four firms is the experimental model chosen as the best based on a mean absolute error criterion. In addition, it should be noted, the naive model of β=1.0 is best for 13 of the firms and the naive model of no change in β from the prior period is best for the remaining 10 firms.

Unfortunately, the results don't improve dramatically when the three combined models are added to the model set. While models containing accounting data now provide the best predictions for 11 firms, β for 16 firms is still best predicted by one of the two naive models. Thus accounting data still does not provide important information for the prediction of β for the majority of firms in the sample.

Yet it can be stated that the combined models provided an improvement in prediction over the experimental model. For only two firms, Ford and Motorola, were the predictions from the experimental model superior to those from each of the three combined models (i.e. none of the three combined models improved on the predictions of the experimental model for these two firms). Thus, use of combined models appears to be one mechanism to use to improve the predictions of the experimental model.

III. Correlations of the Original Variables With Beta

While computing the principal components and fitting the experimental model, the SAS procedure PROC CORR was used to compute the Pearson Product Moment correlations between the ARM's and the observed β for the period following their release. Recall the ARM's are the original accounting variables which were defined prior to the principal components analysis. (see Table 1 in the Appendix for a list of these variables) The SAS procedure produces both the correlation coefficient and its significance level. These significance levels are summarized by accounting variable and by firm in the Appendix as Table 8.

The most striking result is the low level of correlation between the ARM's and the observed β in the following period for some of the firms. Five firms had no significant correlation coefficients even at the .10 level. These were Digital Equipment, DuPont, IBM, International Paper, and Johnson & Johnson. Six more firms had less than six (of the 40) risk variables with significant correlations with the one step ahead β. Also, there appears to be no relationship between the success of the experimental model and the number of significant correlation coefficients. For the four firms reported in the prior section with successful experimental models, Motorola had a low of only four significant correlation coefficients and NCR had a high of 23 significant coefficients. For the firms where the naive models were successful and the experimental model failed, General Instrument and RCA both had 30 of the 40 ARM's significantly correlated with the one-step-ahead β.

When the significance of the correlation coefficients are examined for individual ARM's across firms, the results are no less interesting. Again the low level of correlation is striking. These ARM's were chosen based on their usefulness in predicting some form of risk in prior studies (risk of failure or risk of return on investment). Several variables have as few as three instances in which they exhibit a significant correlation with the next period β. This small number of significant correlation coefficients indicates that, in general, these ARM's are not correlated with next period's β. Those ARM's were; (2) Asset Growth used by BKS (1970) and others, (25) Quick Assets to Sales used by Beaver (1966),(1968) and others, (28) Net Worth to Sales used by Beaver (1966),(1968) and others, and (32) No-Credit Interval used by Beaver (1966),(1968) and others.

The ARM's were also studied for a subset of the sample, those firms for which the experimental model was successful (Table 10 in the Appendix). Again, no general relationship obtains. For sixteen of the 40 ARM's there is significant correlation with one-step-ahead β for two of the four firms. None of the ARM's had significant correlations with one-step-ahead β for 3 or more of the successful firms. Thus, there seems to be no general pattern of which ARM's exhibit significant correlation with one-step-ahead β for the successful experimental model firms. Table 11 in the Appendix shows the subsample of nine firms for which the experimental model was successful against either naive model. Eight ARM's exhibited significant correlation with one-step-ahead β for at most four firms. No ARM had more than four significant correlation coefficients out of the nine possible firms. Two ARM's exhibited no significant correlation with next period's β for any firm. As above, no general pattern is found.

The ARM's with the highest number of firms with significant correlation coefficients were the size measures; (39) Scaled Total Assets, and (40) Scaled Net Worth. These were suggested by Bowman's (1979) theoretical article and the evidence provided by prior empirical research that size seems to be related to β in cross-sectional studies. Here, in contrast to the cross-sectional studies, the size variable indicates whether or not β for a single firm changes as size changes. For each of the size variables, 12 of the 27 firms, showed a significant negative correlation with next period's β indicating β decreases as firm size increases. 14 firms overall showed some significant level of correlation between β and one of the two size ARM's. Of these 14, eight firms showed both size measures being significant at the .05 level and two others showed both ARM's significant, variable 39 at the .10 level and variable 40 at the .05 level. Three of the 14 firms had less significant results in that only one of the two size measures was significant and that was at the .10 level. All 27 firms showed negative correlations between these two

ARM's and next period's β although most were nonsignificant. However, some of these correlations were very significant. For example, Eastman Kodak, a firm that failed in the experimental model test, showed significance levels of .0003 and .0002 respectively for ARM's 39 and 40. Fully one-third of the sample firms indicated that β declines as size increases. Thus, at the individual firm level an increase in an accounting measurement of firm size may provide a general indication that a decrease in risk will occur in a subsequent period.

Chapter 5

Analysis and Conclusions

This chapter is divided into five major sections. The first discusses the correlation of firm size and β and its theoretical background. The second and major section addresses the failure of the experimental model by discussing the differences between the present study and prior studies in this area. The third section discusses the results of the combined model approach and its relationship to other forms of β estimation. The fourth section addresses implications for further research in this area based on the failure of the experimental model. The final section addresses conclusions of the study as a whole and the author's opinions on the usefulness of accounting risk measures.

I. Correlation of Firm Size and Beta

Cross-sectional studies of the association of ARM's with the market risk, β, have generally shown that the firm size is a variable which is negatively correlated with β. This indicates that the larger the firm, *ceteris paribus*, the lower the β. In Bowman (1979), the theoretical effect of size is specifically analyzed by assuming a consolidation of two firms to form a third. Through his analysis, Bowman finds no theoretical explanation for the association of size and β. "The risk which results from entering into new investments is a simple weighted average of the risk of the individual investments."[20] Without theoretical support, researchers in this field have been at a loss to explain the cross-sectional results for size. The usual explanation is that size is proxying for some unknown omitted variable.

The present study allows a different look at size and β. Since the approach herein is on an individual firm basis, we can investigate whether or not β declines as the firm size increases over time. The results based on the Pearson correlation statistic seem to agree with prior empirical results done in cross-section at a point in time. For 14 of 27 firms in this sample, a significant negative correlation between size and next period's β was observed. While the sample of firms chosen was definitely not random, this result may still hold for the general case. The sampling procedure employed isolated only large New York Stock Exchange firms. This should, the author expects, bias against finding a significant relationship between size and future β, since the sample contains no small, newly established firms of high risk which are more likely to exhibit decreases in risk (β) as they grow and become established.

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[20] Bowman (1979), p. 626.

In spite of this probable bias, this study still finds a relationship between risk and size for the individual firm over time. Why this should be so for this study, in absence of theory, is also unknown.

In summary, it appears that for individual firms over time, as well as in cross-section at one time, firm size is significantly negatively related to the systematic risk of the firm.

II. Failure of the Experimental Model

This section is divided into seven parts organized around the differences between this study and prior studies. Part A deals with daily return data. Part B deals with the S&W technique. Part C deals with quarterly data. Part D deals with the specification of the ARM's used in the study. Part E deals with timing of the disclosures and their relationship to the experimental model. Part F deals with individual firm modeling. Finally, part G summarizes the section and gives the author's conclusions.

A. Daily Return Data

All the prior studies cited in Chapter 1 estimated β using monthly return data. Because a shorter prediction horizon was desired for this study, daily returns were used.

Potential problems with daily data in comparison to weekly or monthly data are excessive noise in the return stream and possible bias due to non-trading of some securities. The first concern is addressed in this section while the non-trading problem is addressed in a subsequent section.

Noise is of of great concern to this study as it introduces the errors-in-variables problem. Yet the author knows of no good way of adjusting for it. The less frequently a security return is computed, the greater the possibility that random daily errors will offset each other. An alternative to daily return data that could be suggested is that weekly returns be used for the study. While weekly returns are not available on the CRSP tapes, it is not difficult to generate them from daily returns. For this study, however, weekly returns are not frequent enough. Remember that the number of trading days between the release of the annual report and the first quarter report is small for some firms. One of the sample firms had a low of only 19 trading days between these reports. While this is not typical, it could be expected that some of the S&W regressions to compute the observed β would be required to use as few as four or five data points if weekly observations were employed. The average quarter contains 13 weeks of data and therefore only 13 weekly data points for estimation of the observed β. The author feels more comfortable about β estimation with an average of 63 noisy daily data points than a 13 point regression on less noisy weekly data. 63 data points scattered about a regression line are not as susceptible to outlier effects as would be a regression line generated by only 13 data points.

If more data points are required to allow use of weekly data, overlapping estimation periods could be used to calculate the S&W β and fit the experimental model. This was the original intention of the author, but this methodology creates other problems. If overlapping periods are used, the observed β would change slowly since it would essentially be a moving average. A slow or gradual change in the observed β would be more difficult to associate with a single quarterly release of accounting data since observations occurring beyond the release of the next report would be used in computation of the observed β. In addition, all the criticisms of Fisher and Kamin (1985) in regard to β estimation methodologies using long estimation intervals would then be appropriate. (see Chapter 2 for a summary of these points) In addition, it should be noted that even if weekly data were used it would not eliminate noise but only reduce it.

Thus, the author feels that while daily data can be a problem with respect to random error, noise, in the return stream, the research design choices made in this study are the best possible given the research objective. This problem with daily return data, however, is still an excellent candidate for the failure of the model as a noisy return stream creates a noisy stream of β estimates.

B. The Scholes and Williams Technique

Prior studies in this area have used OLS regression to estimate β. More recent studies have adjusted the OLS β using one of several cross-sectional Bayesian revision techniques. As discussed in Chapter 2, using this or similar techniques for correcting for bias in the estimation of β can be suspect because of our inability to measure "true β" and the likelihood that β is nonstationary. These factors make the determination of the level and existence of the bias in β estimation indeterminable and therefore leaves no obviously superior β estimation mechanism to an OLS based procedure. Besides, since the emphasis in this study is on individual firm modeling, the use of the Bayesian adjustments of Vasicek (1973) and Maier et.al. (1977) are precluded since these revisions make use of the average β across firms at the estimation date. This is a portfolio approach which is contrary to the objectives of this study.

The potential bias of non-trading firms was addressed in Chapter 2. The S&W procedure was specifically developed to correct for this. By using a β calculated as an average of the OLS regressions for the contemporaneous, lag and lead series of returns (see Chapter 3), the nonsynchronous trading problem should not affect the results. It is also possible that this averaging reduces the problems due to random error in the returns (noise).

For the above reasons, the S&W procedure was chosen as the benchmark for estimation of β and the testing of the predictive models. In a real sense, this study has adopted this particular β estimate as the benchmark or "true β". It is possible that this choice of a β estimation technique, which is not used in other studies, was responsible for the failure of the experimental model. The author, however, feels that this is unlikely. As mentioned in Chapter 2, different estimation techniques lead to β series that are highly correlated with the S&W estimates. Thus, the author feels that the choice of the S&W technique was the appropriate one and that choosing this technique was unlikely to have been responsible for the failure of the experimental model.

C. Quarterly Data

The prior studies in this area have all used annual accounting numbers to form their ARM's. To achieve more frequent predictions of β than that allowed with annual data, quarterly data was used in this study. Two problems can be related to use of quarterly data, unreliability and seasonality.

The use of annual data limited the prior studies to prediction of the average β over a five to nine year period. It was felt that for a β estimate to be useful, it must be more frequent and cover a shorter time interval, thus providing the justification for use of quarterly data.

The annual accounting numbers reported to the market are subject to audit, the quarterly reports are not. Potentially, this makes the quarterly numbers less reliable. The author feels that this is not a problem. Errors in the accounts are equally likely to occur in any quarter, and while the auditor may find errors, this may not affect the overall materiality of the reports. Also, the firm has an interest in making the quarterly reports as free from material error as possible. If a prior quarter's report must be corrected in the audited annual report, it makes the firm look bad. This holds true for lying also. The firm that lies cannot count on the lie remaining undiscovered by the auditor and being corrected on the annual report. It should be noted that although the quarterly reports are not audited, they are monitored by the SEC and firms are subject to SEC penalties for errors. For the large firms in this study, it is felt that the quarterly numbers are as reliable as the annual numbers. Thus, the use of quarterly data should not have caused the failure of the experimental model.

Seasonal variation in the accounting numbers is potentially a more serious problem. The prior studies using annual data did not encounter this difficulty. In choosing the definitions of the ARM's, the author considered the merits of adjusting for seasonality. Most of the adjustments available for seasonal patterns are of the smoothing type. It was felt that the raw data would better predict risk changes than would smoothed data. Smoothed data would require several periods to pick up a real change in the firm indicated by the accounting numbers. Also, the methodology chosen (PCA) restricted the maximum number of input variables to be less than the number of observations (46 for model fitting for most firms, 43 for the firm with the least number of observations). Additional ARM's, such as the measured change in an ARM from the same quarter of last year, were not included for this reason.

It is possible that this seasonality could have led to the failure of the model. The seasonal change in a variable from quarter to quarter may be the entire reason why an ARM changed from period to period and, therefore, a change as reflected by the raw accounting numbers may not provide any new information to the market. The only way to correct for this problem is to use additional or more appropriate ARM's. However, due to the data limitations discussed above, this would have required trying different sets of ARM's through the full estimation and model fitting process. Yet, the results shown in Chapter 4 point out that even when an ARM is significantly correlated with the one-step-ahead β, the model may still not be successful; and a successful model may have very few ARM's with significant correlations coefficients. This makes the selection of the criteria for choosing a potential ARM set very difficult. In this study, the author used the same input ARM's for all firms so that some general results would hopefully obtain. In retrospect, the best predictive model may use firm specific ARM's.

In summary, the author feels that the seasonal variation of some accounting numbers used in calculation of the ARM's could have contributed to the the failure of the experimental model. Correction for this problem would require the inclusion of ARM's designed to pick up changes over and above the normal seasonal change, such as change in the variable from the same quarter of the previous year.

D. Specification of the Accounting Risk Measures

This section deals with the choice of the ARM's for the predictive model. Concerns are expressed that the omission of one or more of the ARM's used in prior research may have caused the low predictive power of the experimental model in this research. In general, the inavailability to the market of this data caused the exclusion of these variables.

All prior studies in this area have used some form of the "accounting β" as an indicator or input variable. This variable is the scaled covariance of the firms earnings with the earnings of the market which has been shown, in all previous studies, to be contemporaneously associated with β. Bowman (1979) also develops theoretical support justifying why "accounting β" is contemporaneously associated with the observed β. This study did not include this variable in the ARM's since the emphasis was on forming a predictive model using only accounting numbers available at the release date of an individual firm's financial reports. Since the computation of the "accounting β" requires knowledge of the earnings of all firms in the entire market, it cannot be computed until the last firm releases its financial report.

Potentially, the absence of this important variable could cause the the models employed in this study to fail while others who have used it have succeed.

The author feels that this is probably not the case. Both the theoretical and empirical studies establish a **contemporaneous** association between the "accounting β" and β. Yet, this should not necessarily lead to a predictive association. If β is constant, then we would expect this period's "accounting β" to be associated with next period's β given the significant contemporaneous association documented in prior research. However, if β varies, as is assumed in this study, then there is no reason why the "accounting β" of this period should have any association with the observed β of the following period, much less a predictive one.

Yet this conclusion leads to a further problem with the prior studies. As indicated in Chapter 1, the use of variables not available at the time of the model fitting means the results are jointly dependent on the model and the prediction of the unobservable variable. Given this fact, the author feels that prior studies have been successful in showing a contemporaneous association of ARM's with β but questions the validity of prior studies in predicting β. This argument reduces to the statement, "It's always easier to win if you cheat." This is not meant as a direct criticism of all the prior studies. However, this study has scrupulously tried to avoid all potential problems of data availability. The generation of a useful predictive model using only all available accounting numbers has been the goal of this study.

A second ARM that was omitted from this study is an operating leverage measure consistent with any of the three employed by Elgers (1980). The computation of operating leverage requires a breakdown of costs into fixed and variable components. Since this data was not reported in any of the 10Q's examined for this study, an operating leverage variable could not be calculated. The omission of this variable due to data constraints may have reduced the predictive power of the experimental model employed in this study.

