The information value of segment disclosure : Australian evidence

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THE INFORMATION VALUE OF SEGMENT DISCLOSURE: AUSTRALIAN EVIDENCE

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CERTIFICATE OF ORIGINALITY

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institute of higher learning, except where due acknowledgement is made in the text.

(Signed) . . . .

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Abstract

This thesis provides empirical evidence on the impact of segment reporting on earnings prediction. In 1984 the Australian Accounting Research Foundation [AARF] released Australian Accounting Standard 16 [AAS 16]. This was followed by the release of ASRB 1005 by the Accounting Standards Review Board [ASRB] in 1986. These standards required the disclosure of segment revenues, earnings, assets, and geographical segments. Previous studies over the past two decades have reported mixed results on the impact of segment disclosure on earnings prediction.

A new research design was employed that allowed the integration of research into the impact of segment disclosure on security price revisions and into the prediction of accounting earnings. It was hypothesized that investors would be able to more accurately predict the accounting earnings of firms that disclosed segment information than firms that disclosed on a consolidated basis only. This was investigated by examining the change in the relationship between expected earnings and cumulative abnormal returns for firms that increased their level of segment disclosure over time. The sample of firms was divided into three treatment portfolios: firms that moved from disclosing no segment information in 1983 to full disclosure as per ASRB 1005 by 1987; firms that disclosed only segment revenues in 1983; and firms that disclosed only segment earnings. The results confirmed the additional information value of segment disclosure in general and the primacy of segment earnings over segment revenues in particular.

Contents

I. Introduction

Since the 1960's a significant increase in the number of conglomerate companies has heightened the level of international debate concerning the merits of segment reporting. One consequence of this debate was the issuing of standards in both the United States (SFAS 14) and Australia (AAS 16) in 1976 and 1984, respectively. The central motivation behind these official pronouncements was the belief that segment reports were useful to users of financial statements.

> *'Segmentation by industry ... is highly relevant to an analysis of the reporting entity's profit prospects and risk exposure when making investment and credit decisions'* (AAS 16, 1987, para. 3)

The purpose of this thesis is to test the proposition that segment information as required by Australian Accounting Standard 16 [AAS 16] provides information useful for investment decision making. Theoretical models in accounting and finance imply that accounting earnings should be associated with annual security returns in a manner that differs predictably both in terms of the sign and magnitude of the association. This thesis investigates whether segment disclosure, as required by AAS 16, indeed exhibits differential association with stock returns, and whether this association is consistent with the theory.

The proposition that segment disclosure has information content has been the subject of much research (e.g. Ajinkya, 1980; Baldwin, 1984; Collins, 1976, Collins and Simonds, 1979; Horwitz and Kolodny, 1977; Kinney, 1971; Kochanek, 1974). Results to date are at best inconclusive. This research returns to the issue armed with a new research design as well as a more comprehensive and finely partitioned data set. The paper proceeds as follows. Section two reviews the background to the current regulatory requirements while section three reviews previous research on this topic. In section four the research design and hypotheses are developed. Section five describes the data with the empirical analysis and results presented in the penultimate section. Section seven summarises the findings and forecasts future research.

II. Regulatory Background

In March 1984 the Australian Accounting Research Foundation [AARF][1] released AAS 16 which required companies to report segment information in their annual reports. In 1986 the Australian Standards Review Board [ASRB][2] issued ASRB 1005 which effectively gave AAS 16 the force of law. Multi-segment firms were required to disclose segment revenues, earnings, assets and geographical segments where material[3]. One of the reasons provided in ASRB 1005 for the inclusion of segment information in company accounts was that " ... such information may be highly relevant to an analysis of a company's profit prospects" (ASRB 1005, Commentary (i)). This study tests the robustness of this reasoning. In the process it extends previous research into the economic consequences of segment disclosure.

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1 A research body jointly sponsored by the two main Australian professional accounting associations, the Australian Society of Certified Practicing Accountants and the Institute of Chartered Accountants.

2 A body established by the companies legislation and directed by the Ministerial Council (consisting of the Attorneys-General of the six Australian States).

3 Segment information is considered to be material where "... its omission, non-disclosure or mis-statement is likely to affect economic decisions or other evaluations made by users entitled to rely on the accounts or groups accounts" (ASRB 1005, par. .05).

III. Prior Research

Prior studies can be divided into three main classifications; those examining the

(1) consequences for earnings prediction,

(2) consequences for systematic risk, and

(3) consequences for security returns.

Tables one to three in Appendix 1 provide a synopsis of the major studies conducted along these three lines of inquiry. Each of the three research areas are considered in more detail below.

(a) Impact on Earnings Prediction

Studies investigating the impact of segment disclosure on earnings prediction may be further divided into two main groups: analyst forecast accuracy and prediction model research.

Analyst Forecast Accuracy

Studies of this type investigate the information content of segment reports by examining the effect such information has on the forecasts of professional analysts (Baldwin, 1984; Barefield and Comisky, 1975). Baldwin (1984) divided his sample of 215 companies into three portfolios:-

1. Multi-segment firms that provided either no segment data or multi-segment firms that provided only segment revenues but not segment earnings figures prior to the Line-of-Business [LOB] requirements.

2. Multi-segment firms that provided both segment revenue and earnings before the requirements.

3. Single segment firms.

The second two groups were used as controls.

No change in forecast accuracy was expected for the two control groups. If there was a change this would reflect a general improvement or worsening in analyst's predictions. Any statistically significant decrease in forecast error for the first group, relative to the change for the two control samples, was to be attributed to change in the level of disclosure.

Baldwin's results showed a significant decrease in forecast error for both multi-segment groups but no significant change for the single segment group. The change for the first group supported the proposition that segment reports provide more information than consolidated reports, but the change in the forecast accuracy of the second group was surprising. The results cannot be explained by a general improvement in forecast accuracy because the third group exhibited no such improvement. Baldwin speculated that this may have been caused by a greater homogeneity in the presentation of segment reports after the SEC's LOB requirements for the second group.

Prediction model research

In this type of work (Kinney, 1971; Collins, 1976, Balakrishnan, 1990) expected earnings are operationalised by the use of earnings prediction models.

Kinney (1971) developed four prediction models:-

1. 1967 (and 1968) consolidated earnings multiplied by the increase in GNP.

2. An extension of the linear trend of consolidated earnings using double exponential smoothing.

3. The sum of predicted sub-entity sales multiplied by consolidated profit rates.

4. The sum of predicted sub-entity earnings (p. 131).

Kinney also identified three levels of segment information: consolidated earnings, segment revenue, and segment revenue and earnings.

Using a restricted sample, Kinney's results suggest that while segment reports provide more information than consolidated reports, reports containing segment earnings do not provide more information than reports containing segment revenues alone. However, Kinney qualifies this result by noting that the segment earnings data was often difficult to classify.

Collins (1976) provides an extension of Kinney's work by increasing his sample to 96 firms, adding five additional forecasting models, and extending the time period from 2 to 3 years. The additional five earning forecasting models were all based upon consolidated data. Collins decided to use Kinney's segment based prediction models due to the short time period over which these firms had disclosed segment data. This latter point made it impractical to use time series models. Collin's results generally supported those of Kinney[4].

Both Kinney's and Collin's results are limited in that they simply indicate that one prediction model was better than another. These results do not show that one information set conveys more relevant information to investors operating in the market. One way to overcome this problem is to examine "real-world" investment decisions. It is to such studies that we now turn.

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4 Balakrishnan, et al (1990) provides an evaluation of the information content of geographical segment disclosure based on the Kinney and Collins prediction model approach. The authors concluded that such information does have value at the margin. However, this finding was qualified by stating that in practice the "...usefulness of these data is reduced because detailed geographic segments are frequently not reported and because of inaccuracy in annual forecasts of country specific growth and exchange rates" (Balakrishnan, et al, 1990, p. 320).

(b) Impact on Systematic Risk

Such studies (Barefield and Comiskey, 1975; Horwitz and Kolodny, 1977; Simonds and Collins, 1978, Collins and Simmonds, 1979; Dhaliwal, 1978; Prodhan and Harris, 1989;) investigate the effect the provision of segment information has upon a firm's market risk. Sunder (1973) noted that a change in the market's assessment of a firm's risk was dependent upon two factors: changes in the firm's operating environment and changes in its information system (p.30). As Collins and Simonds (1979) point out, it is difficult to predict *a priori* the direction of information induced risk changes. However, they identified two factors, presented below, that suggested the introduction of segment disclosure tends to lead to a downward revision of systematic risk on average.

Studies by Mautz (1968) and Backer and McFarland (1968) both reported that analysts believed that the introduction of segment disclosure would, on average, lead to a reduction in the uncertainty of future cash flows of diversified firms. Second, it was argued that segment reporting requirements would lead to changes in a firm's production/investment policies:

> *'A common concern expressed by management surveyed...was that detailed segment disclosure would discourage entry into new endeavours and would force them to adopt a more conservative posture with respect to investment projects'* (Collins and Simonds, 1979, p. 363).

Operationalising systematic risk as the beta coefficient in the market model regression, Horwitz and Kolodny (1977) failed to identify any evidence of a relationship between risk and segment disclosure. Collins and Simonds (1979) claimed that this failure to produce significant results was due to deficient testing procedures (p. 352, fn. 2). Utilising an improved research design, the latter authors reported that firms which provided minimal or no prior segment disclosure did experience significant downward revisions in relative systematic risk within the critical disclosure period. In addition, there was evidence to suggest that the provision of segment earnings, in addition to revenues, did have some marginal effect on the market risk of disclosing firms (p. 373)[5].

