THE PREDICTIVE ABILITY OF GEOGRAPHIC SEGMENT INFORMATION AT THE COUNTRY, CONTINENT, AND CONSOLIDATED LEVELS

By

DONALD RICHARD HERRMANN

Bachelor of Science
John Brown University
Siloam Springs, Arkansas
1985

Master of Accountancy
Kansas State University
Manhattan, Kansas
1987

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
July, 1995

THE PREDICTIVE ABILITY OF GEOGRAPHIC SEGMENT INFORMATION AT THE COUNTRY, CONTINENT, AND CONSOLIDATED LEVELS

Thesis Approved:

Gary Meek
Thesis Advisor

Carol Bauer Johnson

Wade Brown

Dennis H. Patz

Thomas C. Collins
Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to my dissertation committee members, Dr. Carol B. Johnson, Dr. B. Wade Brorsen, and Dr. Dennis H. Patz, and especially to my dissertation committee chairman, Dr. Gary K. Meek. Their guidance, suggestions, and encouragement were invaluable to me throughout the dissertation process. I would also like to express my appreciation to my close friends and co-authors, Wayne Thomas and Tatsuo Inoue, for their insights and expertise.

I wish to acknowledge my father, Richard A. Herrmann, and my father-in-law, Dr David Mugler, for building confidence and providing support these past four years in the doctoral program. My wife, Mary, and my two children, Rachel and David, deserve special recognition for making the sacrifices necessary so that I could pursue this career. Finally, I give all the glory to God; my strength and my shield.

TABLE OF CONTENTS

CHAPTER I

THE RESEARCH PROBLEM

Introduction

Current U.S. requirements for disaggregated disclosures were adopted primarily in Financial Accounting Standards Board (FASB) Statement No. 14, *Financial Reporting for Segments of a Business Enterprise*. A total of six separate FASB Statements relating to disaggregated disclosures have been issued (FASB Statements No. 14, 18, 21, 24, 30, and 94). In a joint project with the Accounting Standards Board (AcSB) of the Canadian Institute of Chartered Accountants, the FASB issued an Invitation to Comment, *Reporting Disaggregated Information by Business Enterprises* [1993]. In the first quarter of 1995, the FASB and the AcSB distributed for comment a draft of tentative conclusions. An Exposure Draft on disaggregated disclosures will follow. The timing of the Exposure Draft is uncertain and depends on the preliminary comments received on the draft of tentative conclusions (FASB [1995]).

The International Accounting Standards Committee (IASC) is also reevaluating the relevance of the disclosure requirements for disaggregated disclosures in International Accounting Standard No. 14. In September 1994, the IASC issued a Draft Statement of Principles entitled "*Reporting Financial Information by Segment.*" The IASC intends to issue an exposure draft in late 1995 after reconciling differences with the FASB.

These standard setters are reexamining the issue of disaggregated disclosures due, at least in part, to the increasing importance of segment information to users of financial data. The importance of disaggregated disclosures is emphasized in a position paper on corporate financial reporting published by the Association for Investment Management and Research (AIMR) [1992, p.39]. The AIMR represents over 23,000 professional financial analysts worldwide.

> In our previous discussion of quarterly segment reporting we alluded to the need of analysts for disaggregated financial data. It actually is more than necessary. It is vital, essential, fundamental, indispensable and integral to the investment analysis process. Different segments will generate dissimilar streams of cash flows to which are attached disparate risks and which bring unique values.

While users agree on the importance of segment disclosures, numerous sources have expressed dissatisfaction with the adequacy of current standards on disaggregated information. The FASB's decision to reexamine the current standards was influenced by the growing dissatisfaction with current disaggregated disclosures as expressed by the two primary user groups: investors represented by the AIMR and lenders represented by the Robert Morris Associates (RMA). Additionally, in 1994 the American Institute of Certified Public Accountants (AICPA) formed a Special Committee on Financial Reporting to address the information needs of investors and creditors. The highlights of the Committee's findings regarding disaggregated information indicate that although investors and creditors place a high value on segment reporting, current disaggregated disclosures generally do not provide adequate information to help them predict an entity's future earnings. The Committee (AICPA [1994]) recommends that users would be better served if an enterprise's segments for external reporting adopted a management perspective whereby external reporting is aligned with the organizational units used for internal reporting. A similar recommendation is included in the FASB's tentative conclusions.

Accounting researchers have also expressed dissatisfaction with the current disaggregated disclosure standards, especially as they relate to geographic disclosures. Bavishi and Wyman [1980, p.163] state that the way companies classify and report geographic segments implies that present disclosures are almost useless. Arnold, Holder and Mann [1980, p.135] conclude that SFAS No. 14 has not resulted in an adequately narrow operational definition of geographic area to satisfy the needs of investors and creditors. Radebaugh [1987, p.80] argues that, in order for geographic information to be useful to financial statement users, there needs to be a greater geographic disaggregation than what currently exists. Ahadiat [1993, p.369] points out that the lack of consensus as to what constitutes a geographic segment (i.e., country, region, continent, or hemisphere) results in a loss of information that could otherwise be influential in evaluating the overall operations of the firm.