In summary, as stated in part C above for seasonal change variables, the exclusion of the "accounting β" and other variables not available from the financial reports could be responsible for this study's failure. As to the "accounting β," this author feels its omission did not cause the study to fail. Other omitted variables, such as operating leverage, could potentially have improved prediction, but what a full list of those other variables might contain is unknown.

E. Timing and Accounting Reports

Great care was taken in the design of this study to be sure the estimation, model fitting and prediction periods were measured from one release date of the full set of accounting numbers in a quarterly or annual report to the next release date. It is possible that the timing of this study could have led to its failure. Two issues are important in this regard. One has been discussed above, the availability of the accounting numbers at the balance sheet date (see Chapter 1). The other is the disclosure of accounting information in releases other than the financial statements.

Financial reporting includes more than the release of the financial statements in quarterly or annual reports. Press releases, earnings or dividend announcements, forecasts (whether management generated or by outsiders such as analysts), and articles in the financial press are some of these additional disclosures. This more or less continuous dissemination of information for large firms, such as those used in this study, makes it difficult to decide on one single date for estimation and model fitting. The release of any information on a firm allows an investor to update his/her assessment of risk. The investor will not necessarily wait for the next quarter's report to trade. It is certainly possible that this timing problem could have led to the failure of the experimental model.

Earning announcements are published in the Wall Street Journal for major firms when disclosed by the company. These announcements lead the release of the 10Q's and the financial statements by several days or weeks. While these contain only Sales, Net Income, and Earnings per Share, if these are the most important variables, then the estimation and model fitting should be determined by the release of this information alone. (i.e. The full set of accounting numbers may not be necessary for updating a risk assessment.)

To correct for this potential problem would require use of multiple release points during a quarter and there is not sufficient data for this estimation. One release point must be chosen. Besides, the objective of this study was to assess the predictive ability of accounting information in assessing one-step-ahead β estimates. To meet this objective, only the release date of the full set of accounting numbers could be chosen to assure that the data necessary to test the research question was available.

While these timing considerations are vexing, it is not felt that they alone led to the failure of the model although they may very well have contributed to it.

F. Individual Firm Modeling

Most of the prior research in this area used portfolios of stocks for their model estimation and fitting. Elgers (1980) was one study that used individual firms to estimate the parameters of his model. Yet, he used cross-sectional data to estimate his Bayesian adjusted β. This study has used individual firm models to estimate β. While this emphasis on single firm portfolios could have led to the failure of the model, the author feels it is unlikely.

While the market model and the Capital Asset Pricing Model were both developed as portfolio models, with β as a parameter, it is valid to calculate β for an individual firm. [Fama and Miller (1972) and Fama (1976)] In this sense, the individual firm β becomes a measure of the firm's contribution to portfolio risk. In addition, researchers in the accounting and finance literature have estimated β on an individual firm basis for many years. For this study, the sample selection process selected firms where the regression R^2 for the estimation of β was high. Thus, the failure of the β prediction models are unlikely to be due to the fact that the observed β was an unimportant variable in describing the security returns of the sample firms.

G. Summary

In this section, reasons for the failure of the experimental prediction model were discussed. While the exclusion of an accounting β in the ARM set creates the greatest difference between this study and the prior research, the author feel that this is not the cause of the failure. The problems that could be responsible for the failure of the model were: noise in the daily return stream, and thus in the computed S&W β; omitted ARM variables, particularly those reflecting seasonal change; and additional disclosures at times other than the release date of the annual or 10Q report.

III. Combined Models

The results of applying averaging techniques in creating combined models should not be surprising. When the experimental model has a higher absolute error than the naive model as measured relative to the observed β, combining the experimental and naive models by averaging will, of necessity, result in the combination having a lower error than the experimental model. This is true whether the error for the naive model is in the same direction as, or in the opposite direction from, the error of the experimental model. When the experimental model has a lower absolute error than the naive model, it is possible for the combined model to either improve the prediction or not, depending on the direction of the errors across the two sets of models. If both the experimental and naive model are overestimated relative to the observed β and the experimental has a smaller error than the naive, the combined model will not improve the prediction over the experimental but rather make it worse. This was the case for Ford and Motorola, the two firms where predictions were not improved by the combinations. These firms, however, were two of the four firms where the experimental model outperformed both naive models. If the errors of the experimental and the naive models are in different directions from the observed, the combined model could improve or worsen the prediction relative to the experimental model depending on the relative size of the errors. Since the experimental model failed to outperform either naive model for the majority of the firms in the sample, it is not surprising that these combined models improved the poor predictions of the experimental model.

One of the combined models used in this study is a form of the "shrinking factor" approach discussed by Fisher and

Kamin (1985) and others in the finance literature. This model is also used by some analysts on Wall Street to adjust their estimates of OLS computed β's. When the combined model containing the average prediction for the β=1.0 naive model and the experimental model is computed, this prediction is equivalent to the prediction that would be made using the "shrinking factor" approach with .5 as the weighting factor. This combined model results in the prediction of β being closer to 1.0, the theoretical β of the market portfolio, than the β predicted by the experimental model. This approach follows the arguments of Vasicek (1973) quoted in Chapter 2 as to the postulated bias of the OLS estimation technique. The reason this model was not the dominant prediction model, being best for only three firms, is probably because the best model was the naive of β=1.0, and this averaging moved the combined β away from 1.0.

In summary, the poor performance of the combined models was a result of the poor performance of the experimental model. While these combined models improved the predictability of the experimental model, this improvement was not enough for the combined to consistently outperform the naive models.

IV. Implications for Further Study

The major conclusion of this study is that accounting information alone was, for this sample, not sufficient to predict the change in β for individual firms. This section addresses three implications for future research into the role ARM's play in the prediction of β. The discussion is based on the items covered in section II. In particular, the implications for future research of (1) a change in the timing of the release of information; (2) the mixing of accounting and market variables in the model; and (3) the search for additional variables to predict β are discussed.

In agreement with the prior discussion on timing issues, further research might look at defining the estimation period based on the disclosure of earning announcements. These dates are available in the Wall Street Journal Index. As discussed above, this would make successful β prediction jointly dependent on the model and prediction of the accounting variables used that are not available until the later release of the financial statements. A case could be made that the earnings announcement is more important in assessing risk than the total accounting data set.

Since the accounting variables alone failed, future research could consider adding market based variables, but only those variables available at the release date of the financial statements. This could potentially add such variables as share price, the P/E ratio, scaling by market value of the firm, and other variables that have been used in prior accounting and finance studies. Since the emphasis in this study was on accounting data only, these additional variables were not added herein. Finally, future research could add firm specific variables to the ARM set. However, the extensive computations necessary to identify the best set of ARM's would be complicated by adding such variables. To reduce these complications and to provide generalizable results, this study attempted to find one set that could be used across firms.

V. Final Conclusions

While the experimental model failed to predict β better than the naive models, this project was a learning experience for the experimenter. The major result: Accounting data alone is not sufficient for the prediction of an individual firm's one-step-ahead β over a quarterly time horizon for the chosen sample of firms. This is not to say that accounting data is not associated with β. Based on the conclusions of the Rosenberg (1973)(1975) studies, and others, that used accounting variables, and in spite of the weaknesses the author sees in these prior studies, he still feels that the major conclusion that accounting numbers aid in prediction of β over longer time horizons is a valid one.

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APPENDIX

Sample 10Q Report - Pre 1976

A. Summarized Financial Information

Company or group of companies for which report is filed:

Avon Products, Inc. and Subsidiaries

Profit and Loss Information (In Thousands of Dollars)

For Nine Months Ended September 30: (Unaudited)

		1972	1971
1.	Gross sales less discounts, returns and allowances	$650,268	$564,546
2.	Operating revenues	-	-
3.	Total of captions 1 and 2	650,268	564.546
4.	Costs and expenses	503,068	437,940
	Interest expense	2,689	3,391
	Total Costs and Expenses	505,757	441,331
5.	Income (or loss) before taxes on income and extraordinary items	144,511	123,215
6.	Provision for taxes on income	74,263	64,546
7.	Minority interest	-	-
8.	Income or loss before extraordinary items	70,248	58,669
9.	Extraordinary items, less applicable income tax	-	-
10.	Net income (or loss)	$ 70,248	$ 58,669
11.	Earnings per share*	$1.21	$1.01
12.	Dividends per share	$1.01	$ .92

* Per share amounts are based on the average number of shares outstanding during each period. Shares issuable under stock options are excluded from the average number of shares (utilizing the treasury stock method) because their inclusion would not reduce earnings per share for either of the above two years.

B. Capitalization and Shareholders' Equity
September 30, 1972
(In Thousands of Dollars)

Debt	(Unaudited)
Short-term loans, notes, etc.	$ 19,974
Long-term debt (excluding current installment of $1,170)	28,126
Total debt	$ 48,100
Deferred income taxes	$ 4,621
Shareholders' equity	
Capital stock, par value $.50	
Authorized 64,800,000 shares	
Issued 57,803,093 shares	$ 28,901
Capital surplus	20,988
Retained earnings, January 1	277,500
Net income	70,248
Cash dividends - $1.01 per share	(58,466)
Retained earnings, September 30	289,282
Total Shareholders' Equity	$339,171

There were reserved for issuance under stock option plans 632,111 shares of Capital stock (par value $.50) at September 30, 1972.

In the opinion of management, the foregoing information includes all adjustments (consisting only of normal recurring accruals) necessary for a fair statement of results for the interim periods reported.

C. Sale of Unregistered Securities
(Debt or Equity)

There have been no sales of unregistered securities during the nine months ended September 30,1972.

Table 1

Ratios Used As Input For Principal Components Analysis

1 Payout (BKS-70) Dividends to common/NI avail to common
2 Asset growth (BKS-70) (total assets/last period total assets)-1
3 Leverage (BKS-70) C.L.+LTD+Preferred at Liq Value/total assets
4 Cash flow to sales (Beaver) NI+Dep amort etc/sales
5 Cash flow to total assets (Beaver) NI+Dep amort etc/total assets
6 Cash flow to net worth (Beaver) NI+Dep amort etc/ com st eq+def tax+Intangibles
7 Cash flow to total debt (Beaver) NI+Dep amort etc/CL+LTD+Pref at Liq
8 Net Income to Sales (Beaver) NI/Sales
9 Net income to total assets (Beaver) NI/TA
10 Net income to net worth (Beaver) NI/Com St Eq+Def Tax+intangibles
11 Net Income to total debt (Beaver) NI/CL+LTD+Pref at Liq
12 Current liabilities to total assets (Beaver) CL/TA
13 LT liabilities to total assets (Beaver) LTD/TA
14 Current + LT liabilities to total assets (Beaver) CL+LTD/TA
15 Cash to total assets (Beaver) Cash+MES/TA
16 Quick Assets to Total Assets (Beaver) Cash+MES+AR/TA
17 Current Assets to Total Assets (Beaver) CA/TA
18 Working Capital to Total Assets (Beaver) CA-CL/TA
19 Cash to Current Liabilities (Beaver) Cash+MES/CL
20 Quick Assets to Current Liabilities (Beaver) Cash+MES+AR/CL
21 Current Ratio (BKS 1970)(Beaver) CA/CL
22 Cash to Sales (Beaver) Cash+MES/Sales
23 Accounts Receivable to Sales (Beaver) AR/Sales
24 Inventory to Sales (Beaver) INV/Sales
25 Quick Assets to Sales (Beaver) Cash+MES+AR/Sales
26 Current Assets to Sales (Beaver) CA/Sales
27 Working Capital to Sales (Beaver) CA-CL/Sales
28 Net Worth to Sales (Beaver) CSE+Def Tax+Intangibles/sales
29 Total Assets to Sales (Beaver) TA/Sales
30 Cash interval (Beaver) Cash+MES/ operating expenses-dep(GP-NI-INT-Tax-Dep)
31 Defensive interval (Beaver) Cash+MES+AR/ operating expenses-dep(GP-NI-INT-Tax-Dep)
32 No-credit Interval (Beaver) Cash+MES+AR-CL/ operating expenses-dep(GP-NI-INT-Tax-Dep)
33 Retained Earnings to Total Assets (Altman) RE/TA
34 Earnings B4 Interest & Taxes To Total Assets (Altman) NI+Int+Tax/TA
35 Sales to Total Assets (Altman) Sales/TA
36 Net Worth to Total Debt (Altman) CSE+Def Tax/CL+LTD+Pref at Liq
37 Sales to Current Assets (Libby) Sales/CA
38 Earnings Variability (Bowman) Std Dev of EBIT (current and 3 prior Qts)/10,000
39 Size (Bowman) TA/1,000,000
40 Size (Bowman) CSE+Def Tax/1,000,000

Table 2 - Panel 1

Firms Used To Collect Quarterly Data

			OLS-Firm Selection		
Firm Name	Compustat #	Crsp #	Avg R^2	Avg β	SD β
Amoco Corp	2911 031905	03190510	.353	1.066	.373
Atlantic Richfield Co	2911 048825	04882510	.365	1.238	.337
Avon Products	2844 054303	05430310	.325	1.219	.460
Burroughs Corp	3680 122781	12278110	.406	1.365	.395
Caterpillar Inc	3531 149123	14912310	.328	.994	.312
Chevron Corp	2911 166751	16675110	.361	1.202	.359
Control Data Corp	3680 212363	21236310	.422	2.003	.437
Digital Equipment	3680 253849	25384910	.409	1.667	.434
Dow Chemical	2800 260543	26054310	.417	1.352	.374
DuPont (E.I.) De Nemours	2800 263534	26353410	.440	1.186	.299
Eastman Kodak Co	3861 277461	27746110	.474	1.402	.353
Exxon Corp	2911 302209	30220910	.405	.944	.203
Ford Motor Co	3711 345370	34537010	.338	1.113	.359
General Electric Co	3600 369604	36960410	.461	1.167	.275
General Instrument Corp	3670 370118	37011810	.367	2.141	.801
General Motors Corp	3711 370442	37044210	.394	1.081	.231
Hewlett-Packard Co	3680 428236	42823610	.387	1.436	.337
Honeywell Inc	3680 438506	43850610	.393	1.495	.438
Intl Business Machines	3680 459200	45920010	.488	1.139	.231
Intl Paper Co	2600 460146	46014610	.345	1.189	.293
Johnson & Johnson	2834 478160	47816010	.351	1.021	.323
Merck & Co	2830 589331	58933110	.328	1.001	.268
Minnesota Mining & Mfg	2649 604059	60405910	.411	1.105	.318
Mobil Corp	2911 607059	60705910	.337	1.115	.414
Monsanto Co	2800 611662	61166210	.359	1.076	.304
Motorola Inc	3663 620076	62007610	.358	1.492	.327
N C R Corp	3680 628862	62886210	.385	1.630	.440
National Semiconductor	3674 637640	63764010	.336	2.328	.570
R C A Corp	3651 749285	74928510	.334	1.386	.469
Sperry Corp	3680 848355	84835510	.453	1.558	.389
Texas Instruments Inc	3674 882508	88250810	.386	1.414	.304
Union Carbide Corp	2800 905581	90558110	.419	1.192	.244
Westinghouse Electric	3600 960402	96040210	.336	1.401	.353
Xerox Corp	3861 984121	98412110	.442	1.444	.306

Table 2 - Panel 2

Summary of Industry Membership For Sample of Firms

Industry Classification	SIC Code #	# of Firms	
Paper & Allied Products	2600	1	
Convert Paper-Paperbd Pd Nec	2649	1	
Chemicals & Allied Products	2800	4	
Drugs	2830	1	
Health Care-Diversified	2834	1	
Perfumes Cosmetics Toil Prep	2844	1	
Petroleum Refining	2911	5	not in final sample
Construction Machinery & Equip	3531	1	
Elec & Electr Mach Eq & Supp	3600	2	
Radio-TV Receiving Sets	3651	1	
Radio-TV Transmitting Equip-AP	3663	1	
Electronic Components & Acce	3670	1	
Semiconductor & Rel Devices	3674	2	
Electronic Computing Equipment	3680	8	less 2 deleted
Motor Vehicles & Car Bodies	3711	2	
Photographic Equip & Suppl	3861	2	
Total Firms		34	