(c) Impact on Security Prices

The third approach to investigating the economic effects of segment reporting, that concerned with the effect on security prices, can be further divided into two distinct but related groups: those interested in the effect of segment disclosure on the mean return on the disclosing firm's shares, and those concerned with the effect of segment disclosure on the variance/covariance matrix of returns. The current study falls within the ambit of the former type of research. Nonetheless it is instructive to briefly consider some of the main findings of the latter.

Variance/Covariance of Returns

Variance/covariance of returns research attempts to discover whether the provision of segment information contributes to greater consensus among users of accounting information, i.e. the relationship between divergence of beliefs and segment information. Primary examples of such research include Ajinkya (1980) and Swaminathan (1991). Ajinkya argued that:

> *'...the covariance of the returns on all multi-product firm's securities should be higher if the structure of the disclosed information has the same degree of fineness[6] (i.e. during the after*

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5 Prodhan and Harris (1989) reported the finding of significant beta shifts due to the disclosure of geographical segments.

6 One information set (n) is said to be as fine as, or finer than, another information set (n) if n' is a sub-partition of n " .. such that every set in n' is contained in some set of n. Hence, n' tells us all that n can tell us, and possibly more." (Blackwell and Girschick,

> *LOB [line of business] requirement period) compared to the case when the disclosed information has lower and varying degrees of fineness (i.e. during the before LOB requirement period)'* (Ajinkya, 1980, p. 351)

Ajinkya's results supported this theory, leading him to conclude that " ... the uniformity and greater fineness of disclosure practices mandated by the SEC's LOB requirements appear to have contributed to a greater consensus among market agents" (Ajinkya, 1980, p. 357).

In a more recent study Swaminathan (1991), drawing on theories developed in the information economics literature (Holthausen and Verrecchia, 1990; Cukierman and Givoly, 1982) finds support for the hypotheses that the provision of segment information (1) increases price variability around earnings announcements, and (2) decreases divergence of beliefs.

Security Returns Research

The second group of studies, and those of primary importance to the present research, are those that have investigated the relationship between mean security returns and segment disclosure. Prominent examples of this approach are the works of Horwitz and Kolodny (1977), Twombly (1979) and Ajinkya (1980). Horwitz and Kolodny (1977) created two portfolios:-

1. A primary sample consisting of 50 firms required in 1971 to report to the Securities Exchange Commission [SEC] for the first time on a LOB basis; and

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1954). For the purposes of this paper, we can equate increasing levels of information set fineness with increasing levels of information content.

2. A control sample consisting of 50 firms which in 1971 reported all information to the SEC on a consolidated basis only.

The study was conducted over three independent time periods: pre-requirement, requirement (when segment disclosure was first required), and post-requirement. It was hypothesized that for the primary sample, if the increased level of disclosure resulted in more information becoming available to investors, then this should be reflected in larger abnormal returns when segment information was first disclosed than for the control sample. In other words the increased information would cause investors to revalue the firm's shares. Their results showed no significant difference between the abnormal returns for the two samples. This was interpreted as evidence against the proposition that segment reports were finer information sets than consolidated reports.

After improving on Horwitz and Kolodny's design Twombly (1979) concluded that " ... the event of a firm's disclosure of both segment revenues and profits, only segment revenues, or neither segment revenues nor profits provided no anticipated information to the capital market, whether the disclosures were conditional upon the market concentration ratio or not" (Twombly, 1979, p.77).

Further design improvements (e.g. including a learning period to allow users to learn how to use the new information and dividing the sample on the basis of whether they had positive or negative forecast errors) by Ajinkya (1980) did not change the basic result. Ajinkya speculates that the lack of support for his hypotheses may be because it was impossible *a priori* to predict the direction of the change in the returns of a portfolio of firms that go from less "fine" to more "fine" information reporting. Therefore, the individual effects of the change may cancel out at the portfolio level. This implied that in future studies it would be necessary to distinguish between "good" and "bad" news contained in the "finer" information structures.

In summary, research into the relationship between segment disclosure and security returns, in contrast to research into the effect on market agent consensus, price variability and systematic risk, provides evidence unsupportive of the proposition that segment reports contain additional information content. One explanation of these results may be that the above research designs relied on signed risk-adjusted returns. This implicitly assumes that the provision of segment information disclosed only positive (return increasing) or negative (return decreasing) information. Accordingly, in order to control for the directional effects of segment disclosure future research designs must take the actual reported accounting return into consideration. Such research represents a hybrid of the designs that have investigated the impact of segment disclosure on earnings prediction and security prices.

Earnings Prediction and Expected Returns Research

Foster (1975) conducted a study of the relationship between "good" and "bad" news aspects of segment reports and cumulative residual returns. Rather than examine firms across a number of industries, Foster chose to study firms within a single industry. By using a single industry and examining the effect of segment disclosure at a single point in time, Foster ensured that there were no differences between his sample groups. Foster developed a trading rule of going long in firms expected to disclose "good" news and short in those expected to disclose "bad" news. His results indicated that when the classification of expected returns was based on sub-entity data, higher abnormal returns were earned than when the classification was based on consolidated data alone.

The conflict between the results of Foster and Ajinkya may be due to Foster's partitioning of the firms into those reporting "good" or "bad" news. However, Foster provided no tests of further levels of fineness among segment reports That is, he focused solely on the comparison between segment data and consolidated data, not on one level of segment disclosure compared to another. Further Foster's results were based on data drawn from a single industry and did not directly relate to segment disclosure as mandated by either the SEC's LOB requirements or ASRB 1005 in Australia.

A different approach to this problem, that explicitly considers the effects of varying degrees of segment disclosure, was provided by Kochanek (1974). His study was designed to test the following two part hypothesis:-

> *'External financial reports for diversified firms disclosing segment data reduce the uncertainty of investors to such a degree that (1) investors with segment data are better able to predict future earnings changes of the firm and (2) security price fluctuations of the firm are dampened'.* (Kochanek, 1974, p.246)

To test these hypotheses Kochanek selected a sample of 37 diversified firms that provided some level of segment disclosure prior to 1970. Kochanek then assigned points to a firm depending upon the quality of its disclosure. Out of a maximum of 196 points the "best" firm received a total of 181 points and the "lowest" received 20 points. Kochanek defined a "good" reporter as one which consistently disclosed narrative segment descriptions and corresponding gross revenue during the time period surveyed.

Kochanek concluded that:-

> *'In addition to the general recognition that the number of 'superior' reporters included in the sample was limited, the results indicated that predicted stock market reactions were generally more significant when comparisons were made between segment reporters and non-reporters than between 'good' reporters disclosing*

differing degrees of sub-entity results.' (Kochanek, 1974, p.256)

Note that the distinction between "superior" and "good" reporters was defined on the basis of the reporting of segment assets. Therefore Kochanek's results provide no information on the value of segment earnings over segment revenues. Both of these levels of disclosure were subsumed under the definition of "good" reporters. Share price variability was measured by computing the observed weekly stock price range as a percentage of average weekly price. The results, however, failed to reject the null hypothesis that "good" reporters would exhibit lower price variability than "bad" reporters.

(d) Summary of Prior Research

Previous research into the economic consequences of segment disclosure is mixed. The earnings prediction and systematic risk studies have produced significant results, as has research into the effect on price variability and investor consensus. In contrast, research into the effect of segment disclosure on the mean security returns of disclosing firms has failed to produce significant results. As discussed earlier, this could be due to the inability of the research designs employed to distinguish between positive and negative "news" revealed by segment disclosure. While the work of Foster (1975) and Kochanek (1974) suggests that controlling for the sign of accounting information does produce results supportive of the claim that segment disclosure is finer than consolidated information each suffers from certain drawbacks. Being industry specific, Foster's results lack generalisability whereas Kochanek's design is subject to the criticism of subjectivity and arbitariness in the creation of "good" and "bad" reporting groups.

The purpose of this paper is to return to the issue of the impact of segment disclosure on earnings prediction and to attempt to reconcile the conflict between the results of the earnings prediction approach and those of the security returns approach. A research design that permits the integration of the effect on earnings prediction and security price revisions and controls for the sign of the security return is developed.

Another problem with prior studies has been that they did not identify the exact date at which the relevant information first hit the market (Swaminathan, 1991). This paper overcomes this problem by basing the calculation of abnormal returns around the date at which each firm's earnings were first announced. Further, this paper employs a more detailed price series that focuses on daily abnormal returns.

IV. Research Design and Hypotheses

In this study the value of segment information is assessed by examining hypothesized changes in the relationship between unexpected earnings and annual security returns. The method parallels that of Livnat and Zarowin (1990) in which the following regression model is estimated:

$$CAR = a_0 + a_1 \text{Accounting Earnings}^{7} \text{.......................(1)}$$

where CAR is a measure of annual abnormal return and the independent variable is an estimate of unexpected accounting earnings deflated by market capitalisation[8]. Note that from hereon we make use of the term earnings response coefficient [ERC] to refer to the coefficient on accounting earnings.

$$ERC = \frac{\text{Cumulative Abnormal Returns}}{\text{Unexpected Earnings}} \text{..............(2)}$$

In this study, the ERCs of firms in five different disclosure portfolios are compared across time to determine any systematic differences between the portfolios.