Barth et al. [1994] provide a response by the American Accounting Association's Financial Accounting Standards Committee (FASC) to the FASB Discussion Memorandum, *Reporting Disaggregated Information by Business Enterprises*. Regarding geographic segments, the Committee states that the current guidelines for grouping foreign operations into geographic segments are too vague and too flexible. As a result, current geographic segment disclosures often hide the important risk and prospective return differences that exist in the various foreign markets in which a firm operates. The Committee recommends that geographic segments be defined along country boundaries for operations in each of the major industrialized countries of the world (the United States, Canada, England, France, Italy, Germany, and Japan). The remaining geographic segments should be defined by continent or major region. The Committee (Barth et al. [1994 p.78]) asserts that "by defining the geographic segments in this manner, the financial statement user will be able to better understand and assess the risks and rewards of doing business in these foreign markets."

The flexibility in defining geographic segments, currently allowed under Statement of Financial Accounting Standard (SFAS) No. 14, results in the use of inconsistent levels (i.e., country, continent, etc.) of geographic segment disclosure as well as a tendency to use very broad, general classification schemes. For example, IBM discloses three geographic segments: the United States, Europe/ MiddleEast/Africa, and Americas/Far East. The latter category includes operations from Canada, Mexico, Brazil, Japan, South Korea, and Australia among others. The financial, economic, and political risks of operating in these countries vary extensively. This flexibility in reporting may result in reduced information to financial analysts, creditors, and other users of geographic segment information.

Research Objective

The primary purpose of this dissertation is to determine whether geographic information disclosed at an increasingly disaggregated level (specifically, consolidated vs. continent vs. country) results in increased predictive ability of company operations (specifically, sales, gross profit, and earnings). The predictive ability of company operations is used as the evaluative criterion for a number of reasons. First, SFAS

No. 14 includes predictive ability in its justification for the disclosure of disaggregated information. "The purpose of requiring segment disclosures is to assist financial statement users in assessing an enterprise's past performance and future prospects" (SFAS No. 14, paragraph 5). Second, Statement of Financial Accounting Concepts No. 2 includes predictive ability as one of the three primary ingredients of relevant accounting information. Third, the AICPA's Special Committee on Financial Reporting uses the predictive value criterion in its report on the needs of investors and creditors. The Committee states that, because of the predictive value of segment information, improving segment reporting is of the highest priority (AICPA [1994]). Finally, an evaluation of disaggregated disclosures based on predictive ability is consistent with much of the prior research in the area (e.g., Kinney [1971], Collins [1976], Garrod and Emmanuel [1988], Roberts [1989], and Balakrishnan, Harris, and Sen [1990]).

A secondary purpose of the study is to examine the accuracy of forecasts between sales, gross profit, and earnings. Since earnings is computed with greater measurement error than sales or gross profit, forecasts of earnings may be less accurate than forecasts of sales or gross profit. Likewise, since gross profit is computed with greater measurement error than sales, forecasts of gross profit may be less accurate than forecasts of sales.

Importance of the Problem

The results of the study provide evidence useful in evaluating financial analysts' recommendations of greater disaggregation of segment information and more uniformity in the level of disaggregation used by companies. Furthermore, the results of the study provide timely evidence to regulators, such as the FASB, the AcSB, and the IASC, in their examination of the adequacy of current requirements for disaggregated disclosures.

Financial analysts generally find the disclosures required under SFAS No. 14 useful but inadequate. The AIMR's Corporate Information Committee lists segment reporting as the most repeated shortcoming in financial reporting and disclosure (AIMR Position Paper [1992]). The following recommendations relating to disaggregated disclosures recur consistently over the past fifteen years subsequent to the issuance of SFAS No. 14.

1.) Disaggregation into a greater number of segments.

2.) More meaningful segments.

3.) More uniformity in segmentation by comparable companies.

4.) Disclosure of the criteria that a company used to determine its industry and geographic segments - to inhibit unnecessary or misleading changes in segmentation from one period to the next.

5.) Disclosure of additional annual information for each industry and geographic segment such as . . . cost of goods sold and gross profit.

Although the current study does not specifically address each of the above recommendations made by financial analysts, it does provide relevant information relating directly to recommendations 1, 2, and 5 and indirectly to recommendations 3 and 4.

The FASB and its Canadian counterpart (AcSB) have distributed an invitation to comment, *Reporting Disaggregated Information by Business Enterprises* [1993].

One of the primary issues relates to *geographic* segment disclosures. Subissue 2.1 inquires whether current standards should be modified to provide a more meaningful and more useful disaggregation of geographic information. Many users argue that the flexibility allowed by current standards in determining geographic segments results in information of limited usefulness. One approach discussed in subissue 2.1 (p.13) is to require geographic segmentation on a country-by-country basis. As mentioned previously, the reporting of foreign operations along country boundaries for major industrialized countries has been recommended by the American Accounting Association's Financial Accounting Standards Committee. The current study provides evidence on the predictive value of disaggregation by country in comparison to disaggregation by continent or on a consolidated basis.

Subissue 2.2 raises the question of the appropriate level of detail to be disclosed for geographic segments. Currently, a firm must disclose a separate geographic segment if the segment's revenues or identifiable assets exceed 10% of the related consolidated amounts. A separate geographical segment, however, can be made up of a mixture of countries, groups of countries, continents, and so on. Previous research has not examined the relative predictive ability of different levels of disaggregated geographic information.