Table 3

Firms Used For Final Model Fitting

	Maximum and Minimum For Number of Trading Days Between Reports For Scholes-Williams Estimation Procedure.		Maximum and Minimum Number of Principal Components in Best Fit Models	
Firm Name	Max #	Min #	Max #	Min #
Avon Products	97	27	11	5
Burroughs Corp	83	44	10	5
Caterpillar Inc	95	38	5	3
Digital Equipment	102	27	6	4
Dow Chemical	106	19	8	4
DuPont (E.I.) De Nemours	90	37	10	6
Eastman Kodak Co	118	25	9	6
Ford Motor Co	95	30	3	2
General Electric Co	84	42	11	7
General Instrument Corp	97	29	9	5
General Motors Corp	97	33	4	2
Hewlett-Packard Co	101	25	13	7
Honeywell Inc	88	34	13	6
Intl Business Machines	74	52	4	2
Intl Paper Co	77	47	9	6
Johnson & Johnson	92	36	10	8
Merck & Co	90	35	5	3
Minnesota Mining & Mfg	86	39	7	5
Monsanto Co	94	31	11	8
Motorola Inc	106	33	2	1
N C R Corp	82	45	14	10
National Semiconductor	108	26	6	4
R C A Corp	87	39	8	6
Texas Instruments Inc	77	48	8	2
Union Carbide Corp	90	37	6	3
Westinghouse Electric	85	40	10	7
Xerox Corp	84	42	5	3

Highest maximum	118	
Lowest maximum	74	
Highest minimum		52
Lowest minimum		19

Table 4

Scholes & Williams Beta Summary Statistics

Firm Name	For β Computed Quarter By Quarter Minimum Quart β	 Maximum Quart β	 Mean Quart β	 Std Dev Quart β	Experi-mental Period β
Avon Products	0.1758	2.1363	1.1673	0.4972	1.1556
Burroughs Corp	0.1816	2.2818	1.2309	0.4631	1.1411
Caterpillar Inc	0.0959	2.0048	1.0558	0.3948	1.0235
Digital Equipment	0.4926	2.8298	1.4314	0.4765	1.3186
Dow Chemical	0.6872	2.1497	1.3143	0.2990	1.2380
DuPont (E.I.) De Nemours	0.5596	1.9964	1.0960	0.3273	1.0236
Eastman Kodak Co	0.3114	1.9158	1.1145	0.3831	1.0392
Ford Motor Co	0.0425	2.3565	1.0062	0.4366	0.9593
General Electric Co	0.4805	1.7905	1.1227	0.3116	1.1266
General Instrument Corp	1.1618	3.4366	1.9600	0.5479	1.8377
General Motors Corp	0.5091	1.7604	0.9488	0.2933	0.9471
Hewlett-Packard Co	0.5379	3.1928	1.4524	0.6135	1.2827
Honeywell Inc	0.4819	2.2356	1.2966	0.4052	1.2684
Intl Business Machines	0.2013	1.3761	0.9377	0.2415	0.9533
Intl Paper Co	0.3323	2.1964	1.2823	0.3848	1.1667
Johnson & Johnson	0.4398	1.9458	0.9539	0.3227	0.9272
Merck & Co	0.2683	1.8205	1.0246	0.3545	0.9743
Minnesota Mining & Mfg	0.4177	1.8766	1.0876	0.3695	1.0419
Monsanto Co	-0.0427	1.9268	1.1180	0.4339	1.1310
Motorola Inc	0.4614	2.3242	1.4468	0.3902	1.4509
N C R Corp	0.6022	2.6496	1.4935	0.4893	1.3942
National Semiconductor	0.8208	2.9813	1.8565	0.5430	1.8563
R C A Corp	0.0353	2.4073	1.2880	0.5300	1.1874
Texas Instruments Inc	0.3226	2.2799	1.3100	0.4362	1.1473
Union Carbide Corp	0.5820	2.3157	1.2072	0.3129	1.1549
Westinghouse Electric	0.6238	2.2357	1.3262	0.3715	1.2668
Xerox Corp	0.3006	2.2321	1.2713	0.3574	1.2070

The first four columns of the above table are statistics on the Scholes and Williams β computed between the quarterly release dates for the estimation period. The final column is a β computed using the Scholes and Williams technique for one long period, the estimation and model testing period combined, to show the central tendency or average over the entire study.

Table 5

Quarters In Which Experimental Beta Had Lower Absolute Error Than Naive

	Naive=1 Model		Naive=NC Model		
Firm Name	# of Quart	Total on MAE	# of Quart	Total on MAE	Outperform Both Naive
Avon Products	3	Fail	3	Fail	No
Burroughs Corp	2	Fail	2	Fail	No
Caterpillar Inc	1	Fail	1	Fail	No
Digital Equipment	3	Success	4	Fail	No
Dow Chemical	3	Fail	2	Fail	No
DuPont (E.I.) De Nemours	1	Fail	3	Fail	No
Eastman Kodak Co	3	Fail	3	Fail	No
Ford Motor Co	6	Success	4	Success	YES
General Electric Co	2	Fail	4	Success	No
General Instrument Corp	3	Fail	3	Fail	No
General Motors Corp	2	Success	0	Fail	No
Hewlett-Packard Co	3	Fail	1	Fail	No
Honeywell Inc	4	Fail	3	Success	No
Intl Business Machines	0	Fail	3	Fail	No
Intl Paper Co	0	Fail	1	Fail	No
Johnson & Johnson	1	Fail	2	Fail	No
Merck & Co	3	Success	1	Fail	No
Minnesota Mining & Mfg	1	Fail	1	Fail	No
Monsanto Co	2	Fail	2	Fail	No
Motorola Inc	6	Success	3	Success	YES
N C R Corp	5	Success	6	Success	YES
National Semiconductor	4	Success	4	Success	YES
R C A Corp	0	Fail	2	Fail	No
Texas Instruments Inc	0	Fail	1	Fail	No
Union Carbide Corp	1	Fail	3	Fail	No
Westinghouse Electric	1	Fail	1	Fail	No
Xerox Corp	2	Fail	1	Fail	No
Maximum possible	6		6		
Total firms whose mean absolute error was less than Naive Model (Total=27)		7 Naive=1		6 Naive=NC	4 Both

Key to the Following Tables

Quart	is the quarter of the study
Observed	is the computed Scholes & Williams beta value-the benchmark
Naive=1	is the naive model of $\beta = 1.0$
Naive=NC	is the naive model of β = no change from last period
Experimnt	is the value computed from the experimental model using ARM's
C=1 & E	is the average of the Naive=1 and Experimental Models
C=NC & E	is the average of the Naive=NC and Experimental Models
C=1,NC&E	is the average of the three models
*	indicates the best performing model on Mean Absolute Error
Success	means the experimental model outperformed the naive for that quarter based on absolute error
Fail	means the naive model outperformed the experimental for that quarter based on absolute error
Success	means the experimental model outperformed the naive for the test period based on mean absolute error
Fail	means the naive model outperformed the experimental for the test period based on mean absolute error

Table 6

Model Comparison-Summary

Model ⇒	Naive=1	Naive=NC	Experimental
# of times performed best (total=27)	13	10	4

Model ⇒	Naive=1	Naive=NC	Experimental	C=1 & E	C=NC & E	C=1,NC&E
# of times performed best (total=27)	12	4	2	3	3	3

Model ⇒	C=1 & E	C=NC & E	C=1,NC&E
# of times outperformed Experimental (total=27)	22	23	25

Table 7 - Panel 1
Model Comparison - Avon

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.6075						
47	1.1528	1.00	1.6075	1.6760	1.3380	1.6418	1.4278
48	2.0323	1.00	1.1528	2.2384	1.6192	1.6956	1.4637
49	1.2499	1.00	2.0323	1.8630	1.4315	1.9476	1.6318
50	0.4841	1.00	1.2499	0.5633	0.7816	0.9066	0.9377
51	0.4653	1.00	0.4841	0.7822	0.8911	0.6331	0.7554
52	-0.1615	1.00	0.4653	1.9168	1.4584	1.1910	1.1274
Mean AE		0.6079	0.5880	0.6361	0.5205	0.5777	0.5430
					*		

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1528	0.5232	Fail	47	0.4547	0.5232	Fail
48	1.0323	0.2061	Success	48	0.8795	0.2061	Success
49	0.2499	0.6131	Fail	49	0.7824	0.6131	Success
50	0.5159	0.0792	Success	50	0.7658	0.0792	Success
51	0.5347	0.3169	Success	51	0.0188	0.3169	Fail
52	1.1615	2.0783	Fail	52	0.6268	2.0783	Fail
Mean AE	0.6079	0.6361	Fail	Mean AE	0.5880	0.6361	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.1528	0.1852	Fail	47	0.4547	0.1852	Success
48	1.0323	0.4131	Success	48	0.8795	0.4131	Success
49	0.2499	0.1816	Success	49	0.7824	0.1816	Success
50	0.5159	0.2975	Success	50	0.7658	0.2975	Success
51	0.5347	0.4258	Success	51	0.0188	0.4258	Fail
52	1.1615	1.6199	Fail	52	0.6268	1.6199	Fail
Mean AE	0.6079	0.5205	Success	Mean AE	0.5880	0.5205	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.1528	0.4890	Fail	47	0.4547	0.4890	Fail
48	1.0323	0.3367	Success	48	0.8795	0.3367	Success
49	0.2499	0.6977	Fail	49	0.7824	0.6977	Success
50	0.5159	0.4225	Success	50	0.7658	0.4225	Success
51	0.5347	0.1678	Success	51	0.0188	0.1678	Fail
52	1.1615	1.3525	Fail	52	0.6268	1.3525	Fail
Mean AE	0.6079	0.5777	Success	Mean AE	0.5880	0.5777	Success

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.1528	0.2750	Fail	47	0.4547	0.2750	Success
48	1.0323	0.5686	Success	48	0.8795	0.5686	Success
49	0.2499	0.3819	Fail	49	0.7824	0.3819	Success
50	0.5159	0.4536	Success	50	0.7658	0.4536	Success
51	0.5347	0.2901	Success	51	0.0188	0.2901	Fail
52	1.1615	1.2889	Fail	52	0.6268	1.2889	Fail
Mean AE	0.6079	0.5430	Success	Mean AE	0.5880	0.5430	Success

Table 7 - Panel 2
Model Comparison-Burroughs Corp

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.7655						
47	1.5827	1.00	0.7655	1.1877	1.0939	0.9766	0.9844
48	0.5859	1.00	1.5827	-2.0380	-0.5190	-0.2276	0.1816
49	1.5743	1.00	0.5859	0.4428	0.7214	0.5143	0.6762
50	1.6460	1.00	1.5743	0.9147	0.9574	1.2445	1.1630
51	1.1070	1.00	1.6460	1.0041	1.0020	1.3250	1.2167
52	1.0040	1.00	1.1070	4.7058	2.8529	2.9064	2.2709
Mean AE		0.3880	0.5860	1.4477	0.8482	0.8336	0.6267
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.5827	0.3950	Success	47	0.8172	0.3950	Success
48	0.4141	2.6239	Fail	48	0.9968	2.6239	Fail
49	0.5743	1.1315	Fail	49	0.9884	1.1315	Fail
50	0.6460	0.7313	Fail	50	0.0717	0.7313	Fail
51	0.1070	0.1029	Success	51	0.5390	0.1029	Success
52	0.0040	3.7018	Fail	52	0.1030	3.7018	Fail
Mean AE	0.3880	1.4477	Fail	Mean AE	0.5860	1.4477	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.5827	0.4888	Success	47	0.8172	0.4888	Success
48	0.4141	1.1049	Fail	48	0.9968	1.1049	Fail
49	0.5743	0.8529	Fail	49	0.9884	0.8529	Success
50	0.6460	0.6886	Fail	50	0.0717	0.6886	Fail
51	0.1070	0.1050	Success	51	0.5390	0.1050	Success
52	0.0040	1.8489	Fail	52	0.1030	1.8489	Fail
Mean AE	0.3880	0.8482	Fail	Mean AE	0.5860	0.8482	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.5827	0.6061	Fail	47	0.8172	0.6061	Success
48	0.4141	0.8135	Fail	48	0.9968	0.8135	Success
49	0.5743	1.0600	Fail	49	0.9884	1.0600	Fail
50	0.6460	0.4015	Success	50	0.0717	0.4015	Fail
51	0.1070	0.2180	Fail	51	0.5390	0.2180	Success
52	0.0040	1.9024	Fail	52	0.1030	1.9024	Fail
Mean AE	0.3880	0.8336	Fail	Mean AE	0.5860	0.8336	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.5827	0.5983	Fail	47	0.8172	0.5983	Success
48	0.4141	0.4043	Success	48	0.9968	0.4043	Success
49	0.5743	0.8981	Fail	49	0.9884	0.8981	Success
50	0.6460	0.4830	Success	50	0.0717	0.4830	Fail
51	0.1070	0.1097	Fail	51	0.5390	0.1097	Success
52	0.0040	1.2669	Fail	52	0.1030	1.2669	Fail
Mean AE	0.3880	0.6267	Fail	Mean AE	0.5860	0.6267	Fail

Table 7 - Panel 3
Model Comparison-Caterpillar Tractor Co

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.1959						
47	1.2455	1.00	1.1959	0.4149	0.7074	0.8054	0.8703
48	1.7983	1.00	1.2455	-1.2562	-0.1281	-0.0053	0.3298
49	1.3817	1.00	1.7983	6.4967	3.7483	4.1475	3.0983
50	0.4443	1.00	1.3817	5.7798	3.3899	3.5808	2.7205
51	0.8612	1.00	0.4443	0.8573	0.9287	0.6508	0.7672
52	0.2775	1.00	0.8612	1.5585	1.2793	1.2099	1.1399
Mean AE		0.4738 *	0.4928	2.6034	1.4743	1.5481	1.1322

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.2455	0.8306	Fail	47	0.0496	0.8306	Fail
48	0.7983	3.0545	Fail	48	0.5528	3.0545	Fail
49	0.3817	5.1150	Fail	49	0.4166	5.1150	Fail
50	0.5557	5.3355	Fail	50	0.9374	5.3355	Fail
51	0.1388	0.0039	Success	51	0.4169	0.0039	Success
52	0.7225	1.2810	Fail	52	0.5837	1.2810	Fail
Mean AE	0.4738	2.6034	Fail	Mean AE	0.4928	2.6034	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.2455	0.5381	Fail	47	0.0496	0.5381	Fail
48	0.7983	1.9264	Fail	48	0.5528	1.9264	Fail
49	0.3817	2.3666	Fail	49	0.4166	2.3666	Fail
50	0.5557	2.9456	Fail	50	0.9374	2.9456	Fail
51	0.1388	0.0675	Success	51	0.4169	0.0675	Success
52	0.7225	1.0018	Fail	52	0.5837	1.0018	Fail
Mean AE	0.4738	1.4743	Fail	Mean AE	0.4928	1.4743	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.2455	0.4401	Fail	47	0.0496	0.4401	Fail
48	0.7983	1.8036	Fail	48	0.5528	1.8036	Fail
49	0.3817	2.7658	Fail	49	0.4166	2.7658	Fail
50	0.5557	3.1365	Fail	50	0.9374	3.1365	Fail
51	0.1388	0.2104	Fail	51	0.4169	0.2104	Success
52	0.7225	0.9324	Fail	52	0.5837	0.9324	Fail
Mean AE	0.4738	1.5481	Fail	Mean AE	0.4928	1.5481	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.2455	0.3752	Fail	47	0.0496	0.3752	Fail
48	0.7983	1.4685	Fail	48	0.5528	1.4685	Fail
49	0.3817	1.7166	Fail	49	0.4166	1.7166	Fail
50	0.5557	2.2762	Fail	50	0.9374	2.2762	Fail
51	0.1388	0.0940	Success	51	0.4169	0.0940	Success
52	0.7225	0.8624	Fail	52	0.5837	0.8624	Fail
Mean AE	0.4738	1.1322	Fail	Mean AE	0.4928	1.1322	Fail