There are a number of techniques available for calculating unexpected earnings, (Ball and Brown, 1968; Beaver, Clarke and Wright, 1979; Ajinkya, 1980). The most common are based on a variant of the sub-martingale model. If investors' expectations follow those predicted by a strict sub-martingale model, equation (2) can be rewritten as:

$$ERC = \frac{\text{Cumulative Abnormal Returns}}{(A_t - A_{t-1})/MC_{t-1}} \text{...............(3)}$$

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7 For ease of exposition equation 1 omits subscripts j and t, which denote a particular firm j in year t, respectively.

8 The deflation by market capitalisation follows Christe (1987).

where MC = Market Capitalisation.

Although the observed ERC is an imperfect measure of response (since the proxy for unexpected earnings is naive), the fact that this paper focuses on the relative precision of earnings expectations means that the use of an imperfect measure is less problematic.

Consider now the predicted movements in ERCs for the various groups. Such predictions depend upon the expectations regarding the movements in both the numerator and denominator of equation 3. Taking the numerator of equation 3 first, if segment information allows investors to better predict earnings, then it is expected that the release of a firm's annual earnings number will contain less surprise information. In other words, the abnormal returns for a diversified non-discloser (DND) of segment information should, on average, be larger before the requirement to disclose than after the requirement. By contrast, in respect of single segment firms (SS), on average no change in earnings predictability is expected.

Consider now the denominator of equation 3. Because ERCs are calculated based upon the naive model both before and after the requirement to disclose, the improvement in prediction accuracy is not expected to be captured. Therefore, the estimated denominator in equation 3 is expected to remain constant before and after the requirement to segment disclose for both DND and SS firms with the result that, on average, the overall change in ERCs should be downward for the DND group but static for SS groups. A result similar to the later is expected for diversified firms that were voluntarily disclosing some level of segment information prior to the requirement to disclose. Because a change is expected in the numerator but not in the denominator for firms that increased the amount of segment disclosure after the regulatory change, it is postulated that the ERCs should reduce for this group of firms post-regulation.

The above discussion results in four testable hypotheses:

1. If disclosure of segment information leads to improved earnings prediction, then the DND group's average ERC should be lower in the post disclosure period when compared to the pre-disclosure period.

   H1 magnitude of $ERC_{DND(post)}$ < magnitude of $ERC_{DND(pre)}$

2. If the additional disclosure of segment revenues leads to improved earnings prediction, then the average ERC for groups already disclosing segment earnings (DE) should be lower in the post disclosure period when compared to the pre-disclosure period.

   H2 magnitude of $ERC_{DE(post)}$ < magnitude of $ERC_{DE(pre)}$

3. If the additional disclosure of segment earnings leads to improved earnings prediction, then the average ERC for groups already disclosing segment revenues (DR) should be lower in the post disclosure period when compared to the pre-disclosure period.

   H3 magnitude of $ERC_{DR(post)}$ < magnitude of $ERC_{DR(pre)}$

4. Since the control groups have not changed their disclosure practices, in the absence of extraneous environmental factors, post-disclosure ERCs for groups unaffected by segment disclosure requirements (i.e. single segment (SS) and pre-requirement disclosers of both segment revenues and earnings (DRE))[9] should not be different from the pre-disclosure ERCs.

   H4 magnitude of $ERC_{SS(post)}$ = magnitude of $ERC_{SS(pre)}$ and
   magnitude of $ERC_{DRE(post)}$ = magnitude of $ERC_{DRE(pre)}$

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[9] The control group of pre-requirement disclosers of both segment revenues and earnings (DRE) served as a proxy for the diversified disclosers (DD) discussed above.

V. Data

The sample was collected from firms traded on the Australian Associated Stock Exchanges (now the Australian Stock Exchange, hereafter, ASX) over the period January 1983 to December 1987. Reasoning that those firms affected by segment requirements (i.e. multi-segment firms) are likely to be large, the initial search was conducted on firms in the top 500 as measured by market capitalisation at June 1983. To qualify for inclusion a firm had to be listed on the ASX in both January 1983 and December 1987. This search revealed a total of 46 firms that disclosed some level of segment information prior to the release of AAS 16.

A review of the initial search revealed that (1) pre-requirement disclosers tended to be large (the vast majority of segment disclosers were in the top 200), and (2) they tended to be concentrated in industries #22 (Miscellaneous Services), #23 (Miscellaneous and Diversified Industrials) and #24 (Diversified Resources) as defined by the ASX industry codes.

In an attempt to expand the sample of pre-requirement segment disclosers a second search of all firms listed in the above three industries was conducted. This resulted in a search of a further 79 firms [192 - 93 (previously searched) - 20 (not listed in both 1983 and 1987)]. However no new pre-requirement disclosers were found.

Descriptive information relating to the sample of pre-requirement disclosers of segment information is provided in table 4.

Two points stand out in table 4:

(1) As mentioned above, disclosers of segment information prior to the release of AAS 16 were large. In fact, 96% of those firms found were in the top 200.

(2) In a search of 579 firms (top 500 + 79 firms not in the top 500 but in listed in one of the three industries mentioned above) only 46 pre-requirement disclosures of segment information were found. Note that the total number of firms listed on the ASX in 1983 was 828, so 70% of the total population was searched. Given this, it is likely that the sample of pre-requirement disclosers of segment information closely approximates the population.

Table 4: Pre-Requirement Disclosers of Segment information by Market Capitalization (1983-87)

	(n)	Cumulative (n)
Top 50	22	22
51 -100	11	33
101-150	8	41
151-200	3	44
201-300	0	44
301-400	1	45
401-500	1	46
Total	46	

The sample was then divided into five portfolios based on an examination of their annual reports. These are described in Exhibit 1. Note that the single segment firms were identified in our search for pre-requirement disclosers and were subsequently chosen on the basis of size to match the treatment groups.

The data was collected from a number of sources. Accounting earnings and the level of disclosure were taken from each company's annual report. Market model parameters for all companies were calculated using the ASX Statex daily price database adjusted for dividend and capitalization changes. The dates of earning announcements and the daily market accumulation index were collected from the ASX Statex database.

Exhibit 1: Description of Sample after Partitioning

DND:	Diversified non-disclosers : No disclosure prior to release of AAS 16. (n=64)
DR:	Diversified revenue disclosers : Disclosure of segment revenue only prior to release of AAS 16. (n=13)
DE:	Diversified earnings disclosers : Disclosure of segment earnings only prior to release of AAS 16. (n=10)
DRE:	Diversified revenue and earnings disclosers : Full segment disclosure prior to release of AAS 16 (i.e. segment revenue and earnings). (n=23) (Control Group 1)
SS:	Single-segment firms. (n=58) (Control group 2)

VI. Empirical Analysis

In most previous investigations of segment disclosure the enactment of the SEC Line of Business requirements is taken as the critical event. In Australia the annual report is the only place where segment disclosure is required. The release of AAS 16 in March 1984 provides the first date at which any official pronouncements were made concerning segment disclosure[10]. However, this standard did not have legal backing. It was not until the release of ASRB 1005 in August 1986 that the disclosure of segment information became mandatory. It is possible that firms affected by ASRB 1005 would have anticipated its release and complied before this date. Given this, the annual reports of all the diversified firms contained in the sample for the years 1983 to 1987 (inclusive) were investigated to identify the first time each company supplied segment information. The results showed that the majority of firms disclosed in 1985, with all firms disclosing by 1986. Therefore, the pre-disclosure period was taken as the period surrounding the release of each firm's 1983 earnings announcement and the post-disclosure period as that surrounding the release of the 1987 earnings announcement.

Daily security returns were regressed against a proxy for the market to identify systematic risk. Systematic risk is typically estimated from the market model[11]:

$$r_{jt} = a_j + B_j R_{mt} + e_{jt}$$

where r_{jt} is the return on the jth stock for the period t,
R_m is the return on the market index, and
a_j and B_j are the intercept and slope parameters, respectively.

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10 Although AAS 16 was preceded by a number of related statements about its possible introduction it was not until the introduction of AAS 16 and particularly ASRB 1005 that we notice any substantial movement to provide segment information.

11 A selection of the major FORTRAN programs developed by the candidate and used to calculate these parameters and subsequently the ERCs is contained in Appendix 2.

The parameters of the market model were estimated over a period of 1080 days. Defining the event window as 371 days (365 prior to earnings announcement + announcement day + 5 days post announcement), this resulted in 371 moving betas for each firm for the pre-disclosure period and 371 moving betas for the post-disclosure period. The individual firm betas were weighted following Ajinkya (1980) so as to ensure each of the five portfolios was equated on systematic risk. These weighted betas were used to calculate the average total abnormal returns for each firm over a 371 day period both pre- and post-disclosure. These abnormal returns were then cumulated for each firm.

Unexpected earnings were estimated by a strict sub-martingale model. As discussed above, the absolute accuracy of this model is not of primary importance. Nonetheless, evidence exists to suggest that the strict sub-martingale model is no less accurate than more complex prediction models (Collins 1976).

The earnings response coefficients were estimated, as per equation (3), dividing the abnormal return by unexpected earnings (deflated by market capitalisation). This resulted in an ERC for each firm. The mean estimated ERCs obtained for each portfolio are contained in column three of Table 5[12].