Subissue 2.3 asks what information in addition to revenues, earnings, and identifiable assets, should be disclosed by geographic segment. Cost of goods sold and gross profit are specifically mentioned in the invitation to comment (p.14) as potential additional items of financial information identified as useful in assessing an enterprise's risks and prospective returns. The current study will examine the predictive value of gross profit, as recommended by the AIMR and under consideration by the FASB.

The remainder of this dissertation is organized as follows. Chapter II reviews prior research on disaggregated information especially as it relates to geographic segments. Chapter III discusses the factors useful in forecasting operating results, developing a forecasting model and the related hypotheses. Chapter IV describes the methodology used, including data requirements, model specification, and test statistics. Chapter V reports the empirical results of the study. Chapter VI summarizes the contributions, limitations, and possible extensions of the study.

CHAPTER II

RELATED LITERATURE

Overview

Most of the research on disaggregated information concentrates on industry segment data rather than geographic segment information. As pointed out in Meek and Saudagaran's [1989, p.165] review of international accounting research, "there appears to be considerable scope for extending this research to geographic segment disclosure."

Pactor [1993] classifies the research on disaggregated disclosures into the following three broad categories:

1.) Descriptive studies of domestic or international disaggregated disclosures (industry and/or geographic).

2.) Studies of the effects of disaggregated data (industry or geographic) on investors' assessments of risk.

3.) Studies of the effects of disaggregated data (industry or geographic) on investors' assessments of expected returns.

The third category, representing the emphasis of this dissertation, focuses on the usefulness of disaggregated data in (1) improving the accuracy of sales and earnings forecast models, (2) improving analysts' earnings forecasts and (3) determining stock prices. A summary of the research findings in these three areas is provided in the rest of this section. An in-depth analysis of the research specifically relating to forecasts using disaggregated geographic information and forecasts using simulated mergers is provided in the following two sections.

Studies examining the predictive accuracy of sales and earnings forecast models using disaggregated *industry* information include Kinney [1971], Collins [1976], Emmanuel and Pick [1980], and Garrod and Emmanuel [1988]. These studies find that industry segment data improve the predictive accuracy of both sales and earnings. However, the incremental usefulness of industry segment earnings in addition to industry segment sales is questionable. Earnings predictions including both industry segment sales and industry segment earnings do not differ significantly from earnings predictions using industry segment sales and consolidated profit margins. The studies examining the predictive accuracy of sales and earnings forecast models using disaggregated *geographic* information are separately analyzed in much greater detail in a subsequent section of the literature review.

While some predictive accuracy studies examine only sales (Garrod and Emmanuel [1988]) or only earnings (Kinney [1971], Roberts [1989]), many of the studies examine both the forecasting accuracy of sales and the forecasting accuracy of earnings (Collins [1976], Emmanuel and Pick [1980], and Balakrishnan, Harris, and Sen [1990]). This is most likely due to the disclosure criteria in SFAS No. 14 requiring companies to disclose segment information for both sales and earnings. While the research findings indicate that segment information improves the accuracy of both sales and earnings, the differences between consolidated and segment information are generally more pronounced in the prediction of sales than in the prediction of earnings (Garrod and Emmanuel [1988]). Previous research has not examined the usefulness of segment information in the prediction of gross profit, although the possibility of requiring disaggregated gross profit information is currently under consideration by the FASB.

The usefulness of disaggregated data in improving actual analysts' earnings forecasts has been examined extensively for industry disclosures (e.g., Barefield and Comiskey [1975], Baldwin [1984], Swaminathan [1991], and Fried, Schiff, and Sondhi [1992]). Each of these studies finds evidence that industry segment data improve the estimates made by professional analysts. The research also finds that greater forecast consensus among analysts accompanies the availability of disaggregated industry data. Only one research study has examined the usefulness of geographic disclosures in improving actual analysts' earnings forecasts (Nichols [1992]). In contrast to the results for industry segment data, Nichols [1992] finds that geographic segment data does not significantly improve the estimates made by professional analysts. The insignificance of geographic segment data is attributed to the relatively broad and inconsistent manner in which geographic segments are disclosed under SFAS No. 14.

The usefulness of disaggregated data in determining stock prices has been studied by numerous researchers using industry data (e.g., Kochanek [1974], Collins [1975], Ajinkya [1980], Tse [1989], Swaminathan [1991]). However, only one published paper has analyzed stock market reactions to disaggregated geographic data (Boatsman, Behn, and Patz [1993]). The stock price studies generally find that a company's disclosure of segment data is revealed in market prices. For example, Swaminathan [1991] finds that stock price variability significantly increases with the release of industry segment information. This result is consistent with a theory developed from information economics predicting increasing variability upon receipt of more precise information. Only one study (Twombly [1979]) failed to detect any sort of market return reaction to industry segment data.

Boatsman, Behn, and Patz [1993] find that geographic segment information are value relevant only when unexpected geographic segment earnings are large. In general, they find that the market does not value geographic segment earnings differently. The limited usefulness of geographic segment information may be attributable to the rather broad and general classification schemes currently employed for geographic disclosures by U.S. MNCs.