Table 7 - Panel 4
Model Comparison-Digital Equipment Co

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
42	1.6884						
43	1.5178	1.00	1.6884	1.5570	1.2785	1.6227	1.4151
44	1.6149	1.00	1.5178	2.5773	1.7887	2.0476	1.6984
45	1.1845	1.00	1.6149	1.4817	1.2408	1.5483	1.3655
46	1.1545	1.00	1.1845	1.9997	1.4999	1.5921	1.3947
47	1.1012	1.00	1.1545	1.0633	1.0316	1.1089	1.0726
48	3.3030	1.00	1.1012	1.9677	1.4839	1.5345	1.3563
Mean AE		0.6460	0.4972	0.5862	0.4506	0.5192	0.4305
							*

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
43	0.5178	0.0392	Success	43	0.1706	0.0392	Success
44	0.6149	0.9624	Fail	44	0.0971	0.9624	Fail
45	0.1845	0.2972	Fail	45	0.4304	0.2972	Success
46	0.1545	0.8452	Fail	46	0.0300	0.8452	Fail
47	0.1012	0.0379	Success	47	0.0533	0.0379	Success
48	2.3030	1.3353	Success	48	2.2018	1.3353	Success
Mean AE	0.6460	0.5862	Success	Mean AE	0.4972	0.5862	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
43	0.5178	0.2393	Success	43	0.1706	0.2393	Fail
44	0.6149	0.1738	Success	44	0.0971	0.1738	Fail
45	0.1845	0.0563	Success	45	0.4304	0.0563	Success
46	0.1545	0.3454	Fail	46	0.0300	0.3454	Fail
47	0.1012	0.0696	Success	47	0.0533	0.0696	Fail
48	2.3030	1.8191	Success	48	2.2018	1.8191	Success
Mean AE	0.6460	0.4506	Success	Mean AE	0.4972	0.4506	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
43	0.5178	0.1049	Success	43	0.1706	0.1049	Success
44	0.6149	0.4327	Success	44	0.0971	0.4327	Fail
45	0.1845	0.3638	Fail	45	0.4304	0.3638	Success
46	0.1545	0.4376	Fail	46	0.0300	0.4376	Fail
47	0.1012	0.0077	Success	47	0.0533	0.0077	Success
48	2.3030	1.7685	Success	48	2.2018	1.7685	Success
Mean AE	0.6460	0.5192	Success	Mean AE	0.4972	0.5192	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
43	0.5178	0.1027	Success	43	0.1706	0.1027	Success
44	0.6149	0.0835	Success	44	0.0971	0.0835	Success
45	0.1845	0.1810	Success	45	0.4304	0.1810	Success
46	0.1545	0.2402	Fail	46	0.0300	0.2402	Fail
47	0.1012	0.0286	Success	47	0.0533	0.0286	Success
48	2.3030	1.9467	Success	48	2.2018	1.9467	Success
Mean AE	0.6460	0.4305	Success	Mean AE	0.4972	0.4305	Success

Table 7 - Panel 5
Model Comparison-Dow Chemical

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.4266						
47	1.0849	1.00	1.4266	3.3044	2.1522	2.3655	1.9103
48	1.5752	1.00	1.0849	1.7485	1.3742	1.4167	1.2778
49	1.3542	1.00	1.5752	1.4325	1.2163	1.5039	1.3359
50	1.1394	1.00	1.3542	1.4363	1.2182	1.3953	1.2635
51	1.2879	1.00	1.1394	1.5247	1.2623	1.3320	1.2214
52	1.0976	1.00	1.2879	1.6791	1.3396	1.4835	1.3223
Mean AE		0.2565	0.2678	0.5977	0.2921	0.3791	0.2594
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.0849	2.2195	Fail	47	0.3417	2.2195	Fail
48	0.5752	0.1733	Success	48	0.4903	0.1733	Success
49	0.3542	0.0783	Success	49	0.2210	0.0783	Success
50	0.1394	0.2969	Fail	50	0.2148	0.2969	Fail
51	0.2879	0.2368	Success	51	0.1485	0.2368	Fail
52	0.0976	0.5815	Fail	52	0.1903	0.5815	Fail
Mean AE	0.2565	0.5977	Fail	Mean AE	0.2678	0.5977	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.0849	1.0673	Fail	47	0.3417	1.0673	Fail
48	0.5752	0.2010	Success	48	0.4903	0.2010	Success
49	0.3542	0.1379	Success	49	0.2210	0.1379	Success
50	0.1394	0.0788	Success	50	0.2148	0.0788	Success
51	0.2879	0.0256	Success	51	0.1485	0.0256	Success
52	0.0976	0.2420	Fail	52	0.1903	0.2420	Fail
Mean AE	0.2565	0.2921	Fail	Mean AE	0.2678	0.2921	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.0849	1.2806	Fail	47	0.3417	1.2806	Fail
48	0.5752	0.1585	Success	48	0.4903	0.1585	Success
49	0.3542	0.1497	Success	49	0.2210	0.1497	Success
50	0.1394	0.2559	Fail	50	0.2148	0.2559	Fail
51	0.2879	0.0441	Success	51	0.1485	0.0441	Success
52	0.0976	0.3859	Fail	52	0.1903	0.3859	Fail
Mean AE	0.2565	0.3791	Fail	Mean AE	0.2678	0.3791	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.0849	0.8254	Fail	47	0.3417	0.8254	Fail
48	0.5752	0.2974	Success	48	0.4903	0.2974	Success
49	0.3542	0.0183	Success	49	0.2210	0.0183	Success
50	0.1394	0.1241	Success	50	0.2148	0.1241	Success
51	0.2879	0.0665	Success	51	0.1485	0.0665	Success
52	0.0976	0.2247	Fail	52	0.1903	0.2247	Fail
Mean AE	0.2565	0.2594	Fail	Mean AE	0.2678	0.2594	Success

Table 7 - Panel 6
Model Comparison-DuPont

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.0683						
47	1.4245	1.00	1.0683	1.3811	1.1905	1.2247	1.1498
48	0.7490	1.00	1.4245	2.6990	1.8495	2.0618	1.7078
49	1.0897	1.00	0.7490	1.4185	1.2093	1.0838	1.0558
50	0.3331	1.00	1.0897	1.3361	1.1680	1.2129	1.1419
51	0.8795	1.00	0.3331	1.0193	1.0097	0.6762	0.7841
52	1.6624	1.00	0.8795	0.7147	0.8574	0.7971	0.8647
Mean AE		0.3692 *	0.5764	0.7355	0.5374	0.5778	0.4949

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.4245	0.0434	Success	47	0.3562	0.0434	Success
48	0.2510	1.9500	Fail	48	0.6755	1.9500	Fail
49	0.0897	0.3288	Fail	49	0.3407	0.3288	Success
50	0.6669	1.0030	Fail	50	0.7566	1.0030	Fail
51	0.1205	0.1398	Fail	51	0.5464	0.1398	Success
52	0.6624	0.9477	Fail	52	0.7829	0.9477	Fail
Mean AE	0.3692	0.7355	Fail	Mean AE	0.5764	0.7355	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.4245	0.2340	Success	47	0.3562	0.2340	Success
48	0.2510	1.1005	Fail	48	0.6755	1.1005	Fail
49	0.0897	0.1196	Fail	49	0.3407	0.1196	Success
50	0.6669	0.8349	Fail	50	0.7566	0.8349	Fail
51	0.1205	0.1302	Fail	51	0.5464	0.1302	Success
52	0.6624	0.8050	Fail	52	0.7829	0.8050	Fail
Mean AE	0.3692	0.5374	Fail	Mean AE	0.5764	0.5374	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.4245	0.1998	Success	47	0.3562	0.1998	Success
48	0.2510	1.3128	Fail	48	0.6755	1.3128	Fail
49	0.0897	0.0059	Success	49	0.3407	0.0059	Success
50	0.6669	0.8798	Fail	50	0.7566	0.8798	Fail
51	0.1205	0.2033	Fail	51	0.5464	0.2033	Success
52	0.6624	0.8653	Fail	52	0.7829	0.8653	Fail
Mean AE	0.3692	0.5778	Fail	Mean AE	0.5764	0.5778	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.4245	0.2747	Success	47	0.3562	0.2747	Success
48	0.2510	0.9588	Fail	48	0.6755	0.9588	Fail
49	0.0897	0.0339	Success	49	0.3407	0.0339	Success
50	0.6669	0.8088	Fail	50	0.7566	0.8088	Fail
51	0.1205	0.0954	Success	51	0.5464	0.0954	Success
52	0.6624	0.7977	Fail	52	0.7829	0.7977	Fail
Mean AE	0.3692	0.4949	Fail	Mean AE	0.5764	0.4949	Success

Table 7 - Panel 7

Model Comparison-Eastman Kodak Co

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.8640						
47	0.8343	1.00	0.8640	1.2632	1.1316	1.0636	1.0424
48	0.6205	1.00	0.8343	1.7372	1.3686	1.2858	1.1905
49	-0.0514	1.00	0.6205	0.5701	0.7850	0.5953	0.7302
50	0.5138	1.00	-0.0514	0.2001	0.6000	0.0743	0.3829
51	0.6506	1.00	0.5138	1.4100	1.2050	0.9619	0.9746
52	-0.2611	1.00	0.6506	0.4068	0.7034	0.5287	0.6858
Mean AE		0.6156	0.4215	0.6513	0.5812	0.5136	0.4936
			*				

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1657	0.4289	Fail	47	0.0297	0.4289	Fail
48	0.3795	1.1167	Fail	48	0.2138	1.1167	Fail
49	1.0514	0.6215	Success	49	0.6719	0.6215	Success
50	0.4862	0.3137	Success	50	0.5652	0.3137	Success
51	0.3494	0.7594	Fail	51	0.1368	0.7594	Fail
52	1.2611	0.6679	Success	52	0.9117	0.6679	Success
Mean AE	0.6156	0.6513	Fail	Mean AE	0.4215	0.6513	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.1657	0.2973	Fail	47	0.0297	0.2973	Fail
48	0.3795	0.7481	Fail	48	0.2138	0.7481	Fail
49	1.0514	0.8364	Success	49	0.6719	0.8364	Fail
50	0.4862	0.0862	Success	50	0.5652	0.0862	Success
51	0.3494	0.5544	Fail	51	0.1368	0.5544	Fail
52	1.2611	0.9645	Success	52	0.9117	0.9645	Fail
Mean AE	0.6156	0.5812	Success	Mean AE	0.4215	0.5812	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.1657	0.2293	Fail	47	0.0297	0.2293	Fail
48	0.3795	0.6653	Fail	48	0.2138	0.6653	Fail
49	1.0514	0.6467	Success	49	0.6719	0.6467	Success
50	0.4862	0.4395	Success	50	0.5652	0.4395	Success
51	0.3494	0.3113	Success	51	0.1368	0.3113	Fail
52	1.2611	0.7898	Success	52	0.9117	0.7898	Success
Mean AE	0.6156	0.5136	Success	Mean AE	0.4215	0.5136	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.1657	0.2081	Fail	47	0.0297	0.2081	Fail
48	0.3795	0.5700	Fail	48	0.2138	0.5700	Fail
49	1.0514	0.7816	Success	49	0.6719	0.7816	Fail
50	0.4862	0.1309	Success	50	0.5652	0.1309	Success
51	0.3494	0.3240	Success	51	0.1368	0.3240	Fail
52	1.2611	0.9469	Success	52	0.9117	0.9469	Fail
Mean AE	0.6156	0.4936	Success	Mean AE	0.4215	0.4936	Fail

Table 7 - Panel 8

Model Comparison-Ford Motor Co

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.3454						
47	1.1174	1.00	1.3454	1.1845	1.0923	1.2650	1.1766
48	1.6651	1.00	1.1174	1.4574	1.2287	1.2874	1.1916
49	1.0990	1.00	1.6651	1.1715	1.0857	1.4183	1.2789
50	1.9794	1.00	1.0990	1.4780	1.2390	1.2885	1.1923
51	2.0278	1.00	1.9794	1.8040	1.4020	1.8917	1.5945
52	2.3789	1.00	2.0278	1.4520	1.2260	1.7399	1.4933
Mean AE		0.7113	0.4370	0.3332 *	0.4990	0.3851	0.4698

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1174	0.0671	Success	47	0.2280	0.0671	Success
48	0.6651	0.2077	Success	48	0.5477	0.2077	Success
49	0.0990	0.0725	Success	49	0.5661	0.0725	Success
50	0.9794	0.5014	Success	50	0.8804	0.5014	Success
51	1.0278	0.2238	Success	51	0.0484	0.2238	Fail
52	1.3789	0.9269	Success	52	0.3511	0.9269	Fail
Mean AE	0.7113	0.3332	Success	Mean AE	0.4370	0.3332	Success

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.1174	0.0251	Success	47	0.2280	0.0251	Success
48	0.6651	0.4364	Success	48	0.5477	0.4364	Success
49	0.0990	0.0133	Success	49	0.5661	0.0133	Success
50	0.9794	0.7404	Success	50	0.8804	0.7404	Success
51	1.0278	0.6258	Success	51	0.0484	0.6258	Fail
52	1.3789	1.1529	Success	52	0.3511	1.1529	Fail
Mean AE	0.7113	0.4990	Success	Mean AE	0.4370	0.4990	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.1174	0.1476	Fail	47	0.2280	0.1476	Success
48	0.6651	0.3777	Success	48	0.5477	0.3777	Success
49	0.0990	0.3193	Fail	49	0.5661	0.3193	Success
50	0.9794	0.6909	Success	50	0.8804	0.6909	Success
51	1.0278	0.1361	Success	51	0.0484	0.1361	Fail
52	1.3789	0.6390	Success	52	0.3511	0.6390	Fail
Mean AE	0.7113	0.3851	Success	Mean AE	0.4370	0.3851	Success

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.1174	0.0592	Success	47	0.2280	0.0592	Success
48	0.6651	0.4735	Success	48	0.5477	0.4735	Success
49	0.0990	0.1799	Fail	49	0.5661	0.1799	Success
50	0.9794	0.7871	Success	50	0.8804	0.7871	Success
51	1.0278	0.4333	Success	51	0.0484	0.4333	Fail
52	1.3789	0.8856	Success	52	0.3511	0.8856	Fail
Mean AE	0.7113	0.4698	Success	Mean AE	0.4370	0.4698	Fail

Table 7 - Panel 9

Model Comparison-General Electric Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.8559						
47	1.1056	1.00	0.8559	0.8770	0.9385	0.8665	0.9110
48	1.2210	1.00	1.1056	0.7441	0.8721	0.9249	0.9499
49	1.6714	1.00	1.2210	1.6230	1.3115	1.4220	1.2813
50	0.8879	1.00	1.6714	1.2460	1.1230	1.4587	1.3058
51	0.9784	1.00	0.8879	1.7458	1.3729	1.3169	1.2112
52	2.1643	1.00	0.9784	1.4413	1.2207	1.2099	1.1399
Mean AE		0.3827	0.4792	0.4337	0.4082	0.4414	0.4218
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1056	0.2286	Fail	47	0.2497	0.2286	Success
48	0.2210	0.4769	Fail	48	0.1154	0.4769	Fail
49	0.6714	0.0484	Success	49	0.4504	0.0484	Success
50	0.1121	0.3581	Fail	50	0.7835	0.3581	Success
51	0.0216	0.7674	Fail	51	0.0905	0.7674	Fail
52	1.1643	0.7230	Success	52	1.1859	0.7230	Success
Mean AE	0.3827	0.4337	Fail	Mean AE	0.4792	0.4337	Success

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.1056	0.1671	Fail	47	0.2497	0.1671	Success
48	0.2210	0.3489	Fail	48	0.1154	0.3489	Fail
49	0.6714	0.3599	Success	49	0.4504	0.3599	Success
50	0.1121	0.2351	Fail	50	0.7835	0.2351	Success
51	0.0216	0.3945	Fail	51	0.0905	0.3945	Fail
52	1.1643	0.9436	Success	52	1.1859	0.9436	Success
Mean AE	0.3827	0.4082	Fail	Mean AE	0.4792	0.4082	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.1056	0.2391	Fail	47	0.2497	0.2391	Success
48	0.2210	0.2961	Fail	48	0.1154	0.2961	Fail
49	0.6714	0.2494	Success	49	0.4504	0.2494	Success
50	0.1121	0.5708	Fail	50	0.7835	0.5708	Success
51	0.0216	0.3385	Fail	51	0.0905	0.3385	Fail
52	1.1643	0.9544	Success	52	1.1859	0.9544	Success
Mean AE	0.3827	0.4414	Fail	Mean AE	0.4792	0.4414	Success