A plot of the ERCs indicated that an assumption of normality may prove problematic. Therefore, a Wilcoxon matched-pairs signed-ranks test was used to determine the significance of changes in mean estimated ERCs for the portfolios across time. The results are presented in Table 6.

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12 As we are only interested in the difference in the magnitude of the change in the ERCs across time, the mean ERCs presented in table 5 are calculated on the absolute constructed ERC for each firm.

Table 5: Mean Estimated Earnings Response Coefficients [ERCs] for each of the five disclosure groups

Period	Group	Mean ERC	Standard Deviation
Pre	SS	0.88	1.06
Post	SS	0.97	1.80
Pre	DND	1.33	2.36
Post	DND	0.45	0.59
Pre	DR	1.15	1.32
Post	DR	0.43	0.43
Pre	DE	0.82	1.41
Post	DE	0.65	0.78
Pre	DRE	0.35	0.57
Post	DRE	0.35	0.34

DND: Diversified non-disclosers: No disclosure prior to the release of AAS 16.
DR: Diversified revenue disclosers: Disclosure of segment revenue only prior to release of AAS 16.
DE: Diversified earnings disclosers: Disclosure of segment earnings only prior to release of AAS 16
DRE: Diversified revenue and earnings disclosers: Full segment disclosure prior to release of AAS 16. **(Control Group 1)**
SS: Single-segment firms **(Control Group 2)**

Table 6: Test for changes in ERCs over time

	SS	**DND**	**DR**	**DE**	**DRE**
Change in ERC	0.09	-0.88	-0.72	-0.17	0.00
Wilcoxon(Z)	-0.25	-1.76	-1.56	-0.18	-1.10
P(one tailed)	0.40	0.03	0.05	0.43	0.14

The results indicate that firms that failed to disclose segment information until the post disclosure period (DND) experienced a significant drop in their estimated ERCs. H1 was therefore accepted. This evidence supports the proposition that segment disclosure, in aggregate, improves earnings prediction. The control groups SS and DRE, (single segment and pre-requirement disclosers of segment revenues and earnings), had estimated changes of 0.09 and 0.00, respectively. The computed Wilcoxon Z statistics of -0.25 and -1.10 indicate that pre and post ERCs are equal, and that H4 cannot be rejected at any reasonable level of significance for either portfolio. Since by design, the only difference between our test groups and control groups was the level of segment disclosure, we conclude that the observed differences in ERCs were attributable to the initiation of the segment disclosure requirements.

The ERC shift for firms voluntarily disclosing segment earnings but not revenues (DE) was in the hypothesized direction but not significant. This suggests that the addition of segment revenues post-requirement did not led to improved earnings prediction. H2 was therefore rejected. The ERC shift for firms that voluntarily disclosed segment revenues (DR) was significantly different from zero and in the hypothesized direction. Therefore, H3, that the additional disclosure of segment earnings leads to improved earnings prediction, was accepted. While not conclusive, these latter two results tend to suggest that the information in segment earnings subsumes that in revenues.

VII. Conclusions

The purpose of this study was to provide further empirical evidence on the impact of segment disclosure on earnings prediction. A research design that enabled the integration of the earnings prediction and the security returns literature was developed that focused on relative changes in the ERCs of groups differentiated by their level of segment disclosure. The results affirm that segment information leads to improved earnings prediction. In addition, the results also suggest the primacy of segment earnings as an information source over segment revenues. The failure to detect any change in the ERCs of firms that voluntarily disclosed both segment revenues and earnings prior to the requirement to disclose suggests that the changes introduced by ASRB 1005 (i.e. disclosure of segment assets, geographical segments, and consistent presentation) did not lead to improved earnings prediction.

A possible limitation of the present study lies in the use of a naive model of earnings prediction. It is unlikely that this model approximates the actual prediction models used by market participants. However, it seems reasonable to assume that the naive model used is closer to prediction models that are based on consolidated data than models based on segment data. If this assumption is correct, then this inaccuracy does not present a major threat to the research design outlined in this paper. Further research could usefully investigate more appropriate prediction models following the lead of Kinney's (1971) consolidated earnings prediction models or the use of analysts' earnings forecasts as employed by Baldwin (1984).

An issue demanding further attention is sample stratification. While in this study firms were stratified into those that did or did not disclose prior to mandatory requirements, or which disclosed either earnings or revenues or both, other stratifications are possible. For example, firms might be distinguished by whether they have pursued synergistic diversification strategies. The disclosure of segment information by firms who have pursued synergistic diversification strategies arguably provides less incremental information content than firms whose diversification strategy leads it into acquiring a number of unrelated segments. Such research could add to the literature by suggesting the types of firms (classified by diversification strategy) for which segment disclosure would be of most value for the prediction of future earnings.

Further research could also usefully investigate the use of segment disclosure as a way of getting around regulations requiring firms to provide consolidated information.

Finally, research could also usefully investigate the effect of segment disclosure on decisions other than investment decisions. For example, the information value of segment disclosure on credit decisions (e.g. loan decisions) might provide an alternative test of the usefulness of segment disclosure.

Appendix 1: Synopsis of Prior Research

Table 1: Earnings Prediction Studies

Author, Year	Research Design/ Problem	Sample Size	Sample Partitioning	Statistical Procedures	Results
Kinney (1974)	Operationalised earnings expectations by use of 4 earnings prediction models	24 firms	Segment revenue; segment revenue and earnings; and consolidated earnings	Student t on average difference in absolute value of errors	Segment disclosure in aggregate is useful; segment earnings contain no marginal information over revenues
Collins (1976)	Extension of Kinney (1974) with 9 models	96 firms	Segment revenue; segment revenue and earnings; and consolidated earnings	Student t on absolute means of forecast errors	Consistent with Kinney
Baldwin (1984)[1]	Improvement in analysts' predictive ability	188 Compustat companies	Two control groups (single segment and multi-segment disclosers) and multi-segment non-disclosure firms	ANOVA on forecast errors partitioned by group and time	Inconclusive arising from unexpected change in control group

1 c.f. Barefield and Comiskey (1975)

Table 2: Segment Risk Studies

Author, Year	Research Design/ Problem	Sample Size	Sample Partitioning	Statistical Procedures	Results
Horwitz and Kolodny (1977)	Changes in pre and post systematic risk	100 Compustat firms	Treatment sample of diversified non-disclosing firms and control sample of single industry firms	Difference in means test	Average change in beta of treatment group was not significantly different from change in control group beta.
Collins and Simonds (1979)	Changes in pre and post systematic risk	215 firms	1. nondisclosure 2. segment revenues only 3. both segment revenues and earnings 4. single segment	ANCOVA	Segment disclosure in total led to a decrease in systematic risk; disclosure of segmental earnings in addition to revenue had some marginal effect
Prodhan and Harris (1989)	Compared moving betas pre and post	82 Compustat firms	Control group of disclosers pre and post; treatment group of required disclosers post	T test on means betas and ANCOVA test for homogeneity of regression	Disclosure of geographic segments associated with decrease in systematic risk

Table 3: Security Prices Studies

Author, Year	Research Design/Problem	Sample Size	Sample Partitioning	Statistical Procedures	Results
Kochanek (1974)	Examines earnings prediction under various qualities of disclosure measured by changes in correlation between EPS and price changes.	37 diversified firms with some level of segment disclosure.	Good and bad reporters.	MannWhitney U test to examine difference in Spearman rank correlation coefficients between EPS and price change.	Segment disclosure aided earnings prediction.
Foster (1975)	Examines whether trading rules based on subentity data can outperform rules based on consolidated data.	58 firms included on A.M. Best *Insurance Securities Research Service*	One sample consisting of firms reporting both consolidated and segment data	Jonckheere's nonparametric test for ordered alternatives.	Trading rule using sub earnings data outperformed trading rule using consolidated data.
Horwitz and Kolodny (1977)	Examined abnormal returns to determine whether segment disclosure led investors to revalue securities at time on initiation of requirement	100 Compustat firms	Treatment sample of diversified nondisclosing firms and control sample of singleindustry firms	Difference in proportions in positive and negative tails of return distribution. Return selected as extreme when return was more than 1.64s away from company's mean	Segment disclosure found to have no effect on return of securities close to time of disclosure requirement.
Twombly (1979)	Compared means returns of companies not disclosing and voluntarily disclosing segment data pre 1970.		Portfolios classified by segment disclosure: none segment revenues segment revenues and earnings	Risk equalized matched pairs portfolio design	Disclosure of segment information had no effect.

Ajinkya (1980)	Extended Twombly to examine effect of segment disclosure on mean returns and covariance structure of returns.	172 Compustat firms	Two treatment groups (diversified non-disclosers; and diversified disclosers of revenues) and two control groups (diversified firms disclosing revenue and earnings; single segment firms)	Hotelling T^2 test for mean return vector differences. Box c^2 test for evaluating the homogeneity of n covariance matrices.	No difference between mean returns across portfolios. Found significant increase in covariance of returns in the post period. Implies increased consensus under segment reporting.
Swaminathan (1991)	Examines price variability before and at initial segment disclosure; Initial release of segment data decreased divergence of beliefs among investors using	261 firms	Two groups: Control group (firms that voluntarily disclosed segment earnings and income pre) Experimental group (first public disclosure of some or all SEC mandated data in 1970); two subgroups: no disclosure; and segment revenue only	Wilcoxon signed ranks test.	Experimental group had significant increase in variability at initial disclosure. Control group variability did not change. Subsequently, experimental groups belief divergence decreased.