Forecasts Using Disaggregated Geographic Information

Three papers have examined the predictive accuracy of forecast models using disaggregated geographic data: Roberts [1989], Balakrishnan, Harris and Sen (BHS) [1990], and Ahadiat [1993]. The first two papers are similar in that both use year-ahead forecast models to examine the relative predictive accuracy of forecasts using geographic segment disclosures. However, the studies differ in several ways. In contrast to Roberts [1989], BHS [1990] (1) analyze the predictive ability of sales in addition to the predictive ability of earnings, (2) include exchange rates in addition to nominal GNP in the predictive models, and (3) base the sample on U.S. rather than U.K. multinational companies (MNCs). The most recent paper, Ahadiat [1993], differs significantly in methodology from the other two studies. Ahadiat [1993] uses Box-Jenkins time-series models in contrast to the year-ahead forecast models employed in Roberts and BHS.

Roberts [1989] evaluates whether geographic segment data can generate earnings forecasts that outperform earnings forecasts based solely on consolidated data. Roberts constructs earnings forecasts for 78 U.K. based companies from 1981 to 1983. Forecasts of consolidated earnings are made using random walk and percentage change models (i.e., random walk with a drift component). Forecasts of segment earnings are based on prior period segment earnings adjusted for forecasted changes in GNP in the respective geographic segments, both with and without the addition of forecasted inflation rates. A comparison of forecast errors from the various segment models demonstrates that inflation is an important variable in forecasting next period earnings and should be included in the forecasting models. Changes in exchange rates were not considered.

The results indicate that the predictive ability of models based on geographic data exceed that of consolidated data based models. Similar to the research on disaggregated industry information discussed earlier, Roberts finds that models using geographic segment sales and geographic segment earnings do not outperform models using geographic segment sales and consolidated profit margins in the prediction of future earnings. The limited usefulness of segment earnings is attributed to arbitrary common cost allocations and manipulation of transfer pricing in the determination of segment earnings. This additional measurement error may distort segment earnings more than segment sales, reducing the predictive value of the disaggregated earnings figure.

BHS [1990] examine whether geographic segment data improve sales and earnings forecasts in comparison to forecasts using consolidated data only. The authors examine forecasts for 89 U.S. based MNCs from 1979 to 1985. To control for errors in forecasting exchange rates, inflation, and real GNP, the authors first assume perfect foresight using the actual year-ahead changes in exchange rates, inflation, and changes in real GNP. The perfect foresight assumption is then relaxed so that forecasts of these variables can be examined. Two separate consolidated forecast models are used: (1) a random walk model and (2) a growth model whereby prior period operating results are adjusted for changes in U.S. GNP and inflation. Similarly, two separate segment forecast models are used: (1) a random walk model adjusted for exchange rates and (2) a growth model whereby prior period results are adjusted for changes in exchange rates, changes in real GNP, and inflation.

Assuming perfect foresight, the results indicate that, relative to consolidated data, geographic segment data can improve the accuracy of sales and earnings forecasts. However, the use of forecast variables rather than perfect foresight variables, results in the finding of no additional predictive value of disaggregated geographic data over consolidated data. The inaccuracy of forecasting these macroeconomic variables, especially exchange rates, over a long period of time such as a year, restricts the usefulness of the geographic segment data. This finding points to the potential usefulness of interim geographic segment data since the forecast horizon could be significantly reduced.

Ahadiat [1993] examines the predictive value of geographic earnings using a different methodology than that found in the two previous studies. Box-Jenkins time series models are identified for both geographic segment and consolidated income series for periods up to 19 years.

The results indicate that, although consolidated income series provide a reasonably adequate forecast of income, geographic segment earnings improve the accuracy of predictions. The findings further suggest that the predictive ability of earnings may improve with greater disaggregation since the predictive ability of firms disclosing more than two geographic segments exceeds the predictive ability of firms disclosing only two geographic segments. The generalizability of the results is limited, however, as the sample firms were restricted to only those voluntarily disclosing geographic segment data prior to FASB Statement No. 14. This restriction was necessary in order to obtain observations over enough years to estimate the models using Box-Jenkins.

While finding limited evidence of enhanced predictive ability using geographic segment information, Roberts [1989], BHS [1990], and Ahadiat [1993] each conclude that the broad manner in which companies currently disclose geographic segment information limits the usefulness of the information. By examining whether geographic information disclosed at a more disaggregated level results in increased predictive ability of company results, the current study represents a logical extension to the previous research.

Forecasts Using Simulated Mergers

Silhan [1982] [1983] [1984] represent the only research articles to use simulated mergers in testing the usefulness of disaggregated information. All three studies examine the predictive ability of industry segment data using Box-Jenkins time series methods.

Silhan [1982] simulates mergers of 60 U.S. based, single industry firms into 3, 5, 7, and 10 industry segment conglomerates. Box-Jenkins forecast models are identified over 36 quarters from 1967 to 1975 for (1) the simulated consolidated earnings data and (2) the simulated segment earnings data. These models are used to forecast consolidated quarterly and annual earnings for the holdout period, 1976 and 1977. The results indicate that neither consolidated earnings nor industry segment earnings consistently outperforms the other in the accuracy of earnings forecasts.