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.1056	0.1946	Fail	47	0.2497	0.1946	Success
48	0.2210	0.2711	Fail	48	0.1154	0.2711	Fail
49	0.6714	0.3901	Success	49	0.4504	0.3901	Success
50	0.1121	0.4179	Fail	50	0.7835	0.4179	Success
51	0.0216	0.2328	Fail	51	0.0905	0.2328	Fail
52	1.1643	1.0244	Success	52	1.1859	1.0244	Success
Mean AE	0.3827	0.4218	Fail	Mean AE	0.4792	0.4218	Success

Table 7 - Panel 10

Model Comparison-General Instruments Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
44	1.7479						
45	1.6957	1.00	1.7479	2.2974	1.6487	2.0226	1.6818
46	2.1590	1.00	1.6957	1.6418	1.3209	1.6688	1.4458
47	1.2201	1.00	2.1590	1.8719	1.4359	2.0154	1.6770
48	0.6423	1.00	1.2201	1.0669	1.0334	1.1435	1.0957
49	0.9678	1.00	0.6423	-0.2964	0.3518	0.1730	0.4486
50	2.5333	1.00	0.9678	1.1281	1.0640	1.0479	1.0320
Mean AE		0.6663	0.6539	0.8108	0.5962 *	0.7323	0.6096

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
45	0.6957	0.6017	Success	45	0.0522	0.6017	Fail
46	1.1590	0.5172	Success	46	0.4633	0.5172	Fail
47	0.2201	0.6518	Fail	47	0.9389	0.6518	Success
48	0.3577	0.4246	Fail	48	0.5778	0.4246	Success
49	0.0322	1.2642	Fail	49	0.3255	1.2642	Fail
50	1.5333	1.4052	Success	50	1.5655	1.4052	Success
Mean AE	0.6663	0.8108	Fail	Mean AE	0.6539	0.8108	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
45	0.6957	0.0470	Success	45	0.0522	0.0470	Success
46	1.1590	0.8381	Success	46	0.4633	0.8381	Fail
47	0.2201	0.2158	Success	47	0.9389	0.2158	Success
48	0.3577	0.3911	Fail	48	0.5778	0.3911	Success
49	0.0322	0.6160	Fail	49	0.3255	0.6160	Fail
50	1.5333	1.4693	Success	50	1.5655	1.4693	Success
Mean AE	0.6663	0.5962	Success	Mean AE	0.6539	0.5962	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
45	0.6957	0.3269	Success	45	0.0522	0.3269	Fail
46	1.1590	0.4902	Success	46	0.4633	0.4902	Fail
47	0.2201	0.7953	Fail	47	0.9389	0.7953	Success
48	0.3577	0.5012	Fail	48	0.5778	0.5012	Success
49	0.0322	0.7948	Fail	49	0.3255	0.7948	Fail
50	1.5333	1.4854	Success	50	1.5655	1.4854	Success
Mean AE	0.6663	0.7323	Fail	Mean AE	0.6539	0.7323	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
45	0.6957	0.0139	Success	45	0.0522	0.0139	Success
46	1.1590	0.7132	Success	46	0.4633	0.7132	Fail
47	0.2201	0.4569	Fail	47	0.9389	0.4569	Success
48	0.3577	0.4534	Fail	48	0.5778	0.4534	Success
49	0.0322	0.5192	Fail	49	0.3255	0.5192	Fail
50	1.5333	1.5013	Success	50	1.5655	1.5013	Success
Mean AE	0.6663	0.6096	Success	Mean AE	0.6539	0.6096	Success

Table 7 - Panel 11

Model Comparison-General Motors

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.1234						
47	1.0411	1.00	1.1234	0.9072	0.9536	1.0153	1.0102
48	1.6556	1.00	1.0411	0.9579	0.9789	0.9995	0.9997
49	1.3565	1.00	1.6556	1.0414	1.0207	1.3485	1.2323
50	1.1802	1.00	1.3565	0.9321	0.9660	1.1443	1.0962
51	1.2743	1.00	1.1802	0.9213	0.9606	1.0507	1.0338
52	1.3212	1.00	1.2743	1.2493	1.1247	1.2618	1.1745
Mean AE		0.3048	0.2189	0.3033	0.3041	0.1681	0.2137
						*	

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.0411	0.1339	Fail	47	0.0823	0.1339	Fail
48	0.6556	0.6977	Fail	48	0.6145	0.6977	Fail
49	0.3565	0.3151	Success	49	0.2991	0.3151	Fail
50	0.1802	0.2481	Fail	50	0.1763	0.2481	Fail
51	0.2743	0.3530	Fail	51	0.0941	0.3530	Fail
52	0.3212	0.0719	Success	52	0.0469	0.0719	Fail
Mean AE	0.3048	0.3033	Success	Mean AE	0.2189	0.3033	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.0411	0.0875	Fail	47	0.0823	0.0875	Fail
48	0.6556	0.6767	Fail	48	0.6145	0.6767	Fail
49	0.3565	0.3358	Success	49	0.2991	0.3358	Fail
50	0.1802	0.2142	Fail	50	0.1763	0.2142	Fail
51	0.2743	0.3137	Fail	51	0.0941	0.3137	Fail
52	0.3212	0.1965	Success	52	0.0469	0.1965	Fail
Mean AE	0.3048	0.3041	Success	Mean AE	0.2189	0.3041	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.0411	0.0258	Success	47	0.0823	0.0258	Success
48	0.6556	0.6561	Fail	48	0.6145	0.6561	Fail
49	0.3565	0.0080	Success	49	0.2991	0.0080	Success
50	0.1802	0.0359	Success	50	0.1763	0.0359	Success
51	0.2743	0.2236	Success	51	0.0941	0.2236	Fail
52	0.3212	0.0594	Success	52	0.0469	0.0594	Fail
Mean AE	0.3048	0.1681	Success	Mean AE	0.2189	0.1681	Success

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.0411	0.0309	Success	47	0.0823	0.0309	Success
48	0.6556	0.6559	Fail	48	0.6145	0.6559	Fail
49	0.3565	0.1242	Success	49	0.2991	0.1242	Success
50	0.1802	0.0840	Success	50	0.1763	0.0840	Success
51	0.2743	0.2405	Success	51	0.0941	0.2405	Fail
52	0.3212	0.1467	Success	52	0.0469	0.1467	Fail
Mean AE	0.3048	0.2137	Success	Mean AE	0.2189	0.2137	Success

Table 7 - Panel 12

Model Comparison-Hewlett-Packard Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.6142						
47	1.7004	1.00	1.6142	2.0881	1.5440	1.8511	1.5674
48	1.0738	1.00	1.7004	2.2740	1.6370	1.9872	1.6581
49	1.2700	1.00	1.0738	1.5070	1.2535	1.2904	1.1936
50	0.8765	1.00	1.2700	2.1890	1.5945	1.7295	1.4863
51	1.8146	1.00	0.8765	0.9365	0.9682	0.9065	0.9377
52	2.0766	1.00	1.8146	3.0743	2.0372	2.4445	1.9630
Mean AE		0.5098	0.4171	0.8355	0.3900	0.5356	0.3990
					*		

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.7004	0.3877	Success	47	0.0862	0.3877	Fail
48	0.0738	1.2002	Fail	48	0.6266	1.2002	Fail
49	0.2700	0.2370	Success	49	0.1962	0.2370	Fail
50	0.1235	1.3125	Fail	50	0.3935	1.3125	Fail
51	0.8146	0.8781	Fail	51	0.9381	0.8781	Success
52	1.0766	0.9977	Success	52	0.2620	0.9977	Fail
Mean AE	0.5098	0.8355	Fail	Mean AE	0.4171	0.8355	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.7004	0.1564	Success	47	0.0862	0.1564	Fail
48	0.0738	0.5632	Fail	48	0.6266	0.5632	Success
49	0.2700	0.0165	Success	49	0.1962	0.0165	Success
50	0.1235	0.7180	Fail	50	0.3935	0.7180	Fail
51	0.8146	0.8464	Fail	51	0.9381	0.8464	Success
52	1.0766	0.0394	Success	52	0.2620	0.0394	Success
Mean AE	0.5098	0.3900	Success	Mean AE	0.4171	0.3900	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.7004	0.1507	Success	47	0.0862	0.1507	Fail
48	0.0738	0.9134	Fail	48	0.6266	0.9134	Fail
49	0.2700	0.0204	Success	49	0.1962	0.0204	Success
50	0.1235	0.8530	Fail	50	0.3935	0.8530	Fail
51	0.8146	0.9081	Fail	51	0.9381	0.9081	Success
52	1.0766	0.3679	Success	52	0.2620	0.3679	Fail
Mean AE	0.5098	0.5356	Fail	Mean AE	0.4171	0.5356	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.7004	0.1330	Success	47	0.0862	0.1330	Fail
48	0.0738	0.5843	Fail	48	0.6266	0.5843	Success
49	0.2700	0.0764	Success	49	0.1962	0.0764	Success
50	0.1235	0.6098	Fail	50	0.3935	0.6098	Fail
51	0.8146	0.8769	Fail	51	0.9381	0.8769	Success
52	1.0766	0.1136	Success	52	0.2620	0.1136	Success
Mean AE	0.5098	0.3990	Success	Mean AE	0.4171	0.3990	Success

Table 7 - Panel 13
Model Comparison-Honeywell Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.2616						
47	1.6896	1.00	1.2616	1.2420	1.1210	1.2518	1.1679
48	1.5863	1.00	1.6896	1.6024	1.3012	1.6460	1.4307
49	0.9342	1.00	1.5863	1.9298	1.4649	1.7581	1.5054
50	1.4930	1.00	0.9342	1.4070	1.2035	1.1706	1.1137
51	0.7986	1.00	1.4930	1.8627	1.4314	1.6779	1.4519
52	1.9265	1.00	0.7986	1.1338	1.0669	0.9662	0.9775
Mean AE		0.4938	0.5941	0.5670	0.5277	0.5806	0.5384
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.6896	0.4476	Success	47	0.4280	0.4476	Fail
48	0.5863	0.0161	Success	48	0.1033	0.0161	Success
49	0.0658	0.9956	Fail	49	0.6521	0.9956	Fail
50	0.4930	0.0860	Success	50	0.5588	0.0860	Success
51	0.2014	1.0641	Fail	51	0.6944	1.0641	Fail
52	0.9265	0.7927	Success	52	1.1279	0.7927	Success
Mean AE	0.4938	0.5670	Fail	Mean AE	0.5941	0.5670	Success

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.6896	0.5686	Success	47	0.4280	0.5686	Fail
48	0.5863	0.2851	Success	48	0.1033	0.2851	Fail
49	0.0658	0.5307	Fail	49	0.6521	0.5307	Success
50	0.4930	0.2895	Success	50	0.5588	0.2895	Success
51	0.2014	0.6328	Fail	51	0.6944	0.6328	Success
52	0.9265	0.8596	Success	52	1.1279	0.8596	Success
Mean AE	0.4938	0.5277	Fail	Mean AE	0.5941	0.5277	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.6896	0.4378	Success	47	0.4280	0.4378	Fail
48	0.5863	0.0597	Success	48	0.1033	0.0597	Success
49	0.0658	0.8239	Fail	49	0.6521	0.8239	Fail
50	0.4930	0.3224	Success	50	0.5588	0.3224	Success
51	0.2014	0.8793	Fail	51	0.6944	0.8793	Fail
52	0.9265	0.9603	Fail	52	1.1279	0.9603	Success
Mean AE	0.4938	0.5806	Fail	Mean AE	0.5941	0.5806	Success

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.6896	0.5217	Success	47	0.4280	0.5217	Fail
48	0.5863	0.1556	Success	48	0.1033	0.1556	Fail
49	0.0658	0.5712	Fail	49	0.6521	0.5712	Success
50	0.4930	0.3793	Success	50	0.5588	0.3793	Success
51	0.2014	0.6533	Fail	51	0.6944	0.6533	Success
52	0.9265	0.9490	Fail	52	1.1279	0.9490	Success
Mean AE	0.4938	0.5384	Fail	Mean AE	0.5941	0.5384	Success

Table 7 - Panel 14
Model Comparison-IBM Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.9105						
47	1.0929	1.00	0.9105	0.5881	0.7940	0.7493	0.8329
48	0.6268	1.00	1.0929	1.1247	1.0623	1.1088	1.0725
49	1.2794	1.00	0.6268	0.7285	0.8642	0.6776	0.7851
50	1.0170	1.00	1.2794	0.9993	0.9997	1.1394	1.0929
51	0.6989	1.00	1.0170	1.3652	1.1826	1.1911	1.1274
52	1.4406	1.00	0.6989	0.9826	0.9913	0.8407	0.8938
Mean AE		0.2507	0.4372	0.4493	0.3500	0.4403	0.3752
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.0929	0.5048	Fail	47	0.1824	0.5048	Fail
48	0.3732	0.4979	Fail	48	0.4661	0.4979	Fail
49	0.2794	0.5509	Fail	49	0.6526	0.5509	Success
50	0.0170	0.0177	Fail	50	0.2624	0.0177	Success
51	0.3011	0.6663	Fail	51	0.3181	0.6663	Fail
52	0.4406	0.4580	Fail	52	0.7417	0.4580	Success
Mean AE	0.2507	0.4493	Fail	Mean AE	0.4372	0.4493	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.0929	0.2989	Fail	47	0.1824	0.2989	Fail
48	0.3732	0.4355	Fail	48	0.4661	0.4355	Success
49	0.2794	0.4152	Fail	49	0.6526	0.4152	Success
50	0.0170	0.0173	Fail	50	0.2624	0.0173	Success
51	0.3011	0.4837	Fail	51	0.3181	0.4837	Fail
52	0.4406	0.4493	Fail	52	0.7417	0.4493	Success
Mean AE	0.2507	0.3500	Fail	Mean AE	0.4372	0.3500	Success

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.0929	0.3436	Fail	47	0.1824	0.3436	Fail
48	0.3732	0.4820	Fail	48	0.4661	0.4820	Fail
49	0.2794	0.6018	Fail	49	0.6526	0.6018	Success
50	0.0170	0.1224	Fail	50	0.2624	0.1224	Success
51	0.3011	0.4922	Fail	51	0.3181	0.4922	Fail
52	0.4406	0.5999	Fail	52	0.7417	0.5999	Success
Mean AE	0.2507	0.4403	Fail	Mean AE	0.4372	0.4403	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.0929	0.2600	Fail	47	0.1824	0.2600	Fail
48	0.3732	0.4457	Fail	48	0.4661	0.4457	Success
49	0.2794	0.4943	Fail	49	0.6526	0.4943	Success
50	0.0170	0.0759	Fail	50	0.2624	0.0759	Success
51	0.3011	0.4285	Fail	51	0.3181	0.4285	Fail
52	0.4406	0.5468	Fail	52	0.7417	0.5468	Success
Mean AE	0.2507	0.3752	Fail	Mean AE	0.4372	0.3752	Success

Table 7 - Panel 15

Model Comparison-International Paper Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	1.4733						
47	1.5342	1.00	1.4733	0.8592	0.9296	1.1663	1.1108
48	1.2630	1.00	1.5342	3.7716	2.3858	2.6529	2.1019
49	1.1070	1.00	1.2630	1.2235	1.1117	1.2432	1.1622
50	1.2245	1.00	1.1070	1.5002	1.2501	1.3036	1.2024
51	1.0503	1.00	1.2245	2.6838	1.8419	1.9542	1.6361
52	-0.7497	1.00	1.0503	1.8338	1.4169	1.4421	1.2947
Mean AE		0.4881	0.4300 *	1.2988	0.7860	0.8448	0.6616