Appendix 2: Computer Programs

The following programs were devised by the candidate. Only a selection of all the necessary programs is presented. Additional programs are available on request.

The first two programs (ACALCRET and DMKTRET) calculate daily security returns (adjusted for dividend and capitalisation changes) and market returns respectively. ECALCBET calculates the parameters of the market model (Alpha, Beta) and the expected and abnormal return. IWEIGHTS weights the portfolios so that they are equalised on systematic risk, and adjusts the abnormal return. This process is conducted for each day. The ERCs for each firm are calculated in OCALCERC.

```
      PROGRAM ACALCRET
c     calculates returns on stocks in pricefile.asc and adjusts for dividend
c     and capitalisation changes.

c     defining pricefile.asc (price file) read format:
901   format (6x,a3,6x,i10,1x,i2,1x,i2,1x,i2,21x,f9.3,i9)
c     defining variables for old record:
      character *3 opasx
      integer *4 opsecnum
      integer *4 opdd
      integer *4 opmm
      integer *4 opyy
      real *4 oplastprice
      integer *4 opvolume
c     calculated (not read) field:
      integer *4 opdate

c     defining variables for current record:
      character *3 pasx
      integer *4 psecnum
      integer *4 pdd
      integer *4 pmm
      integer *4 pyy
      real *4 plastprice
      integer *4 pvolume
c     calculated (not read) field:
      integer *4 pdate

c     define structure of capfile - capitalization file
902   format (13x,a3,4x,i6,2x,i12)
      character *3 capasx
      integer *4 capdate
      integer *4 capfactor

c     define structure of divfile - dividend file
903   format (13x,a3,4x,i2,1x,i2,1x,i2,8x,i6)
      character *3 divasx
      integer *4 divmm
      integer *4 divdd
      integer *4 divyy
      integer *4 divamount
      integer *4 divdate

c     define structure of return1.tmp (output file)
904   format (a3,1x,i10,1x,i6,f9.3,i9)
c     pasx from current price record from pricefile.asc
c     psecnum asx from current price record from pricefile.asc
c     pdate from current price record from pricefile.asc
      real *8 return
```

```
c       pvolume from current price record from pricefile.asc

c       define other variables
        real *4 change
        integer *4 miss
        parameter (miss=999)
        character *3 lastwrit
        real *4 tempoldprice,realdivamount

c       open files and read them
        open(4,name='return1.tmp',status='new')
        open(2,name='capfile.asc',status='old',readonly)
        capasx='  '
        capdate=0
c       to ensure a read at 101

        open(3,name='divfile.asc',status='old',readonly)
        divasx='  '
        divdate=0
c       to ensure a read at 801

        open(1,name='pricefile.asc',status='old',readonly)
        read (1,901,end=899) opasx,opsecnum,opdd,opmm,opyy,
        oplastprice,opvolume
        opdate=opyy*10000+opmm*100+opdd

111     read (1,901,end=899) pasx,psecnum,pdd,pmm,pyy,plastprice,pvolume
        pdate=pyy*10000+pmm*100+pdd

c the following check inserted because we found some duplicate records
c on the input file. since this is sorted, they are next to each other and
c so we can now check for this condition. if duplicates exist, ignore
c the second one:

        if ((psecnum.eq.opsecnum).and.(pdate.eq.opdate)) goto 111
        if (oplastprice.eq.0) then
                opasx=pasx
                opsecnum=psecnum
                opdd=pdd
                opmm=pmm
                opyy=pyy
                oplastprice=plastprice
                opvolume=pvolume
                opdate=pdate
                goto 111
        end if

777     if ((plastprice.eq.0).and.(pasx.eq.opasx)) plastprice=oplastprice
        if (opasx.ne.pasx) then
```

```
                opasx=pasx
                opsecnum=psecnum
                opdd=pdd
                opmm=pmm
                opyy=pyy
                oplastprice=plastprice
                opvolume=pvolume
                opdate=pdate
                goto 111
        end if

c       make sure that capitalization file is on current company
101     if ((capasx.lt.pasx).or.((capasx.eq.pasx).and.(capdate.lt.pdate)))
        1 read (2,902,end=800) capasx,capdate,capfactor
        if ((capasx.lt.pasx).or.((capasx.eq.pasx).and.(capdate.lt.pdate)))
        1 goto 101

c       if we've read it and it's okay, continue at 801
        goto 801

c       if we've run out of cap data, then make capdate=miss
c        (so that we know this is the case when it comes time to adjust)
800     capdate=miss

c       make sure that div file is on current company
801     if ((divasx.lt.pasx).or.((divasx.eq.pasx).and.(divdate.lt.pdate)))
        1 read (3,903,end=802) divasx,divmm,divdd,divyy,divamount
        divdate=divyy*10000+divmm*100+divdd
        if ((divasx.lt.pasx).or.((divasx.eq.pasx).and.(divdate.lt.pdate)))
        1 goto 801

c       if we've read it okay, cont at 803
        goto 803

c       if run out of data, set divdate to 999
802     divdate=miss

c       make capital adjustment if necessary
803     tempoldprice=oplastprice

c  The use of tempoldprice prevents the assignment
c  in line 777 including the capital adjustment.

        if (capdate.eq.pdate) tempoldprice=tempoldprice*capfactor/10000

c       price change
        change = plastprice-tempoldprice

c       make dividend adjustment if necessary (divs in tenths of a cent)
```

```
        if (divdate.eq.pdate) then
                realdivamount=divamount
c                 using divamount (an integer) in the following calculation
c                 will result in the divamount/1000 component being
c                 rounded to the nearest integer, i.e. zero. therefore,
c                 use a real (realdivamount) instead.
                change=change+realdivamount/1000
        end if
c now in dollars

c       calculate return
        return=log(1+(change/tempoldprice))
c       write out the return
        write (4,904) pasx,psecnum,pdate,return,pvolume

        lastwrit=pasx
        opasx=pasx
        opsecnum=psecnum
        opdd=pdd
        opmm=pmm
        opyy=pyy
        oplastprice=plastprice
        opvolume=pvolume
        opdate=pdate
        goto 111

c       close the files

899     close (1)
        close (2)
        close (3)
        close (4)

        stop
        end
```