Silhan [1983] extends his previous work to include additional forecast models based on (1) consolidated sales and consolidated profit margins, (2) industry segment sales and consolidated profit margins, and (3) industry segment sales and industry segment profit margins. The three additional models are added to examine the relative forecasting power of segment earnings over segment sales and consolidated profit margins as in Kinney [1971] and Collins [1976]. Using the same data base and methods as the 1982 study, Silhan [1983] reports results consistent with Kinney [1971] and Collins [1976], namely that while industry segment data improve forecasting, annual forecasts using segment sales and segment profit margins do not outperform those using segment sales and consolidated profit margins.

Silhan [1984] examines the relationship between the size of a multi-industry firm and the forecast accuracy of industry segment earnings. The same data set and methods are used as in the two prior studies, except that conglomerates are combined by size. The results find no difference between consolidated and segment data in the forecast accuracy of *annual* earnings. However, industry segment earnings did improve the forecast accuracy of *quarterly* earnings, particularly for smaller companies.

This dissertation is similar to the three studies by Silhan in that individual firm operating results are combined to form consolidated entities. However, this study differs from the three studies by Silhan in two important ways. First, this study examines the predictive ability of geographic segment data rather than industry segment data. Second, this study uses an entirely different forecasting methodology. This study uses both year-ahead forecasting models as in Roberts [1989] and BHS [1990] and regression forecasting models explained further in the research design chapter. Box-Jenkins forecasts for individual companies, used in the Silhan studies, cannot be used in this study due to the lack of sufficient data points. A minimum of 20 consecutive years of data are necessary and 40 to 50 data points are recommended, for Box-Jenkins forecasts. Prior research on earnings forecasts indicates that when annual data are used to predict next year's income, simple econometric forecast models (i.e., random walk models) perform as well or better than times series models such as Box-Jenkins forecast models (e.g., Hopwood, Mckeown, and Newbold [1982], Bao et. al. [1983], and Finger [1994]).

Summary

Overall, the literature on disaggregated geographic information provides, at best, modest evidence supporting the potential usefulness of geographic segment information. Previous research consistently attributes the limited value of geographic data to the broad and inconsistent manner in which current geographic information is disclosed. By combining the actual operating results of individual firms from separate countries, this study examines the predictive ability of disaggregated geographic information using an approach analogous to the three disaggregated industry studies by Silhan. This approach makes it possible to compare the forecasting accuracy of data disclosed at the country, continent, and consolidated levels, not possible using current geographic segment disclosures. Furthermore, this approach makes it possible to test the predictive ability of information, such as gross profit, in addition to that already required under current GAAP. The advantages of using this method of combining firms are described in greater detail in Chapter IV.

The forecast models used in the dissertation are comparable to the year-ahead forecast models used in Roberts [1989] and BHS [1990]. Similar to BHS [1990], the forecast models include both perfect foresight measures as well as forecasts of the explanatory variables. Roberts [1989] includes inflation and changes in real GNP as explanatory variables. The forecast models in BHS [1990] contain changes in exchange rates, inflation, and changes in real GNP. The predictive factors for this study are developed in Chapter III and include changes in exchange rates, inflation, and changes in real GNP.

Previous studies utilizing year-ahead forecast models implicitly assume the predictive factors included in the models are significant in forecasting operating results. The specific explanatory variables included in the models are not tested to determine whether they actually are effective in forecasting operating results. By using regression forecast models, the current study tests whether the explanatory variables included in the models are effective in forecasting operating results. This is performed by examining the direction, size, and significance of the coefficient estimates in the regression forecast models.

CHAPTER III

FORECASTING FRAMEWORK

Chapter III examines the financial, economic, and political factors for predicting operating results in an international environment. The first section discusses the predictive factors useful in forecasting sales, gross profit, and earnings. Based on these factors, the second section develops the consolidated and segment forecasting models. The chapter concludes with a formal statement of the hypotheses to be tested.

Predictive Factors

Primary financial factors in predicting sales, gross profit, and earnings in an international context are exchange rates, inflation rates, and interest rates. These three monetary variables are closely related. Solnik [1991] describes the theoretical parity relations as follows:

1.) The purchasing power parity relation linking spot exchange rates and inflation.

2.) The international Fisher relation linking interest rates and inflation.

3.) The interest rate parity relation linking spot exchange rates, forward exchange rates, and interest rates.

Purchasing Power Parity

Purchasing power parity (PPP) states that spot exchange rates adjust perfectly to inflation differentials. The PPP relation can be stated mathematically as

$$\frac{FX_{t+1}}{FX_t} = \frac{1+INFL_F}{1+INFL_D} \tag{1}$$

where

FX = the spot exchange rate in period t and period t+1.

INFL = the inflation rate in the foreign country, F, and the domestic country, D, respectively.