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.5342	0.6750	Fail	47	0.0609	0.6750	Fail
48	0.2630	2.5086	Fail	48	0.2712	2.5086	Fail
49	0.1070	0.1165	Fail	49	0.1560	0.1165	Success
50	0.2245	0.2757	Fail	50	0.1175	0.2757	Fail
51	0.0503	1.6335	Fail	51	0.1742	1.6335	Fail
52	1.7497	2.5835	Fail	52	1.8000	2.5835	Fail
Mean AE	0.4881	1.2988	Fail	Mean AE	0.4300	1.2988	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.5342	0.6046	Fail	47	0.0609	0.6046	Fail
48	0.2630	1.1228	Fail	48	0.2712	1.1228	Fail
49	0.1070	0.0047	Success	49	0.1560	0.0047	Success
50	0.2245	0.0256	Success	50	0.1175	0.0256	Success
51	0.0503	0.7916	Fail	51	0.1742	0.7916	Fail
52	1.7497	2.1666	Fail	52	1.8000	2.1666	Fail
Mean AE	0.4881	0.7860	Fail	Mean AE	0.4300	0.7860	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.5342	0.3679	Success	47	0.0609	0.3679	Fail
48	0.2630	1.3899	Fail	48	0.2712	1.3899	Fail
49	0.1070	0.1362	Fail	49	0.1560	0.1362	Success
50	0.2245	0.0791	Success	50	0.1175	0.0791	Success
51	0.0503	0.9039	Fail	51	0.1742	0.9039	Fail
52	1.7497	2.1918	Fail	52	1.8000	2.1918	Fail
Mean AE	0.4881	0.8448	Fail	Mean AE	0.4300	0.8448	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.5342	0.4234	Success	47	0.0609	0.4234	Fail
48	0.2630	0.8389	Fail	48	0.2712	0.8389	Fail
49	0.1070	0.0552	Success	49	0.1560	0.0552	Success
50	0.2245	0.0221	Success	50	0.1175	0.0221	Success
51	0.0503	0.5858	Fail	51	0.1742	0.5858	Fail
52	1.7497	2.0444	Fail	52	1.8000	2.0444	Fail
Mean AE	0.4881	0.6616	Fail	Mean AE	0.4300	0.6616	Fail

Table 7 - Panel 16

Model Comparison-Johnson & Johnson Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.9692						
47	0.8440	1.00	0.9692	2.7562	1.8781	1.8627	1.5751
48	0.3003	1.00	0.8440	-1.6988	-0.3494	-0.4274	0.0484
49	1.2059	1.00	0.3003	0.3426	0.6713	0.3214	0.5476
50	0.8298	1.00	1.2059	0.7877	0.8938	0.9968	0.9979
51	0.8619	1.00	0.8298	0.6492	0.8246	0.7395	0.8263
52	1.8650	1.00	0.8619	-0.3543	0.3228	0.2538	0.5025
Mean AE		0.3725	0.4976	1.2081	0.6437	0.7553	0.5346
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1560	1.9122	Fail	47	0.1252	1.9122	Fail
48	0.6997	1.9991	Fail	48	0.5437	1.9991	Fail
49	0.2059	0.8633	Fail	49	0.9056	0.8633	Success
50	0.1702	0.0421	Success	50	0.3761	0.0421	Success
51	0.1381	0.2127	Fail	51	0.0321	0.2127	Fail
52	0.8650	2.2193	Fail	52	1.0031	2.2193	Fail
Mean AE	0.3725	1.2081	Fail	Mean AE	0.4976	1.2081	Fail

	Naive=1	C=1 & E			Naive=NC	C=1 & E	
47	0.1560	1.0341	Fail	47	0.1252	1.0341	Fail
48	0.6997	0.6497	Success	48	0.5437	0.6497	Fail
49	0.2059	0.5346	Fail	49	0.9056	0.5346	Success
50	0.1702	0.0640	Success	50	0.3761	0.0640	Success
51	0.1381	0.0373	Success	51	0.0321	0.0373	Fail
52	0.8650	1.5422	Fail	52	1.0031	1.5422	Fail
Mean AE	0.3725	0.6437	Fail	Mean AE	0.4976	0.6437	Fail

	Naive=1	C=NC & E			Naive=NC	C=NC & E	
47	0.1560	1.0187	Fail	47	0.1252	1.0187	Fail
48	0.6997	0.7277	Fail	48	0.5437	0.7277	Fail
49	0.2059	0.8845	Fail	49	0.9056	0.8845	Success
50	0.1702	0.1670	Success	50	0.3761	0.1670	Success
51	0.1381	0.1224	Success	51	0.0321	0.1224	Fail
52	0.8650	1.6112	Fail	52	1.0031	1.6112	Fail
Mean AE	0.3725	0.7553	Fail	Mean AE	0.4976	0.7553	Fail

	Naive=1	C=1,NC&E			Naive=NC	C=1,NC&E	
47	0.1560	0.7311	Fail	47	0.1252	0.7311	Fail
48	0.6997	0.2519	Success	48	0.5437	0.2519	Success
49	0.2059	0.6583	Fail	49	0.9056	0.6583	Success
50	0.1702	0.1681	Success	50	0.3761	0.1681	Success
51	0.1381	0.0356	Success	51	0.0321	0.0356	Fail
52	0.8650	1.3625	Fail	52	1.0031	1.3625	Fail
Mean AE	0.3725	0.5346	Fail	Mean AE	0.4976	0.5346	Fail

Table 7 - Panel 17
Model Comparison-Merck & Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & E	C=NC & E	C=1,NC&E
46	0.8487						
47	0.8378	1.00	0.8487	0.8613	0.9306	0.8550	0.9033
48	0.8076	1.00	0.8378	1.1016	1.0508	0.9697	0.9798
49	0.9034	1.00	0.8076	1.0930	1.0465	0.9503	0.9669
50	0.8505	1.00	0.9034	0.8323	0.9161	0.8678	0.9119
51	0.7883	1.00	0.8505	1.0394	1.0197	0.9449	0.9633
52	0.4390	1.00	0.7883	0.7933	0.8966	0.7908	0.8605
Mean AE		0.2289	0.1002	0.1885	0.2056	0.1253	0.1599
			*				

Absolute Errors

	Naive=1	Experimnt	
47	0.1622	0.0235	Success
48	0.1924	0.2940	Fail
49	0.0966	0.1896	Fail
50	0.1495	0.0182	Success
51	0.2117	0.2511	Fail
52	0.5610	0.3543	Success
Mean AE	0.2289	0.1885	Success

	Naive=NC	Experimnt	
47	0.0109	0.0235	Fail
48	0.0302	0.2940	Fail
49	0.0958	0.1896	Fail
50	0.0529	0.0182	Success
51	0.0622	0.2511	Fail
52	0.3493	0.3543	Fail
Mean AE	0.1002	0.1885	Fail

	Naive=1	C=1 & E	
47	0.1622	0.0928	Success
48	0.1924	0.2432	Fail
49	0.0966	0.1431	Fail
50	0.1495	0.0656	Success
51	0.2117	0.2314	Fail
52	0.5610	0.4576	Success
Mean AE	0.2289	0.2056	Success

	Naive=NC	C=1 & E	
47	0.0109	0.0928	Fail
48	0.0302	0.2432	Fail
49	0.0958	0.1431	Fail
50	0.0529	0.0656	Fail
51	0.0622	0.2314	Fail
52	0.3493	0.4576	Fail
Mean AE	0.1002	0.2056	Fail

	Naive=1	C=NC & E	
47	0.1622	0.0172	Success
48	0.1924	0.1621	Success
49	0.0966	0.0469	Success
50	0.1495	0.0173	Success
51	0.2117	0.1566	Success
52	0.5610	0.3518	Success
Mean AE	0.2289	0.1253	Success

	Naive=NC	C=NC & E	
47	0.0109	0.0172	Fail
48	0.0302	0.1621	Fail
49	0.0958	0.0469	Success
50	0.0529	0.0173	Success
51	0.0622	0.1566	Fail
52	0.3493	0.3518	Fail
Mean AE	0.1002	0.1253	Fail

	Naive=1	C=1,NC&E	
47	0.1622	0.0655	Success
48	0.1924	0.1722	Success
49	0.0966	0.0635	Success
50	0.1495	0.0614	Success
51	0.2117	0.1750	Success
52	0.5610	0.4215	Success
Mean AE	0.2289	0.1599	Success

	Naive=NC	C=1,NC&E	
47	0.0109	0.0655	Fail
48	0.0302	0.1722	Fail
49	0.0958	0.0635	Success
50	0.0529	0.0614	Fail
51	0.0622	0.1750	Fail
52	0.3493	0.4215	Fail
Mean AE	0.1002	0.1599	Fail

Table 7 - Panel 18

Model Comparison-Minnesota Mining & Manufacturing Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.1256						
47	1.1973	1.00	1.1256	0.9080	0.9540	1.0168	1.0112
48	0.9399	1.00	1.1973	0.3066	0.6533	0.7520	0.8346
49	1.0095	1.00	0.9399	1.2738	1.1369	1.1069	1.0712
50	1.1857	1.00	1.0095	0.6842	0.8421	0.8469	0.8979
51	0.8630	1.00	1.1857	0.9088	0.9544	1.0473	1.0315
52	1.1297	1.00	0.8630	0.8257	0.9128	0.8443	0.8962
Mean AE		0.1199	0.1941	0.3397	0.2182	0.2124	0.1738
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1973	0.2893	Fail	47	0.0717	0.2893	Fail
48	0.0601	0.6333	Fail	48	0.2574	0.6333	Fail
49	0.0095	0.2643	Fail	49	0.0696	0.2643	Fail
50	0.1857	0.5015	Fail	50	0.1762	0.5015	Fail
51	0.1370	0.0458	Success	51	0.3227	0.0458	Success
52	0.1297	0.3040	Fail	52	0.2667	0.3040	Fail
Mean AE	0.1199	0.3397	Fail	Mean AE	0.1941	0.3397	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.1973	0.2433	Fail	47	0.0717	0.2433	Fail
48	0.0601	0.2866	Fail	48	0.2574	0.2866	Fail
49	0.0095	0.1274	Fail	49	0.0696	0.1274	Fail
50	0.1857	0.3436	Fail	50	0.1762	0.3436	Fail
51	0.1370	0.0914	Success	51	0.3227	0.0914	Success
52	0.1297	0.2169	Fail	52	0.2667	0.2169	Success
Mean AE	0.1199	0.2182	Fail	Mean AE	0.1941	0.2182	Fail

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.1973	0.1805	Success	47	0.0717	0.1805	Fail
48	0.0601	0.1879	Fail	48	0.2574	0.1879	Success
49	0.0095	0.0974	Fail	49	0.0696	0.0974	Fail
50	0.1857	0.3388	Fail	50	0.1762	0.3388	Fail
51	0.1370	0.1843	Fail	51	0.3227	0.1843	Success
52	0.1297	0.2854	Fail	52	0.2667	0.2854	Fail
Mean AE	0.1199	0.2124	Fail	Mean AE	0.1941	0.2124	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.1973	0.1861	Success	47	0.0717	0.1861	Fail
48	0.0601	0.1053	Fail	48	0.2574	0.1053	Success
49	0.0095	0.0617	Fail	49	0.0696	0.0617	Success
50	0.1857	0.2878	Fail	50	0.1762	0.2878	Fail
51	0.1370	0.1685	Fail	51	0.3227	0.1685	Success
52	0.1297	0.2335	Fail	52	0.2667	0.2335	Success
Mean AE	0.1199	0.1738	Fail	Mean AE	0.1941	0.1738	Success

Table 7 - Panel 19

Model Comparison-Monsanto Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.3476						
47	1.4243	1.00	1.3476	1.4422	1.2211	1.3949	1.2633
48	1.8767	1.00	1.4243	2.1133	1.5566	1.7688	1.5125
49	1.4424	1.00	1.8767	2.0819	1.5410	1.9793	1.6529
50	0.8578	1.00	1.4424	1.9127	1.4564	1.6776	1.4517
51	0.8202	1.00	0.8578	1.6220	1.3110	1.2399	1.1599
52	0.8889	1.00	0.8202	1.8944	1.4472	1.3573	1.2382
Mean AE		0.3627	0.2757	0.6260	0.3782	0.3970	0.3364
			*				

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.4243	0.0179	Success	47	0.0767	0.0179	Success
48	0.8767	0.2366	Success	48	0.4524	0.2366	Success
49	0.4424	0.6395	Fail	49	0.4343	0.6395	Fail
50	0.1422	1.0549	Fail	50	0.5846	1.0549	Fail
51	0.1798	0.8018	Fail	51	0.0376	0.8018	Fail
52	0.1111	1.0055	Fail	52	0.0687	1.0055	Fail
Mean AE	0.3627	0.6260	Fail	Mean AE	0.2757	0.6260	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.4243	0.2032	Success	47	0.0767	0.2032	Fail
48	0.8767	0.3201	Success	48	0.4524	0.3201	Success
49	0.4424	0.0986	Success	49	0.4343	0.0986	Success
50	0.1422	0.5986	Fail	50	0.5846	0.5986	Fail
51	0.1798	0.4908	Fail	51	0.0376	0.4908	Fail
52	0.1111	0.5583	Fail	52	0.0687	0.5583	Fail
Mean AE	0.3627	0.3782	Fail	Mean AE	0.2757	0.3782	Fail

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.4243	0.0294	Success	47	0.0767	0.0294	Success
48	0.8767	0.1079	Success	48	0.4524	0.1079	Success
49	0.4424	0.5369	Fail	49	0.4343	0.5369	Fail
50	0.1422	0.8198	Fail	50	0.5846	0.8198	Fail
51	0.1798	0.4197	Fail	51	0.0376	0.4197	Fail
52	0.1111	0.4684	Fail	52	0.0687	0.4684	Fail
Mean AE	0.3627	0.3970	Fail	Mean AE	0.2757	0.3970	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.4243	0.1610	Success	47	0.0767	0.1610	Fail
48	0.8767	0.3642	Success	48	0.4524	0.3642	Success
49	0.4424	0.2105	Success	49	0.4343	0.2105	Success
50	0.1422	0.5939	Fail	50	0.5846	0.5939	Fail
51	0.1798	0.3397	Fail	51	0.0376	0.3397	Fail
52	0.1111	0.3493	Fail	52	0.0687	0.3493	Fail
Mean AE	0.3627	0.3364	Success	Mean AE	0.2757	0.3364	Fail

Table 7 - Panel 20
Model Comparison-Motorola Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.3031						
47	1.4103	1.00	1.3031	1.1855	1.0928	1.2443	1.1629
48	2.6752	1.00	1.4103	1.0669	1.0335	1.2386	1.1591
49	1.8444	1.00	2.6752	2.1764	1.5882	2.4258	1.9505
50	1.4654	1.00	1.8444	1.6207	1.3103	1.7325	1.4884
51	1.3150	1.00	1.4654	1.5881	1.2940	1.5267	1.3512
52	2.7214	1.00	1.3150	2.2278	1.6139	1.7714	1.5143
Mean AE		0.9053	0.6898	0.5145 *	0.5832	0.6021	0.5227

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.4103	0.2248	Success	47	0.1072	0.2248	Fail
48	1.6752	1.6083	Success	48	1.2649	1.6083	Fail
49	0.8444	0.3320	Success	49	0.8308	0.3320	Success
50	0.4654	0.1553	Success	50	0.3790	0.1553	Success
51	0.3150	0.2731	Success	51	0.1504	0.2731	Fail
52	1.7214	0.4936	Success	52	1.4064	0.4936	Success
Mean AE	0.9053	0.5145	Success	Mean AE	0.6898	0.5145	Success

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.4103	0.3175	Success	47	0.1072	0.3175	Fail
48	1.6752	1.6417	Success	48	1.2649	1.6417	Fail
49	0.8444	0.2562	Success	49	0.8308	0.2562	Success
50	0.4654	0.1551	Success	50	0.3790	0.1551	Success
51	0.3150	0.0210	Success	51	0.1504	0.0210	Success
52	1.7214	1.1075	Success	52	1.4064	1.1075	Success
Mean AE	0.9053	0.5832	Success	Mean AE	0.6898	0.5832	Success

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.4103	0.1660	Success	47	0.1072	0.1660	Fail
48	1.6752	1.4366	Success	48	1.2649	1.4366	Fail
49	0.8444	0.5814	Success	49	0.8308	0.5814	Success
50	0.4654	0.2671	Success	50	0.3790	0.2671	Success
51	0.3150	0.2117	Success	51	0.1504	0.2117	Fail
52	1.7214	0.9500	Success	52	1.4064	0.9500	Success
Mean AE	0.9053	0.6021	Success	Mean AE	0.6898	0.6021	Success