PROGRAM DMKTRET

```
c       calculates market returns using index values in MIKEAIND.TXT

c       define MIKEAIND.TXT (mkt index (input) file) read format:
901     format (9x,i6,f9.3)
        integer *4 mdate
        real *4 mindex

c define MKTRETS.ASC (market index return (output) file)
902     format (i6,2x,f8.3)
c       mdate
        real *4 mktreturn

c       define other variables
        integer *4 lastdate
        real *4 lastindex

        open(1,name='MIKEAIND.TXT', status='old', readonly)
        open(2,name='MKTRETS.ASC',status='new')
        lastindex=0

111     read (1,901,end=899) mdate,mindex
        if (lastindex.eq.0) then
                lastdate=mdate
                lastindex=mindex
                goto 111
        end if

c       adjust for recording errors
        if (mindex.eq.0) mindex=lastindex

c       calculate return
        mktreturn=log(mindex/lastindex)

        write (2,902) MDATE,MKTRETURN
        lastindex=mindex
        lastdate=mdate
        goto 111

899     close (1)
        close (2)
        stop
        end
```

```
      PROGRAM ECALCBET

C     THIS PROGRAM CALCULATES DAILY BETAS FOR EACH OF THE
C     COMPANIES IN THE SAMPLE.  (371 BETAS/COMPANY)
*********************************************************
C     FORMAT AND TYPE DECLARATIONS

C     CONSTANT VARIABLES
C     ALL FOLLOWING VARIABLES IN RELATIVE DATES
      INTEGER *4 WINDOWSTART, WINDOWLEN, CLEANLEN
      INTEGER *4 MINBETAPERIOD
      INTEGER *4 MISS
      PARAMETER (WINDOWSTART=-365)
      PARAMETER (WINDOWLEN=370)
      PARAMETER (CLEANLEN=1080)
      PARAMETER (MINBETAPERIOD=730)

C     MISSING DATA INDICATOR
      PARAMETER (MISS=999)

C     ARRAY VARIABLES
      DIMENSION M(WINDOWSTART-CLEANLEN:WINDOWSTART+
      WINDOWLEN)
      DIMENSION S(WINDOWSTART-CLEANLEN:WINDOWSTART+
      WINDOWLEN)
      REAL *4 M,S

C     FILE DEFINITIONS

C     FILE OF ANNOUNCEMENT DATES "ANNOUNCE.TXT"
101   FORMAT (a3,3x,i6,2i)
      CHARACTER *3 AASX
      INTEGER *4 ADATE
      INTEGER *4 CODE1,CODE2

C     FILE OF MARKET RETURNS "MKTRETS.ASC"
102   FORMAT (i6,2x,f8.3)
      INTEGER *4 MDATE
      REAL *4 MRET

C     FILE OF COMPANY RETURNS "RETURNS.ASC"
103   FORMAT (a3,1x,i10,1x,i6,f9.3,i9)
      CHARACTER *3 RASX
      INTEGER *4 RSECNUM
      INTEGER *4 RDATE
      REAL *4 RRET
      INTEGER *4 RVOLUME

C     FILE OF ALPHAS AND BETAS "XBETAFILE.TXT"
```

```
104     FORMAT (a3,2i,i8,i8,i5,4f8.4)
C       AASX TAKEN FROM ANN1.TXT
C       CODE1, CODE2 TAKEN FROM ANN1.TXT
C       WSDATE FROM CALCULATIONS
C       ADATE FROM ANN1.TXT FILE
        INTEGER *4 BINDEX
        REAL *4 ALPHA,BETA,RETURN,ABNORMAL

C       OTHER VARIABLES
        INTEGER *4 FIRSTTIME
        INTEGER *4 WSDATE
        INTEGER *4 MINBETASTART
        INTEGER *4 DATASTART
        REAL *4 SUMMS,SUMM,SUMS,SUMM2
        REAL *4 BETANUM,BETADENOM,N,ACCUM
        INTEGER *4 NEXT,DROPOFF
        INTEGER *4 I,COUNTER,JUMPBACKFLAG,OFFSET

C       FUNCTION RESULTS
        INTEGER *4 NEXTDAY, BACKDAYS
*************************************************************
C       PART TWO: FILL IN THE SHARE ARRAY

        FIRSTTIME=1
        OPEN (1,NAME='ANNOUNCE.TXT', STATUS='OLD',READONLY)
        OPEN (4,NAME='XBETAFILE.TXT', STATUS='NEW')

C       READ ANNOUNCEMENT DATE OF NEXT COMPANY
200     READ (1,101,END=600) AASX,ADATE,CODE1,CODE2
        IF((ADATE.EQ.0).OR.(ADATE.EQ.MISS)) GOTO 200

C       READ IN STOCK RETURN DATA UP TO ANNOUNCEMENT CO.
C       AND CALCULATE DATES
C       WORK OUT WSDATE=WINDOWSTART
        WSDATE=BACKDAYS(ADATE,-WINDOWSTART)

C       WORK OUT WSDATE-CLEANLEN=DATASTART (YY/MM/DD)
        DATASTART=BACKDAYS(WSDATE,CLEANLEN)

C       WORK OUT MINBETASTART=WSDATE-MINBETAPERIOD
        MINBETASTART=BACKDAYS(WSDATE,MINBETAPERIOD)

C       IS THIS THE FIRST ANNOUNCEMENT?
        IF (FIRSTTIME.EQ.1) THEN
              OPEN (3,NAME='RETURNS.ASC',
        1     STATUS='OLD',READONLY)
              FIRSTTIME=0
        ELSE IF ((RASX.GT.AASX).OR.((RASX.EQ.AASX).AND.
        1     (RDATE.GT.DATASTART))) THEN
```

```
C            WE HAVE A RETURN RECORD IN MEMORY AND
C            WE NEED TO CLOSE AND RE-OPEN THE FILE
             CLOSE (3)
             OPEN (3,NAME='RETURNS.ASC', STATUS='OLD'
             ,READONLY)
        END IF

        COUNTER=WINDOWSTART-CLEANLEN

C       NEED TO INITIALIZE COUNTER SO THAT IF END OF FILE IS
C       REACHED, THE ROUTINE TO FILL-IN MISSING VALUES KNOWS
C       WHERE TO START FROM

210     READ (3,103,END=260) RASX,RSECNUM,RDATE,RRET,RVOLUME

        IF (RASX.LT.AASX) GOTO 210
        IF (RASX.GT.AASX) GOTO 200

C       NOW READ UP TO RIGHT DATE IN ANNOUNCEMENT COMPANY
C       POINTER TO NEXT (SECURITY) ARRAY POSITION TO BE C
        FILLED:
        NEXT=DATASTART

220     READ (3,103,END=260) RASX,RSECNUM,RDATE,RRET,RVOLUME

        IF (((RDATE.LT.DATASTART).AND.(RASX.EQ.AASX)).OR.
        (RASX.LT.AASX)) GOTO 220

C       STOPPED BECAUSE DATE RIGHT OR WENT PAST COMPANY.
C       THE ROUTINE WOULD'VE GONE PAST COMPANY ONLY IF
C       COMPANY EXISTED ON RETURNS.ASC, BUT WITHOUT A DATE
C       GREATER THAN DATASTART. CHECK IF THIS IS THE CASE,
C       I.E. IF COMPANY EXISTS BUT NO DATE > DATASTART

        IF (RASX.GT.AASX) GOTO 200

C       CHECK TO MAKE SURE THAT WE HAVE AT LEAST ONE DATE
C       WITHIN THE PERIOD FROM DATASTART TO MINBETASTART.
C       THIS GUARANTEES THAT THE CO. IS ONLY PROCEEDED WITH
C       IF THERE ARE SUFFICIENT DATA FOR BETA CALCULATION AT
C       THE FRONT END. (WE MAY OF COURSE ONLY HAVE ONE DATE
C       IN THIS PERIOD AND NO OTHERS).

        IF (RDATE.GT.MINBETASTART) THEN
             WRITE (6,*) 'INSUFFICIENT DATA FOR ',AASX,
        1    '''S ANNOUNCEMENT ON ',ADATE
             GOTO 200
C            GET NEXT ANNOUNCEMENT
        END IF
```

```
C     THIS BIT FILLS IN THE STOCK PRICE ARRAY, S(), WHILE NEXT
C     HOLDS THE DATE OF THE NEXT ARRAY ELEMENT TO BE
C     FILLED.
      OFFSET=0
230   IF (NEXT.EQ.RDATE) THEN
            S(WINDOWSTART-CLEANLEN+OFFSET)=RRET
            NEXT=NEXTDAY(NEXT)
      ELSE
C           IF THE DATE DOESN'T EXIST ON RETURNS.ASC
C           (PERHAPS BECAUSE OF WEEKEND/HOLIDAY), WE PUT IN
C           A MISS
            S(WINDOWSTART-CLEANLEN+OFFSET)=MISS
            OFFSET=OFFSET+1
            NEXT=NEXTDAY(NEXT)
C           CYCLE THROUGH UNTIL WE CAN PUT THE FIRST
C           RETURN SOMEWHERE
            IF  (COUNTER.LE.(WINDOWSTART+WINDOWLEN))  GOTO
230
      END IF

C     DO SAME FOR REMAINING RECORDS OF RETURNS.ASC
      COUNTER=WINDOWSTART-CLEANLEN+1+OFFSET
240   READ (3,103,END=260) RASX,RSECNUM,RDATE,RRET,RVOLUME

250   IF (NEXT.EQ.RDATE) THEN
            S(COUNTER)=RRET
            NEXT=NEXTDAY(NEXT)
      ELSE
C           NEXT < RDATE
            S(COUNTER)=MISS
            COUNTER=COUNTER+1
            NEXT=NEXTDAY(NEXT)
            IF  (COUNTER.LE.(WINDOWSTART+WINDOWLEN))  GOTO
250
      END IF

      COUNTER=COUNTER+1
      IF (COUNTER.LE.(WINDOWSTART+WINDOWLEN)) GOTO 240
      GOTO 300

C     HAVE NOW FINISHED READING RETURNS.ASC
C     FILL IN ELEMENTS NOT READ WITH MISSING
C     VALUE MARKER=MISS
260   DO I=COUNTER,WINDOWSTART+WINDOWLEN
            S(I)=MISS
      END DO
*******************************************************************
C     PART THREE: FILL IN THE MARKET RETURN ARRAY
```

```
C       READ IN MARKET RETURN DATA AND FOLLOW SAME
C       PROCEDURES AS FOR STOCK RETURN DATA POINTER TO