PPP is often presented as a linear approximation of equation (1). The linear approximation states that the movement in exchange rates is approximately equal to the difference in inflation rates. This relationship can be expressed as

$$\frac{FX_{t+1} - FX_t}{FX_t} \cong INFL_F - INFL_D \tag{2}$$

The empirical evidence indicates that PPP is a poor explanation for short-term exchange rate movements. Little short-term exchange rate volatility is explained by inflation. Adler and Dumas [1983] find that inflation differentials explain less than 5% of monthly exchange rate movements since floating exchange rates began in 1973. While PPP generally does not hold in the short run, the deviation in PPP does tend to correct over several years (Kravis et al. [1982]). However, Adler and Lehman [1983] and Abuaf and Jorion [1990] find significant deviations from PPP even over the long run. Other studies suggesting the violation of PPP include Richardson [1978], Kravis and Lipsey [1978], Genberg [1978], and Thygesen [1978]. Therefore, a model forecasting annual operating results should include both exchange rate forecasts and inflation forecasts as these factors vary extensively, at least in the short-run.

International Fisher Relation

The international Fisher relation states that the difference in nominal interest rates between two countries is linked to the difference in real interest rates and expected inflation.

$$\frac{1+r_F}{1+r_D} = \frac{1+p_F}{1+p_D} \times \frac{1+E(INFL_F)}{1+E(INFL_D)} \tag{3}$$

where

r	=	the nominal interest rate.
p	=	the real interest rate.
E(INFL)	=	the expected inflation rate.

The nominal interest rate is the interest rate observed in the market, while the real interest rate is computed from the nominal interest rate and forecasted inflation. The economic theory proposed by Fisher [1930] is that changes in interest rates are caused by revisions in inflationary expectations, since real interest rates are assumed to be stable. The linear approximation can be stated as

$$r_F - r_D \cong p_F - p_D + E(INFL_F) - E(INFL_D) \tag{4}$$

If real interest rates are assumed to be stable over regions and time, the linear approximation can be simply restated as

$$r_F - r_D \cong E(INFL_F - INFL_D) \tag{5}$$

The empirical evidence supports the international Fisher relation when applied to major currencies. Kane and Rosenthal [1982] examine six major currencies in the Eurocurrency market from 1974 to 1979, finding strong evidence in support of the international Fisher relation. Since interest rates and expected inflation are correlated, a model predicting future sales, gross profit, and earnings need not include both interest rates and inflation.

Interest Rate Parity

Interest rate parity states that, in the absence of market frictions, the forward exchange rate (FW_t) is equal to the spot exchange rate (FX_t) adjusted by the interest rate differential. Stated another way, the forward exchange rate premium or discount is equal to the interest rate differential between countries. In contrast to PPP and the international Fisher relation, interest rate parity is not an economic theory, but rather, is derived from the potential for riskless arbitrage.

For example, if the interest rate in country A exceeds the interest rate in country B even after consideration of the forward premium or discount, then riskless arbitrage can occur. An investor can borrow funds in Country B, exchange to country A's currency at the going spot rate, invest funds in country A, and cover any foreign currency exchange risk by purchasing a forward exchange contract. No capital is invested in the position, and the gain is certain, since interest rates, spot rates, and forward rates are fixed at the time of the transaction. To prevent this riskless arbitrage, the forward premium or discount must equal the interest rate differential.

This relationship can be expressed mathematically as

$$\frac{FW_t}{FX_t} = \frac{1+r_F}{1+r_D} \tag{6}$$

or with the linear approximation

$$\frac{FW_t - FX_t}{FX_t} \cong r_F - r_D \tag{7}$$

As Solnik [1988, p.82] points out, "forward exchange rates and interest rates are direct substitutes. Forward exchange rates are simply calculated by applying interest rate differentials to spot exchange rates." The empirical evidence demonstrates that interest rate parity holds closely, but it does not hold precisely due to market imperfections such as transaction costs, political risks, and tax considerations (Overturf [1982], Bahmani-Oskooee and Das [1985], and Clinton [1988]).

Interest rate parity links *forward rates* with interest rates. Levi [1990] argues that up to the level of a very small risk premium, speculation will make the forward exchange rate equal to the expected future spot rate. A similar argument is provided in Solnik [1988]. Therefore, the future spot rate might be substituted for the forward rate in the previous equation resulting in

$$\frac{FX_{t+1}-FX_t}{FX_t} \cong r_F - r_D \tag{8}$$

The links between exchange rate movements, inflation rate differentials and interest rate differentials based on PPP, the international Fisher relation, and interest rate parity are summarized in Figure 1. If all three of these theoretical parity relations held empirically, then exchange rate movements, inflation rate differentials, and interest rate differentials would be interchangeable. Only one of these factors need be included in a forecasting model. However, as indicated by the empirical evidence for the three parity relations already cited and the evidence discussed below, these three factors are not interchangeable.

Solnik [1991] provides a summary of exchange rate movements, inflation rate differentials, and interest rate differentials from 1973 to 1988 for US dollar/Japanese yen and German mark/British pound comparisons. Based on the theoretical parity relations reviewed, the percentage values of all three variables should be of the same sign and same magnitude for each of the sixteen years. However, while annual inflation and interest rate differentials tend to be of the same sign and magnitude, exchange rate movements are significantly more volatile and are often in the opposite direction from inflation and interest rate differentials. Therefore, a forecasting model should include exchange rates and either inflation or interest rates. Inflation is selected over interest rates in this study because inflation has a more direct impact on operating results. The impact of interest rate changes on operating results are much more difficult to determine. The impact of interest rate changes tend to be more company specific including such factors as investment holdings, company leverage, and industry association.