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.4103	0.2474	Success	47	0.1072	0.2474	Fail
48	1.6752	1.5161	Success	48	1.2649	1.5161	Fail
49	0.8444	0.1061	Success	49	0.8308	0.1061	Success
50	0.4654	0.0230	Success	50	0.3790	0.0230	Success
51	0.3150	0.0362	Success	51	0.1504	0.0362	Success
52	1.7214	1.2071	Success	52	1.4064	1.2071	Success
Mean AE	0.9053	0.5227	Success	Mean AE	0.6898	0.5227	Success

Table 7 - Panel 21
Model Comparison-NCR Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.0764						
47	1.7716	1.00	1.0764	2.1944	1.5972	1.6354	1.4236
48	1.2882	1.00	1.7716	1.0472	1.0236	1.4094	1.2729
49	1.0864	1.00	1.2882	1.1088	1.0544	1.1985	1.1323
50	1.6502	1.00	1.0864	1.2298	1.1149	1.1581	1.1054
51	1.4692	1.00	1.6502	1.3183	1.1591	1.4842	1.3228
52	1.0315	1.00	1.4692	1.3743	1.1871	1.4217	1.2812
Mean AE		0.3829	0.4272	0.2667	0.2453	0.2112 *	0.2250

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.7716	0.4228	Success	47	0.6952	0.4228	Success
48	0.2882	0.2410	Success	48	0.4834	0.2410	Success
49	0.0864	0.0224	Success	49	0.2018	0.0224	Success
50	0.6502	0.4204	Success	50	0.5638	0.4204	Success
51	0.4692	0.1509	Success	51	0.1810	0.1509	Success
52	0.0315	0.3428	Fail	52	0.4377	0.3428	Success
Mean AE	0.3829	0.2667	Success	Mean AE	0.4272	0.2667	Success

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.7716	0.1744	Success	47	0.6952	0.1744	Success
48	0.2882	0.2646	Success	48	0.4834	0.2646	Success
49	0.0864	0.0320	Success	49	0.2018	0.0320	Success
50	0.6502	0.5353	Success	50	0.5638	0.5353	Success
51	0.4692	0.3101	Success	51	0.1810	0.3101	Fail
52	0.0315	0.1556	Fail	52	0.4377	0.1556	Success
Mean AE	0.3829	0.2453	Success	Mean AE	0.4272	0.2453	Success

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.7716	0.1362	Success	47	0.6952	0.1362	Success
48	0.2882	0.1212	Success	48	0.4834	0.1212	Success
49	0.0864	0.1121	Fail	49	0.2018	0.1121	Success
50	0.6502	0.4921	Success	50	0.5638	0.4921	Success
51	0.4692	0.0150	Success	51	0.1810	0.0150	Success
52	0.0315	0.3902	Fail	52	0.4377	0.3902	Success
Mean AE	0.3829	0.2112	Success	Mean AE	0.4272	0.2112	Success

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.7716	0.3480	Success	47	0.6952	0.3480	Success
48	0.2882	0.0153	Success	48	0.4834	0.0153	Success
49	0.0864	0.0459	Success	49	0.2018	0.0459	Success
50	0.6502	0.5448	Success	50	0.5638	0.5448	Success
51	0.4692	0.1464	Success	51	0.1810	0.1464	Success
52	0.0315	0.2497	Fail	52	0.4377	0.2497	Success
Mean AE	0.3829	0.2250	Success	Mean AE	0.4272	0.2250	Success

Table 7 - Panel 22

Model Comparison-National Semiconductor Corp

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
43	1.6830						
44	2.0119	1.00	1.6830	1.9413	1.4706	1.8121	1.5414
45	2.9386	1.00	2.0119	2.1835	1.5918	2.0977	1.7318
46	0.4316	1.00	2.9386	2.1053	1.5526	2.5219	2.0146
47	1.3653	1.00	0.4316	3.1512	2.0756	1.7914	1.5276
48	2.7052	1.00	1.3653	1.6182	1.3091	1.4917	1.3278
49	2.8887	1.00	2.7052	2.5804	1.7902	2.6428	2.0952
Mean AE		1.2464	1.0366	0.9468	1.0357	0.8361	0.9322
						*	

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
44	1.0119	0.0706	Success	44	0.3289	0.0706	Success
45	1.9386	0.7551	Success	45	0.9267	0.7551	Success
46	0.5684	1.6737	Fail	46	2.5070	1.6737	Success
47	0.3653	1.7859	Fail	47	0.9337	1.7859	Fail
48	1.7052	1.0870	Success	48	1.3399	1.0870	Success
49	1.8887	0.3083	Success	49	0.1835	0.3083	Fail
Mean AE	1.2464	0.9468	Success	Mean AE	1.0366	0.9468	Success

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
44	1.0119	0.5413	Success	44	0.3289	0.5413	Fail
45	1.9386	1.3468	Success	45	0.9267	1.3468	Fail
46	0.5684	1.1210	Fail	46	2.5070	1.1210	Success
47	0.3653	0.7103	Fail	47	0.9337	0.7103	Success
48	1.7052	1.3961	Success	48	1.3399	1.3961	Fail
49	1.8887	1.0985	Success	49	0.1835	1.0985	Fail
Mean AE	1.2464	1.0357	Success	Mean AE	1.0366	1.0357	Success

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
44	1.0119	0.1998	Success	44	0.3289	0.1998	Success
45	1.9386	0.8409	Success	45	0.9267	0.8409	Success
46	0.5684	2.0903	Fail	46	2.5070	2.0903	Success
47	0.3653	0.4261	Fail	47	0.9337	0.4261	Success
48	1.7052	1.2135	Success	48	1.3399	1.2135	Success
49	1.8887	0.2459	Success	49	0.1835	0.2459	Fail
Mean AE	1.2464	0.8361	Success	Mean AE	1.0366	0.8361	Success

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
44	1.0119	0.4705	Success	44	0.3289	0.4705	Fail
45	1.9386	1.2068	Success	45	0.9267	1.2068	Fail
46	0.5684	1.5830	Fail	46	2.5070	1.5830	Success
47	0.3653	0.1623	Success	47	0.9337	0.1623	Success
48	1.7052	1.3774	Success	48	1.3399	1.3774	Fail
49	1.8887	0.7935	Success	49	0.1835	0.7935	Fail
Mean AE	1.2464	0.9322	Success	Mean AE	1.0366	0.9322	Success

Table 7 - Panel 23
Model Comparison-RCA

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.1720						
47	1.1518	1.00	1.1720	0.9426	0.9713	1.0573	1.0382
48	0.2027	1.00	1.1518	1.0647	1.0324	1.1083	1.0722
49	0.7842	1.00	0.2027	0.5679	0.7840	0.3853	0.5902
50	1.8565	1.00	0.7842	0.3711	0.6856	0.5777	0.7184
51	1.7516	1.00	1.8565	0.9612	0.9806	1.4089	1.2726
52	1.3028	1.00	1.7516	1.9051	1.4525	1.8283	1.5522
Mean AE		0.5126	0.5295	0.6943	0.5170	0.5910	0.5073 *

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.1518	0.2092	Fail	47	0.0202	0.2092	Fail
48	0.7973	0.8620	Fail	48	0.9491	0.8620	Success
49	0.2158	0.2163	Fail	49	0.5815	0.2163	Success
50	0.8565	1.4854	Fail	50	1.0723	1.4854	Fail
51	0.7516	0.7904	Fail	51	0.1049	0.7904	Fail
52	0.3028	0.6023	Fail	52	0.4488	0.6023	Fail
Mean AE	0.5126	0.6943	Fail	Mean AE	0.5295	0.6943	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.1518	0.1805	Fail	47	0.0202	0.1805	Fail
48	0.7973	0.8297	Fail	48	0.9491	0.8297	Success
49	0.2158	0.0002	Success	49	0.5815	0.0002	Success
50	0.8565	1.1709	Fail	50	1.0723	1.1709	Fail
51	0.7516	0.7710	Fail	51	0.1049	0.7710	Fail
52	0.3028	0.1497	Success	52	0.4488	0.1497	Success
Mean AE	0.5126	0.5170	Fail	Mean AE	0.5295	0.5170	Success

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.1518	0.0945	Success	47	0.0202	0.0945	Fail
48	0.7973	0.9056	Fail	48	0.9491	0.9056	Success
49	0.2158	0.3989	Fail	49	0.5815	0.3989	Success
50	0.8565	1.2788	Fail	50	1.0723	1.2788	Fail
51	0.7516	0.3427	Success	51	0.1049	0.3427	Fail
52	0.3028	0.5255	Fail	52	0.4488	0.5255	Fail
Mean AE	0.5126	0.5910	Fail	Mean AE	0.5295	0.5910	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.1518	0.1136	Success	47	0.0202	0.1136	Fail
48	0.7973	0.8695	Fail	48	0.9491	0.8695	Success
49	0.2158	0.1940	Success	49	0.5815	0.1940	Success
50	0.8565	1.1381	Fail	50	1.0723	1.1381	Fail
51	0.7516	0.4790	Success	51	0.1049	0.4790	Fail
52	0.3028	0.2494	Success	52	0.4488	0.2494	Success
Mean AE	0.5126	0.5073	Success	Mean AE	0.5295	0.5073	Success

Table 7 - Panel 24

Model Comparison-Texas Instruments Corp

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.0185						
47	1.2768	1.00	1.0185	1.8844	1.4422	1.4514	1.3010
48	0.7997	1.00	1.2768	1.1470	1.0735	1.2119	1.1413
49	0.6888	1.00	0.7997	0.3560	0.6780	0.5778	0.7186
50	0.7560	1.00	0.6888	-1.9340	-0.4670	-0.6226	-0.0817
51	1.0480	1.00	0.7560	0.4849	0.7424	0.6204	0.7470
52	1.2331	1.00	1.0480	-2.7718	-0.8859	-0.8619	-0.2413
Mean AE		0.2189	0.2318	1.4243	0.6829	0.7665	0.5014
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.2768	0.6076	Fail	47	0.2583	0.6076	Fail
48	0.2003	0.3473	Fail	48	0.4771	0.3473	Success
49	0.3112	0.3328	Fail	49	0.1109	0.3328	Fail
50	0.2440	2.6900	Fail	50	0.0672	2.6900	Fail
51	0.0480	0.5631	Fail	51	0.2920	0.5631	Fail
52	0.2331	4.0049	Fail	52	0.1851	4.0049	Fail
Mean AE	0.2189	1.4243	Fail	Mean AE	0.2318	1.4243	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.2768	0.1654	Success	47	0.2583	0.1654	Success
48	0.2003	0.2738	Fail	48	0.4771	0.2738	Success
49	0.3112	0.0108	Success	49	0.1109	0.0108	Success
50	0.2440	1.2230	Fail	50	0.0672	1.2230	Fail
51	0.0480	0.3056	Fail	51	0.2920	0.3056	Fail
52	0.2331	2.1190	Fail	52	0.1851	2.1190	Fail
Mean AE	0.2189	0.6829	Fail	Mean AE	0.2318	0.6829	Fail

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.2768	0.1746	Success	47	0.2583	0.1746	Success
48	0.2003	0.4122	Fail	48	0.4771	0.4122	Success
49	0.3112	0.1110	Success	49	0.1109	0.1110	Fail
50	0.2440	1.3786	Fail	50	0.0672	1.3786	Fail
51	0.0480	0.4276	Fail	51	0.2920	0.4276	Fail
52	0.2331	2.0950	Fail	52	0.1851	2.0950	Fail
Mean AE	0.2189	0.7665	Fail	Mean AE	0.2318	0.7665	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.2768	0.0242	Success	47	0.2583	0.0242	Success
48	0.2003	0.3416	Fail	48	0.4771	0.3416	Success
49	0.3112	0.0298	Success	49	0.1109	0.0298	Success
50	0.2440	0.8377	Fail	50	0.0672	0.8377	Fail
51	0.0480	0.3010	Fail	51	0.2920	0.3010	Fail
52	0.2331	1.4744	Fail	52	0.1851	1.4744	Fail
Mean AE	0.2189	0.5014	Fail	Mean AE	0.2318	0.5014	Fail

Table 7 - Panel 25

Model Comparison-Union Carbide Corp

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.3652						
47	1.2183	1.00	1.3652	2.8720	1.9360	2.1186	1.7457
48	1.5634	1.00	1.2183	2.6279	1.8139	1.9231	1.6154
49	0.8417	1.00	1.5634	1.4235	1.2118	1.4935	1.3290
50	0.9196	1.00	0.8417	0.9308	0.9654	0.8862	0.9242
51	1.0141	1.00	0.9196	0.9946	0.9973	0.9571	0.9714
52	0.9890	1.00	1.0141	0.9452	0.9726	0.9797	0.9864
Mean AE		0.1743	0.2352	0.5624	0.2362	0.3352	0.1861
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.2183	1.6537	Fail	47	0.1469	1.6537	Fail
48	0.5634	1.0645	Fail	48	0.3451	1.0645	Fail
49	0.1583	0.5818	Fail	49	0.7217	0.5818	Success
50	0.0804	0.0112	Success	50	0.0779	0.0112	Success
51	0.0141	0.0195	Fail	51	0.0945	0.0195	Success
52	0.0110	0.0438	Fail	52	0.0251	0.0438	Fail
Mean AE	0.1743	0.5624	Fail	Mean AE	0.2352	0.5624	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.2183	0.7177	Fail	47	0.1469	0.7177	Fail
48	0.5634	0.2505	Success	48	0.3451	0.2505	Success
49	0.1583	0.3701	Fail	49	0.7217	0.3701	Success
50	0.0804	0.0458	Success	50	0.0779	0.0458	Success
51	0.0141	0.0168	Fail	51	0.0945	0.0168	Success
52	0.0110	0.0164	Fail	52	0.0251	0.0164	Success
Mean AE	0.1743	0.2362	Fail	Mean AE	0.2352	0.2362	Fail

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.2183	0.9003	Fail	47	0.1469	0.9003	Fail
48	0.5634	0.3597	Success	48	0.3451	0.3597	Fail
49	0.1583	0.6518	Fail	49	0.7217	0.6518	Success
50	0.0804	0.0334	Success	50	0.0779	0.0334	Success
51	0.0141	0.0570	Fail	51	0.0945	0.0570	Success
52	0.0110	0.0093	Success	52	0.0251	0.0093	Success
Mean AE	0.1743	0.3352	Fail	Mean AE	0.2352	0.3352	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.2183	0.5274	Fail	47	0.1469	0.5274	Fail
48	0.5634	0.0520	Success	48	0.3451	0.0520	Success
49	0.1583	0.4873	Fail	49	0.7217	0.4873	Success
50	0.0804	0.0046	Success	50	0.0779	0.0046	Success
51	0.0141	0.0427	Fail	51	0.0945	0.0427	Success
52	0.0110	0.0026	Success	52	0.0251	0.0026	Success
Mean AE	0.1743	0.1861	Fail	Mean AE	0.2352	0.1861	Success

Table 7 - Panel 26

Model Comparison-Westinghouse Company

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	1.2869						
47	1.4460	1.00	1.2869	1.3417	1.1708	1.3143	1.2095
48	1.8963	1.00	1.4460	3.5485	2.2743	2.4973	1.9982
49	1.4870	1.00	1.8963	2.4445	1.7223	2.1704	1.7803
50	1.4501	1.00	1.4870	2.2936	1.6468	1.8903	1.5935
51	1.2943	1.00	1.4501	1.9417	1.4708	1.6959	1.4639
52	1.5738	1.00	1.2943	2.4822	1.7411	1.8883	1.5922
Mean AE		0.5246	0.2485	0.8522	0.2382	0.4287	0.1605
							*

Absolute Errors

	Naive=1	Experimnt	
47	0.4460	0.1043	Success
48	0.8963	1.6522	Fail
49	0.4870	0.9575	Fail
50	0.4501	0.8435	Fail
51	0.2943	0.6474	Fail
52	0.5738	0.9084	Fail
Mean AE	0.5246	0.8522	Fail