C       NEXT (MARKET) ARRAY POSITION TO BE FILLED:
300     NEXT=DATASTART

        OPEN (2,NAME='MKTRETS.ASC', STATUS='OLD',READONLY)

        COUNTER=WINDOWSTART-CLEANLEN
C       (SEE EXPLANATION FOR COMPANY RETURNS ABOVE)

310     READ (2,102,END=350) MDATE,MRET
        IF (MDATE.LT.DATASTART) GOTO 310

C       DEAL WITH FIRST RECORD
        OFFSET=0

320     IF (NEXT.EQ.MDATE) THEN
                M(WINDOWSTART-CLEANLEN+OFFSET)=MRET
                NEXT=NEXTDAY(NEXT)
        ELSE
C               NEXT < MDATE
                M(WINDOWSTART-CLEANLEN+OFFSET)=MISS
                OFFSET=OFFSET+1
                NEXT=NEXTDAY(NEXT)
                IF (COUNTER.LE.(WINDOWSTART+
        1       WINDOWLEN)) GOTO 320
        END IF

C       DEAL WITH REMAINING RECORDS
        COUNTER=WINDOWSTART-CLEANLEN+1+OFFSET
330     READ (2,102,END=350) MDATE,MRET

340     IF (NEXT.EQ.MDATE) THEN
                M(COUNTER)=MRET
                NEXT=NEXTDAY(NEXT)
        ELSE
C               NEXT < MDATE
                M(COUNTER)=MISS
                COUNTER=COUNTER+1
                NEXT=NEXTDAY(NEXT)
                IF (COUNTER.LE.(WINDOWSTART+
        1       WINDOWLEN)) GOTO 340
        END IF

C       END OF LOOP:
        COUNTER=COUNTER+1
        IF (COUNTER.LE.(WINDOWSTART+WINDOWLEN)) GOTO 330
        GOTO 360
```

```
C      FILL IN NOT READ ELEMENTS WITH MISSING
C      VALUE MARKER=MISS
350    DO I=COUNTER,(WINDOWSTART+WINDOWLEN)
              M(I)=MISS
       END DO

360    CLOSE(2)
*************************************************************
C      PART FOUR: RETURN SYNCHRONIZATION
C      DESCRIPTION OF PROCESS. CONSIDER THE FOLLOWING:
C      STOCK RETURNS V    V MARKET RETURNS
C       | X |  | R1 |
C       | X |  | R2 |
C       | X |  | R3 |
C       | RS|  | R4 |
C       | X |  | R5 |
C
C      X=MISSING DATA
C
C      IF THERE IS NO STOCK RETURN FOR A DATE, BUT WE USE A
C      ZERO RETURN FOR THAT DATE IN CALCULATING BETA, THEN
C      THE BETA WILL BE MISSTATED BECAUSE RS IS REALLY A
C      RETURN FOR 4 DAYS, WHILE IN THE BETA CALCULATION
C      PROCEDURE IT WOULD BE MATCHED WITH R4, WHICH IS A
C      ONE DAY RETURN.
C      IN ADDITION, R1..R3 SHOULD BE MATCHED WITH PARTS OF
C      RS, BUT WOULD BE MATCHED WITH ZEROS IF THE MISSING
C      DATA ARE NOT ACCOUNTED FOR.  IN FACT, RS IS A FOUR DAY
C      STOCK RETURN AND SO SHOULD BE MATCHED WITH A FOUR
C      DAY MARKET RETURN. FOR EACH COMPANY, THE
C      FOLLOWING PROCEDURE CONCENTRATES RETURNS IN
C      SUCH A WAY THAT THE ABOVE SEGMENT OF THE RETURN
C      SEQUENCES END UP BEING STORED IN THE ARRAY (PRIOR
C      TO BETA CALCULATION) IN THE FOLLOWING MANNER:
C      STOCK RETURNS V    V MARKET RETURNS
C       | X |  | X |
C       | X |  | X |
C       | X |  | X |
C       | RS|  | A |
C       | X |  | R5|
C
C      WHERE X=MISSING AND A=R1+R2+R3+R4

       ACCUM=0
       DO I=WINDOWSTART-CLEANLEN,WINDOWSTART
       +WINDOWLEN
              IF ((S(I).EQ.MISS).AND.(M(I).NE.MISS)) THEN
                     ACCUM=ACCUM+M(I)
```

```
                M(I)=MISS
            ELSE
C               S(I) NOT MISSING
                IF (M(I).NE.MISS) M(I)=M(I)+ACCUM
                ACCUM=0
            END IF
        END DO
****************************************************************
C       PART FIVE: BETA CALCULATION

C       REGRESSING Y ON X: Y=STOCK, X=MARKET;
C       N WOULD NORMALLY BE CLEANLEN, BUT BECAUSE OF
C       MISSING DATA WE CALCULATE IT DIRECTLY AS NUMBER ARE
C       ENTERED INTO THE MOMENTS.

C       CUMULATE MOMENTS FOR FIRST CLEANLEN FOR THIS
C       COMPANY: INITIALIZE
500     SUMMS=0
        SUMM=0
        SUMS=0
        SUMM2=0
        N=1

        DO I=WINDOWSTART-CLEANLEN,WINDOWSTART-1
            IF ((M(I).NE.MISS).AND.(S(I).NE.MISS)) THEN
                SUMMS=SUMMS+M(I)*S(I)
                SUMM=SUMM+M(I)
                SUMS=SUMS+S(I)
                SUMM2=SUMM2+M(I)**2
                N=N+1
            END IF
        END DO

C       NEXT CLEANLEN WILL ROLL FORWARD ONE DAY; I.E. IT WILL
C       REMOVE THE EFFECT OF DAY DROPOFF (FIRST IN CURRENT
C       CLEANLEN) AND INCLUDE EFFECT OF DAY NEXT (LAST IN
C       NEXT CLEANLEN); KEEP ROLLING FORWARD

        DROPOFF=WINDOWSTART-CLEANLEN
        NEXT=WINDOWSTART

        DO BINDEX=WINDOWSTART,WINDOWSTART+WINDOWLEN
            BETANUM=(SUMMS-((1/N)*SUMM*SUMS))
            BETADENOM=(SUMM2-((1/N)*(SUMM**2)))
            BETA=BETANUM/BETADENOM
            ALPHA=(SUMS/N)-BETA*(SUMM/N)
            RETURN=S(BINDEX)

C           CALCULATE ABNORMAL RETURN FOR THE DAY
```

```
            IF ((S(BINDEX).NE.MISS).AND.(M(BINDEX).NE.MISS))
     1      THEN
                  ABNORMAL=RETURN-ALPHA-BETA*M(BINDEX)
            ELSE
                  ABNORMAL=MISS
            END IF

            WRITE (4,104) AASX,CODE1,CODE2,WSDATE,ADATE,
     1      BINDEX,ALPHA,BETA,RETURN,ABNORMAL

C           AMEND MOMENTS, TESTING FOR MISSING DATA
C           POINTS IN ARRAYS

            IF ((M(DROPOFF).NE.MISS).AND.(S(DROPOFF)
     1      .NE.MISS)) THEN
C           A NON-MISSING DATA PAIR IS BEING DROPPED OFF,
C           SO ACTUALLY DO THE DROPOFF
                  N=N-1
                  SUMMS=SUMMS-M(DROPOFF)*S(DROPOFF)
                  SUMM=SUMM-M(DROPOFF)
                  SUMS=SUMS-S(DROPOFF)
                  SUMM2=SUMM2-(M(DROPOFF)**2)
            END IF

            IF ((M(NEXT).NE.MISS).AND.(S(NEXT).NE.MISS)) THEN
C           A NON-MISSING DATA PAIR IS BEING ADDED,
C           SO ACTUALLY DO THE ADD
                  N=N+1
                  SUMMS=SUMMS+M(NEXT)*S(NEXT)
                  SUMM=SUMM+M(NEXT)
                  SUMS=SUMS+S(NEXT)
                  SUMM2=SUMM2+(M(NEXT)**2)
            END IF

C           ADJUST DROPOFF AND NEXT
            DROPOFF=DROPOFF+1
            NEXT=NEXT+1
      END DO

C     WE NOW HAVE WRITTEN OUT RESULTS OF
C     COMPUTATIONS FOR ONE COMPANY-ANNOUNCEMENT
      GOTO 200
*********************************************************
C     PART SIX: CLOSE AND END

C     JUMP TO HERE WHEN NO MORE ANNOUNCEMENTS TO GO
600   CLOSE (1)
      CLOSE (3)
      CLOSE (4)
```

```
      STOP
      END

C ====================================================================
      INTEGER FUNCTION BACKDAYS(YYMMDD,X)
C ====================================================================
C     ROUTINE TO CALCULATE X DAYS BEFORE YYMMDD
      INTEGER *4 X,YY,MM,DD,BACKAT,YYMMDD,J
      INTEGER *4 PREVIOUS

      BACKAT=YYMMDD
      DO J=1,X
C           CALC PREVIOUS
            BACKAT=PREVIOUS(BACKAT)
      END DO
      BACKDAYS=BACKAT
      RETURN
      END

C ====================================================================
      INTEGER FUNCTION PREVIOUS(B)
C ====================================================================
      INTEGER *4 B,Y,M,D,YMD,L

700   Y=INT(B/10000)
      M=INT((B-Y*10000)/100)
      D=B-Y*10000-M*100

710   IF (D.GT.1) THEN
            D=D-1
      ELSE IF (D.EQ.1) THEN
            IF (M.GT.1) THEN
                  M=M-1
                  IF (M.EQ.1) D=31
                  IF (M.EQ.3) D=31
                  IF (M.EQ.4) D=30
                  IF (M.EQ.5) D=31
                  IF (M.EQ.6) D=30
                  IF (M.EQ.7) D=31
                  IF (M.EQ.8) D=31
                  IF (M.EQ.9) D=30
                  IF (M.EQ.10) D=31
                  IF (M.EQ.11) D=30
                  IF (M.EQ.12) D=31
                  IF (M.EQ.2) THEN
                        L=0