Gross National Product

The primary economic factor in the prediction of future sales, gross profit, and earnings in an international context is the forecast of Gross National Product. In general, countries provide data either on Gross National Product (GNP) or on Gross Domestic Product (GDP), but not both. GNP represents the total of all final goods and services produced. GDP is equal to GNP less foreign incomes. The *OECD Economic Outlook* provides forecasts of GNP for the United States, Canada, Japan, and Germany and forecasts of GDP for the remaining member countries of the Organization for Economic Cooperation and Development (OECD). The difference between the two measures is generally not material for time-series analyses (BHS [1990] p.322). For ease of exposition, both measures are referred to as GNP in this dissertation.

The major assumption underlying the use of GNP in forecasting is that an individual company's performance is positively correlated with the performance of the economy of the country in which it is located. Under perfect correlation, a percentage change in the GNP of the country results in an equivalent percentage change in the company's operating performance.

GNP forecasts are of two types. Nominal GNP includes the effects of inflation, whereas real GNP does not. The inclusion of inflation with real GNP forecasts depends on whether purchasing power parity (PPP) holds. As discussed previously, PPP does not hold, at least in the short-run. Exchange rate changes do not fully explain inflation differences. Therefore, forecasts of inflation and forecasts of real GNP growth will be used for predictive purposes consistent with Roberts [1989] and BHS [1990].

Political and Legal Factors

There are numerous political and legal factors that could influence an MNC's operations. The extreme form of political and legal risk is expropriation: the host country taking control of the subsidiary with or without compensation to the foreign MNC. However, more common forms of political and legal risk include taxation, restrictions on fund transfers, trade barriers, environmental legislation, labor laws, nationalism, and political stability. Political risk forecasts for over 80 countries are published monthly by Coplin and O'Leary, Directors of Political Risk Services. The forecasts are based on a process that combines the opinions of both national and international political risk experts into weighted matrix models. Separate qualitative political risk forecast ratings (A+ to D-) are reported for turmoil, financial transfer, direct investment, and exports in each country.

Political and legal factors are not included in this study for two reasons. The primary reason for excluding these factors is that this study includes only major industrialized countries (France, Germany, the United Kingdom, Canada, the United States, and Japan). Based on the political risk forecasts published by Coplin and O'Leary, forecasts of political and legal factors for these six major industrialized countries are very similar and change little over the sample period from 1989 to 1992. The usefulness of political and legal factors for forecasting operating results should increase with the inclusion of both developed and less developed countries in the sample, creating a greater variation in risk across countries and over time. Although the inclusion of less developed countries is highly desirable, it is not feasible in the current study due to data constraints. Operating data as well as financial and economic forecast variables for the less developed countries are not available.

A secondary reason for excluding political and legal factors involves the difficulty in determining the impact of a change in the political climate on operating results. There has been very little prior research in this area making it difficult to predict the effect of changes in country risk. A favorable change in the forecast of the political climate is expected to have a positive effect on sales, gross profit, and earnings. In certain instances, however, the operating results may actually drop with a favorable change in the political climate. For example, the reduction in trade restrictions between Canada, the United States, and Mexico due to the North American Free Trade Agreement (NAFTA) should decrease costs for many companies operating in these three countries, resulting in higher profit margins and increasing profitability. However, the reduction in trade restrictions due to NAFTA will also increase competition for many companies, resulting in lower profit margins and decreasing profitability.

Forecasting Models

The preceding discussion of predictive factors indicates that forecasting sales, gross profit, and earnings is a function of prior year results, expected changes in exchange rates, expected inflation, and expected changes in real GNP. Based on these factors, a consolidated forecasting model in which no disaggregated geographic information is disclosed may be described as:

$$E[Y_{t+1}] = Y_t(1+E[\Delta FX_{t+1}])(1+E[INFL_{t+1}])(1+E[\Delta GNP_{t+1}]) \quad (9)$$

where

$E[Y_{t+1}]$	=	the expected value of sales, gross profit or earnings in period t+1.
Y_t	=	the actual value of sales, gross profit or earnings in period t.
$E[\Delta FX_{t+1}]$	=	the expected rate of change in exchange rates worldwide from period t to t+1.[1]
$E[INFL_{t+1}]$	=	the expected rate of inflation worldwide in period t+1.
$E[\Delta GNP_{t+1}]$	=	the expected rate of change in real GNP worldwide from period t to t+1.

[1]The reasonableness of including exchange rate changes in a consolidated model and proxies for a global change in exchange rates is discussed further in the research design chapter.

In a similar manner, a segment forecasting model in which disaggregated geographic information is provided may be described as:

$$E[Y_{t+1}] = \sum_{i=1}^{n} Y_{it}(1+E[\Delta FX_{it+1}])(1+E[INFL_{it+1}])(1+E[\Delta GNP_{it+1}]) \qquad \textbf{(10)}$$

where

$E[Y_{t+1}]$	=	the expected value of sales, gross profit or earnings in period t+1.
n	=	the number of geographic segments.
Y_{it}	=	the actual value of sales, gross profit or earnings for segment i in period t.
$E[\Delta FX_{it+1}]$	=	the expected rate of change in exchange rates for segment i from period t to t+1.
$E[INFL_{it+1}]$	=	the expected rate of inflation for segment i in period t+1.
$E[\Delta GNP_{it+1}]$	=	the expected rate of change in real GNP for segment i from period t to t+1.