	Naive=NC	Experimnt	
47	0.1591	0.1043	Success
48	0.4503	1.6522	Fail
49	0.4093	0.9575	Fail
50	0.0369	0.8435	Fail
51	0.1558	0.6474	Fail
52	0.2795	0.9084	Fail
Mean AE	0.2485	0.8522	Fail

	Naive=1	C=1 & P	
47	0.4460	0.2752	Success
48	0.8963	0.3780	Success
49	0.4870	0.2353	Success
50	0.4501	0.1967	Success
51	0.2943	0.1765	Success
52	0.5738	0.1673	Success
Mean AE	0.5246	0.2382	Success

	Naive=NC	C=1 & P	
47	0.1591	0.2752	Fail
48	0.4503	0.3780	Success
49	0.4093	0.2353	Success
50	0.0369	0.1967	Fail
51	0.1558	0.1765	Fail
52	0.2795	0.1673	Success
Mean AE	0.2485	0.2382	Success

	Naive=1	C=NC & P	
47	0.4460	0.1317	Success
48	0.8963	0.6010	Success
49	0.4870	0.6834	Fail
50	0.4501	0.4402	Success
51	0.2943	0.4016	Fail
52	0.5738	0.3145	Success
Mean AE	0.5246	0.4287	Success

	Naive=NC	C=NC & P	
47	0.1591	0.1317	Success
48	0.4503	0.6010	Fail
49	0.4093	0.6834	Fail
50	0.0369	0.4402	Fail
51	0.1558	0.4016	Fail
52	0.2795	0.3145	Fail
Mean AE	0.2485	0.4287	Fail

	Naive=1	C=1,NC&P	
47	0.4460	0.2365	Success
48	0.8963	0.1019	Success
49	0.4870	0.2933	Success
50	0.4501	0.1434	Success
51	0.2943	0.1696	Success
52	0.5738	0.0184	Success
Mean AE	0.5246	0.1605	Success

	Naive=NC	C=1,NC&P	
47	0.1591	0.2365	Fail
48	0.4503	0.1019	Success
49	0.4093	0.2933	Success
50	0.0369	0.1434	Fail
51	0.1558	0.1696	Fail
52	0.2795	0.0184	Success
Mean AE	0.2485	0.1605	Success

Table 7 - Panel 27

Model Comparison-Xerox Corporation

Betas

Quart	Observed	Naive=1	Naive=NC	Experimnt	C=1 & P	C=NC & P	C=1,NC&P
46	0.6317						
47	0.5832	1.00	0.6317	0.5923	0.7961	0.6120	0.7413
48	1.1266	1.00	0.5832	-3.9507	-1.4754	-1.6838	-0.7892
49	1.0026	1.00	1.1266	-0.5941	0.2030	0.2663	0.5108
50	0.9272	1.00	1.0026	1.5208	1.2604	1.2617	1.1745
51	0.7906	1.00	0.9272	0.9322	0.9661	0.9297	0.9531
52	1.0038	1.00	0.7906	-1.4160	-0.2080	-0.3127	0.1249
Mean AE		0.1387	0.1902	1.6397	0.8892	0.8943	0.6424
		*					

Absolute Errors

	Naive=1	Experimnt			Naive=NC	Experimnt	
47	0.4168	0.0091	Success	47	0.0485	0.0091	Success
48	0.1266	5.0773	Fail	48	0.5434	5.0773	Fail
49	0.0026	1.5967	Fail	49	0.1240	1.5967	Fail
50	0.0728	0.5936	Fail	50	0.0754	0.5936	Fail
51	0.2094	0.1416	Success	51	0.1366	0.1416	Fail
52	0.0038	2.4198	Fail	52	0.2132	2.4198	Fail
Mean AE	0.1387	1.6397	Fail	Mean AE	0.1902	1.6397	Fail

	Naive=1	C=1 & P			Naive=NC	C=1 & P	
47	0.4168	0.2129	Success	47	0.0485	0.2129	Fail
48	0.1266	2.6020	Fail	48	0.5434	2.6020	Fail
49	0.0026	0.7996	Fail	49	0.1240	0.7996	Fail
50	0.0728	0.3332	Fail	50	0.0754	0.3332	Fail
51	0.2094	0.1755	Success	51	0.1366	0.1755	Fail
52	0.0038	1.2118	Fail	52	0.2132	1.2118	Fail
Mean AE	0.1387	0.8892	Fail	Mean AE	0.1902	0.8892	Fail

	Naive=1	C=NC & P			Naive=NC	C=NC & P	
47	0.4168	0.0288	Success	47	0.0485	0.0288	Success
48	0.1266	2.8104	Fail	48	0.5434	2.8104	Fail
49	0.0026	0.7363	Fail	49	0.1240	0.7363	Fail
50	0.0728	0.3345	Fail	50	0.0754	0.3345	Fail
51	0.2094	0.1391	Success	51	0.1366	0.1391	Fail
52	0.0038	1.3165	Fail	52	0.2132	1.3165	Fail
Mean AE	0.1387	0.8943	Fail	Mean AE	0.1902	0.8943	Fail

	Naive=1	C=1,NC&P			Naive=NC	C=1,NC&P	
47	0.4168	0.1581	Success	47	0.0485	0.1581	Fail
48	0.1266	1.9158	Fail	48	0.5434	1.9158	Fail
49	0.0026	0.4918	Fail	49	0.1240	0.4918	Fail
50	0.0728	0.2473	Fail	50	0.0754	0.2473	Fail
51	0.2094	0.1625	Success	51	0.1366	0.1625	Fail
52	0.0038	0.8789	Fail	52	0.2132	0.8789	Fail
Mean AE	0.1387	0.6424	Fail	Mean AE	0.1902	0.6424	Fail

Table 8 - Panel 1

Correlation of Accounting Risk Measures With Beta

	ARM Number									
Firm Name	1	2	3	4	5	6	7	8	9	10
Avon Products	*		+	*	*	*	*	*	*	*
Burroughs Corp	+									
Caterpillar Inc										
Digital Equipment		none at either level								
Dow Chemical										
DuPont (E.I.) De Nemours		none at either level								
Eastman Kodak Co	*			*	*	*	*	*	*	*
Ford Motor Co				+	+	*				
General Electric Co										
General Instrument Corp		*	*	*	*	+	*	*	*	*
General Motors Corp										
Hewlett-Packard Co		+	*				*			
Honeywell Inc									+	+
Intl Business Machines		none at either level								
Intl Paper Co		none at either level								
Johnson & Johnson		none at either level								
Merck & Co										
Minnesota Mining & Mfg		+	*		+		*		+	
Monsanto Co										
Motorola Inc										
N C R Corp	*		*	*	*		*	*	*	+
National Semiconductor										
R C A Corp	*			*	*		*	*	*	*
Texas Instruments Inc	*		*				+	+		
Union Carbide Corp										
Westinghouse Electric	*			*						
Xerox Corp	*		*	*	*	*		*	+	*
Total at .05 level (*)	7	1	6	7	6	4	7	6	5	5
Total at .05 to .10 (+)	1	2	1	1	2	1	1	1	3	2
Total possible=27										

Table 8 - Panel 2

Correlation of Accounting Risk Measures With Beta

	ARM Number									
Firm Name	11	12	13	14	15	16	17	18	19	20
Avon Products	*			+	*	*		+	*	*
Burroughs Corp					*				+	
Caterpillar Inc						+				
Digital Equipment										
Dow Chemical								+		+
DuPont (E.I.) De Nemours										
Eastman Kodak Co	*		*							
Ford Motor Co			*				*	*		
General Electric Co			*		*	*	+		*	+
General Instrument Corp	*	+	*	*	*	*	*		+	
General Motors Corp		+	*			+				
Hewlett-Packard Co	*	*		*		*	+	*		
Honeywell Inc	+									
Intl Business Machines										
Intl Paper Co										
Johnson & Johnson										
Merck & Co					*		*	+	*	
Minnesota Mining & Mfg	*		*	*						
Monsanto Co		*			+			*	*	*
Motorola Inc					*				+	
N C R Corp	*	*	*	*		+	+			
National Semiconductor					*				*	
R C A Corp	*	+	+		*	*	+	*	*	*
Texas Instruments Inc	+			*						
Union Carbide Corp										
Westinghouse Electric										
Xerox Corp			*	*	*	+			*	+
Total at .05 level (*)	7	3	8	6	9	5	3	4	7	3
Total at .05 to .10 (+)	2	3	1	1	1	3	4	3	3	3
Total possible=27										

Table 8 - Panel 3

Correlation of Accounting Risk Measures With Beta

	ARM Number									
Firm Name	21	22	23	24	25	26	27	28	29	30
Avon Products		*	*	*						*
Burroughs Corp		*								+
Caterpillar Inc				+						
Digital Equipment										
Dow Chemical	+						+			
DuPont (E.I.) De Nemours										
Eastman Kodak Co			*							
Ford Motor Co	+			*		*	*	+		*
General Electric Co		*			*	+	+			*
General Instrument Corp		+	*						*	*
General Motors Corp										
Hewlett-Packard Co	*						+			
Honeywell Inc					*					
Intl Business Machines										
Intl Paper Co										
Johnson & Johnson										
Merck & Co		+					*			+
Minnesota Mining & Mfg						*			*	
Monsanto Co	*	*	+				*			
Motorola Inc		*								
N C R Corp	*		*					*		
National Semiconductor		*	+	+		+			+	*
R C A Corp	*	*	*	*			+		*	*
Texas Instruments Inc										
Union Carbide Corp										
Westinghouse Electric								+	*	
Xerox Corp		*		*	*					+
Total at .05 level (*)	4	8	5	4	3	2	3	1	4	6
Total at .05 to .10 (+)	2	2	2	2	0	2	4	2	1	3
Total possible=27										

Table 8 - Panel 4

Correlation of Accounting Risk Measures With Beta

	ARM Number									
Firm Name	31	32	33	34	35	36	37	38	39	40
Avon Products	*	*		*	+				+	*
Burroughs Corp								+	+	*
Caterpillar Inc										
Digital Equipment										
Dow Chemical			*							
DuPont (E.I.) De Nemours										
Eastman Kodak Co				*		*		*	*	*
Ford Motor Co	*						*			*
General Electric Co	*						*		+	
General Instrument Corp	*		*	*	*	*	+	+	*	*
General Motors Corp								*		
Hewlett-Packard Co						*				
Honeywell Inc			*							+
Intl Business Machines										
Intl Paper Co										
Johnson & Johnson										
Merck & Co			+						*	*
Minnesota Mining & Mfg			*	+	*	*	*			
Monsanto Co									+	
Motorola Inc								*		
N C R Corp			*	*		*		*	*	*
National Semiconductor		+	+				+			
R C A Corp	+	+		+	*	*			*	*
Texas Instruments Inc						*			*	*
Union Carbide Corp						+		+	*	*
Westinghouse Electric					*					
Xerox Corp		+	+	*		*		*	*	*
Total at .05 level (*)	4	1	5	5	4	8	3	5	8	11
Total at .05 to .10 (+)	1	3	3	2	1	1	2	3	4	1
Total possible=27										

Table 9

Firm Name	Number of ARM's Below .05 Level	Number of ARM's Between .05 & .10
Avon Products	21	5
Burroughs Corp	3	5
Caterpillar Inc	0	2
Digital Equipment	0	0
Dow Chemical	1	4
DuPont (E.I.) De Nemours	0	0
Eastman Kodak Co	16	0
Ford Motor Co	11	4
General Electric Co	9	5
General Instrument Corp	24	6
General Motors Corp	2	2
Hewlett-Packard Co	9	3
Honeywell Inc	2	4
Intl Business Machines	0	0
Intl Paper Co	0	0
Johnson & Johnson	0	0
Merck & Co	6	4
Minnesota Mining & Mfg	11	4
Monsanto Co	7	3
Motorola Inc	3	1
N C R Corp	20	3
National Semiconductor	4	7
R C A Corp	23	7
Texas Instruments Inc	6	3
Union Carbide Corp	2	2
Westinghouse Electric	4	1
Xerox Corp	19	6

Total possible=40

Table 10

Correlation of Accounting Risk Measures With Beta
Subset of Firms Outperforming Both Naive Models

ARM Number

Firm Name	1	2	3	4	5	6	7	8	9	10
Ford Motor Co				+	+	*				
Motorola Inc										
N C R Corp	*		*	*	*		*	*	*	+
National Semiconductor										
Total at .05 level (*)	1	0	1	1	1	1	1	1	1	0
Total at .05 to .10 (+)	0	0	0	1	1	0	0	0	0	1
Total possible= 4										

Firm Name	11	12	13	14	15	16	17	18	19	20
Ford Motor Co			*				*	*		
Motorola Inc					*				+	
N C R Corp	*	*	*	*		+	+			
National Semiconductor					*				*	
Total at .05 level (*)	1	1	2	1	2	0	1	1	1	0
Total at .05 to .10 (+)	0	0	0	0	0	1	1	0	1	0

Firm Name	21	22	23	24	25	26	27	28	29	30
Ford Motor Co	+			*		*	*	+		*
Motorola Inc		*								
N C R Corp	*		*					*		
National Semiconductor		*	+	+		+			+	*
Total at .05 level (*)	1	2	1	1	0	1	1	1	0	2
Total at .05 to .10 (+)	1	0	1	1	0	1	0	1	1	0

Firm Name	31	32	33	34	35	36	37	38	39	40
Ford Motor Co	*						*			*
Motorola Inc								*		
N C R Corp			*	*		*		*	*	*
National Semiconductor		+	+				+			
Total at .05 level (*)	1	0	1	1	0	1	1	2	1	2
Total at .05 to .10 (+)	0	1	1	0	0	0	1	0	0	0

Table 11 - Panel 1

Correlation of Accounting Risk Measures With Beta
Subset of Firms Outperforming Either Naive Model

	ARM Number									
Firm Name	1	2	3	4	5	6	7	8	9	10
Digital Equipment		none at either level								
Ford Motor Co				+	+	*				
General Electric Co										
General Motors Corp										
Honeywell Inc									+	+
Merck & Co										
Motorola Inc										
N C R Corp	*		*	*	*		*	*	*	+
National Semiconductor										
Total at .05 level (*)	1	0	1	1	1	1	1	1	1	0
Total at .05 to .10 (+)	0	0	0	1	1	0	0	0	1	2
Total possible= 9										

Firm Name	11	12	13	14	15	16	17	18	19	20
Digital Equipment										
Ford Motor Co			*				*	*		
General Electric Co			*		*	*	+		*	+
General Motors Corp		+	*			+				
Honeywell Inc	+									
Merck & Co					*		*	+	*	
Motorola Inc					*				+	
N C R Corp	*	*	*	*		+	+			
National Semiconductor					*				*	
Total at .05 level (*)	1	1	4	1	4	1	2	1	3	0
Total at .05 to .10 (+)	1	1	0	0	0	2	2	1	1	1

Table 11 - Panel 2

Correlation of Accounting Risk Measures With Beta
Subset of Firms Outperforming Either Naive Model

	ARM Number									
Firm Name	21	22	23	24	25	26	27	28	29	30
Digital Equipment										
Ford Motor Co	+			*		*	*	+		*
General Electric Co		*			*	+	+			*
General Motors Corp										
Honeywell Inc					*					
Merck & Co		+					*			+
Motorola Inc		*								
N C R Corp	*		*					*		
National Semiconductor		*	+	+		+			+	*
Total at .05 level (*)	1	3	1	1	2	1	2	1	0	3
Total at .05 to .10 (+)	1	1	1	1	0	2	1	1	1	1

Firm Name	31	32	33	34	35	36	37	38	39	40
Digital Equipment										
Ford Motor Co	*						*			*
General Electric Co	*						*		+	
General Motors Corp								*		
Honeywell Inc			*							+
Merck & Co			+						*	*
Motorola Inc								*		
N C R Corp			*	*		*		*	*	*
National Semiconductor		+	+				+			
Total at .05 level (*)	2	0	2	1	0	1	2	3	2	3
Total at .05 to .10 (+)	0	1	2	0	0	0	1	0	1	1

TITLE OF THESIS A DISAGGREGATE APPROACH TO ACCOUNTING BASED MEASURES OF SYSTEMATIC RISK

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