                        IF (MOD(Y,4).EQ.0) L=1
                        IF (MOD(Y,400).EQ.0) L=0
```

```
                    D=28
                    IF (L.EQ.1) D=29
                END IF
            ELSE IF (M.EQ.1) THEN
                Y=Y-1
                M=12
                D=31
            END IF
        END IF
        PREVIOUS=10000*Y+100*M+D
        RETURN
        END

C =========================================================
        INTEGER FUNCTION NEXTDAY(CURRENT)
C =========================================================
C       INCREMENT DATE "CURRENT" BY ONE

        INTEGER *4 CURRENT, NEXTYY, NEXTMM, NEXTDD

C       SPLIT INTO COMPONENTS
        NEXTYY=INT(CURRENT/10000)
        NEXTMM=INT((CURRENT-(NEXTYY*10000))/100)
        NEXTDD=MOD(CURRENT,100)

C       INCREMENT DATE
        NEXTDD=NEXTDD+1
        IF ((NEXTDD.EQ.32).OR.
        1 ((NEXTDD.EQ.31).AND.((NEXTMM.EQ.4).OR.
        1 (NEXTMM.EQ.6).OR.(NEXTMM.EQ.9).OR.(NEXTMM.EQ.11)))
        1 .OR.((NEXTDD.EQ.30).AND.(NEXTMM.EQ.2).AND.
        1 ((MOD(NEXTYY,4).EQ.0).AND.(MOD(NEXTYY,400).NE.0)))
        1 .OR.((NEXTDD.EQ.29).AND.(NEXTMM.EQ.2).AND.
        1 ((MOD(NEXTYY,4).NE.0).OR.(MOD(NEXTYY,400).EQ.0))))
        1 THEN
                NEXTDD=1
                NEXTMM=NEXTMM+1
        END IF

        IF (NEXTMM.EQ.13) THEN
            NEXTMM=1
            NEXTYY=NEXTYY+1
        END IF

        NEXTDAY = 10000*NEXTYY + 100*NEXTMM + NEXTDD

        RETURN
        END
```

```
      PROGRAM IWEIGHTS

C     THIS PROGRAM READS THE DAILY BETAS FROM THE FILE
C     'SAMPLE1.TXT' AND CALCULATES THE WEIGHTS THAT
C     EQUALISE THE TOP HALF OF THE BETA AND THE BOTTOM
C     HALF (DEFINED BY SIZE) TO THE NUMBER STORED IN SUMTO.
C     ONCE THESE WEIGHTS ARE CALCULATED THE ABNORMAL
C     RETURNS FOR EACH COMPANY/PORTFOLIO/DAY ARE
C     ADJUSTED.
******************************************************
C     PART ONE: FORMAT AND DECLARE TYPES

      INTEGER *4 MAX
      REAL *4 SUMTO
      PARAMETER (MAX = 100)
      PARAMETER (SUMTO = 0.595)

C     FORMAT THE ARRAY TO STORE THE BETAS FOR
C     CALCULATION
      DIMENSION T(MAX)
      REAL *4 T

C     FORMAT THE ARRAY TO STORE THE ASX CODE
      DIMENSION C(MAX)
      CHARACTER *3 C

C     FORMAT THE ARRAY TO STORE CODE1, CODE2, CODE3,
C     BINDEX
      DIMENSION P(MAX, 4)
      INTEGER *4 P

C     FORMAT THE ARRAY TO STORE THE ABNORMAL RETURN
      DIMENSION R(MAX)
      REAL *4 R

C     INPUT FILE "SAMPLE1.TXT"
101   FORMAT(a3,1x,i1,1x,i1,1x,i2,1x,i5,10x,f8.4,10x,f8.4,9x)
      CHARACTER *3 ASX, NASX
      INTEGER *4 CODE1, CODE2, CODE3, BINDEX
      INTEGER *4 NCODE1, NCODE2, NCODE3, NBINDEX
      REAL *4 BETA, NBETA, ABNORMAL, NABNORMAL

C     OUTPUT FILE "WEIGHTS.TXT"
102   FORMAT(I1,2X,I2,I5,2X,F8.4,2X,F8.4)
      REAL *4  WEIGHTT, WEIGHTB
C     OUTPUTS CODE2, CODE3, BINDEX, WEIGHTT AND WEIGHTB

C     OUTPUT FILE "WSAMPLE.TXT"
103   FORMAT(a3,1x,i1,1x,i1,1x,i2,1x,i5,1x,f8.4)
```

```
C     THIS FILE CONTAINS ASX, CODES 1-3, BINDEX, ABNORAMAL
C     RETURN

C     OTHER VARIABLES
      INTEGER *4 N, I, HALF, FLAG
      REAL *4 SUMT, SUMB, AVBETAT, AVBETAB
*******************************************************
C     PART TWO: THE PROGRAM

      OPEN(1,NAME='SAMPLE1.TXT',STATUS='OLD',READONLY)
      OPEN(2,NAME='WEIGHTS.TXT',STATUS='NEW')
      OPEN(3,NAME='WSAMPLE.TXT',STATUS='NEW')

C     FLAG IS SET TO 1 ONLY WHEN WE HAVE REACHED THE
C     END OF THE FILE.  IS THIS CASE WE WILL NEED TO
C     CYCLE THROUGH ONE AND ONLY ONE MORE TIME

      FLAG = 0

C     INITIAL READ TO START THE BALL ROLLING
      READ(1,101,END=400)ASX, CODE1, CODE2, CODE3, BINDEX,
      1 BETA, ABNORMAL

200   N = 1
      T(N) = BETA
      C(N) = ASX
      P(N,1) = CODE1
      P(N,2) = CODE2
      P(N,3) = CODE3
      P(N,4) = BINDEX
      R(N) = ABNORMAL
      SUMT = 0
      SUMB = 0

210   READ(1,101,END=300)NASX, NCODE1, NCODE2, NCODE3,
      1 NBINDEX, NBETA, NABNORMAL

      IF(NCODE3.EQ.CODE3) THEN
            N= N+1
            T(N) = NBETA
            C(N) = NASX
            P(N,1) = NCODE1
            P(N,2) = NCODE2
            P(N,3) = NCODE3
            P(N,4) = NBINDEX
            R(N) = NABNORMAL
            ASX = NASX
            CODE1 = NCODE1
            CODE2 = NCODE2
```

```
              CODE3 = NCODE3
              BINDEX = NBINDEX
              BETA = NBETA
              ABNORMAL = NABNORMAL
              GOTO 210
        ELSE
C       FINISHED ONE BLOCK CALCULATE THE WEIGHTS

220           HALF = N/2
              DO I = 1,HALF
                   SUMT = SUMT + T(I)
              END DO

              DO I = HALF + 1, N
                   SUMB = SUMB + T(I)
              END DO

              AVBETAT = SUMT/HALF
              AVBETAB = SUMB/(N - HALF)
              WEIGHTT = (SUMTO - AVBETAB)/(AVBETAT - AVBETAB)
              WEIGHTB = 1 - WEIGHTT

              WRITE(2,102)CODE2, CODE3, BINDEX,
        1     WEIGHTT, WEIGHTB

C       CALCULATE WEIGHTED ABNORMAL RETURN AND OUTPUT
C       WITH ARRAY ELEMENTS TO "WSAMPLE.TXT"

              DO I = 1,HALF
                   R(I) = R(I) * WEIGHTT
                   WRITE(3,103) C(I), P(I,1), P(I,2), P(I,3),
        1          P(I,4), R(I)
              END DO

              DO I = HALF + 1,N
                   R(I) = R(I) * WEIGHTB
                   WRITE(3,103) C(I), P(I,1), P(I,2), P(I,3),
        1          P(I,4), R(I)
              END DO

C       NOW DO THE NEXT PORTFOLIO UNLESS WE HAVE REACHED
C       THE END OF THE FILE
              IF(FLAG.EQ.1) GOTO 400
              ASX = NASX
              CODE1 = NCODE1
              CODE2 = NCODE2
              CODE3 = NCODE3
              BINDEX = NBINDEX
              BETA = NBETA
```

```
            ABNORMAL = NABNORMAL
            GOTO 200
      END IF
***************************************************
C     PART THREE: LAST TIME THROUGH
300   FLAG = 1
      GOTO 220
****************************************************
C     PART FOUR: CLOSE AND END
400   CLOSE(1)
      CLOSE(2)
      CLOSE(3)

      STOP
      END
```

```
      PROGRAM OCALCERC

C     THIS PROGRAM CALCULATES AN ERC FOR EACH FIRM BY
C     DIVIDING THE CAR BY THE UNEXPECTED EARNINGS.
*****************************************************************
C     FORMAT AND TYPE DECLARATIONS

C     INPUT FILE "ERCDATA.TXT"
101   FORMAT(a3,1x,i1,1x,i1,1x,i2,1x,f8.4,1x,f7.3)
      CHARACTER *3 ASX
      INTEGER *4 CODE1, CODE2, CODE3
      REAL *4 ABNORMAL, EARNINGS

C     OUTPUT FILE "ERCS.TXT"
102   FORMAT(a3,1x,i1,1x,i1,1x,i2,1x,f8.4,1x,f7.3,1x,f8.4)
      REAL *4 ERC
C     OUTPUTS: ASX, CODE1, CODE2, CODE3, ABNORMAL,
C     EARNINGS, ERC

C     OTHER VARIABLES
      INTEGER *4 MISS
      PARAMETER (MISS = 999)
*****************************************************************
C     THE PROGRAM

      OPEN(1,NAME='ERCDATA.TXT',STATUS='OLD',READONLY)
      OPEN(2,NAME='ERCS.TXT',STATUS='NEW')

200   READ(1,101,END=300)ASX,CODE1,CODE2,CODE3,ABNORMAL,
      1 EARNINGS
      IF((ABNORMAL.EQ.MISS).OR.(EARNINGS.EQ.MISS)) THEN
            ERC = MISS
      ELSE
            ERC = ABNORMAL/EARNINGS
            IF (ERC.LE.0) ERC = ERC * -1
      END IF
      WRITE(2,102)ASX,CODE1,CODE2,CODE3,ABNORMAL,
      1 EARNINGS,ERC
      GOTO 200
*****************************************************************
300   CLOSE(1)
      CLOSE(2)

      STOP
      END
```

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