The appendix contains a proof demonstrating mathematically that the consolidated and segment models will arrive at the same forecasts only if all of the following hold:

$$E[\Delta FX_{t+1}] = \sum_{i=1}^{n} \left(\frac{Y_{it}}{Y_t}\right) E[\Delta FX_{it+1}] \qquad \textbf{(11)}$$

$$E[INFL_{t+1}] = \sum_{i=1}^{n} \left(\frac{Y_{it}}{Y_t}\right) E[INFL_{it+1}] \qquad \textbf{(12)}$$

$$E[\Delta GNP_{t+1}] = \sum_{i=1}^{n} (\frac{Y_{it}}{Y_t}) E[\Delta GNP_{it+1}] \tag{13}$$

In other words, the two models provide equivalent forecasts if the expected change in each of the predictive factors for the consolidated model is equal to the weighted average of the expected changes in each of the predictive factors for the segment model. Based on this proof, differences between consolidated and segment forecasting models should increase as either (1) the deviation in segment weights (Y_{it}/Y_t) increases or (2) the deviation in explanatory variables (FX, INFL, and GNP) across countries increases. Regarding (1), differences between consolidated and segment forecasting models should be greater for companies with operating results distributed less evenly over disclosed geographic segments than for companies with operating results that are relatively evenly distributed over disclosed geographic segments. For example, a company with an equivalent level of operations in each of six countries would likely demonstrate less difference between the consolidated and segment forecasting models than a company with 75% of operations in one country and 5% of operations in each of the remaining five countries, assuming that the consolidated predictive factors are approximately an equally weighted average of the segment predictive factors. By combining segments of similar firm size, the current study creates a conservative bias towards finding no significant differences between the consolidated and segment models.

Regarding (2), the test results for Roberts [1989] and BHS [1990] are based on data from the early 1980's. The variation in exchange rates, inflation, and real GNP across countries was much greater during the early 1980's than the later period (from 1989 to 1992) on which the test results for this study are based. Furthermore, this study examines the six most industrialized countries. The variation in exchange rates, inflation, and real GNP between these six countries is less than the average variation between countries worldwide. Therefore, differences between consolidated and segment models may be less pronounced in comparison to the previous studies. This issue and its potential impact on the results is discussed further in the summary and conclusions, Chapter VI.

Hypotheses

The accuracy of the forecasting models depends on the forecasting accuracy of the predictive factors employed. The inconsistent and often very broad categories used in current disclosures of geographic segment data may decrease the potential value of disaggregated geographic information (e.g., Roberts [1989], BHS [1990], and Ahadiat [1993]). In contrast to the broad geographic segment classifications currently reported by MNCs, forecasts of financial and economic factors are country specific. Exchange rate forecasts are disclosed by country since each country maintains its own currency. Forecasts of inflation and real GNP are also provided at the country level. These factors are correlated at the continent level, but still possess distinct country specific differences. For example, exchange rates for member countries in the European Monetary System (EMS) move in tandem within a certain range. However, differences in exchange rates between EMS member countries still exist (Shapiro [1992]). Therefore, since forecasts of exchange rates, inflation, and real GNP are prepared at the country level, the accuracy of forecasts should be greater when geographic data are given by country. This leads to the first hypothesis stated in the null form.

H_{01}: The accuracy of forecasts using geographic segment data disclosed on a country basis are no greater than the accuracy of forecasts using geographic segment data disclosed on a continent basis.

Changes in exchange rates, inflation, and GNP are positively correlated on a regional basis. Economic growth, recessions, and major events such as war, tend to affect countries in a particular region similarly. For example, the recession in Europe during the early 1990's was much deeper and more prolonged than that experienced in North America. Thus, greater forecasting accuracy should obtain from information disaggregated on a continent basis than from information provided only on a consolidated basis. This results in the second hypothesis stated in the null form.

H_{02}: The accuracy of forecasts using geographic segment data disclosed on a continent basis are no greater than the accuracy of forecasts using data disclosed on a consolidated basis.

The fineness theorem states that information system n is preferred to n' if every signal from n is fully contained in a signal from n' (Demski [1977]). However, several papers indicate that, for estimation and prediction, using disaggregated data may be less efficient than using aggregated data when the assumption of perfect information is relaxed (Grunfeld and Griliches [1960], Aigner and Goldfield [1974]). Binkley and Nelson [1990] derive conditions when the aggregate estimator is more efficient than the disaggregate estimator. Specifically, if the correlation between the disaggregate explanatory variables is positive and the autocorrelation is negative, then the aggregate estimator is superior.

The fineness theorem applied to the area of geographic segment information suggests that the disclosure of disaggregated geographic data is at least as preferred as the disclosure of consolidated data. However, if the disaggregated geographic data is reported with error, with the errors offsetting in the aggregate, forecasts using the disaggregated data need not be as accurate as forecasts based on consolidated data. The reason is that forecasts using geographic segment data may compound the error in the additional information during the translation process. A formal mathematical proof demonstrating that the use of disaggregated geographic information can result in less accurate forecasts is made available in BHS [1990].

An increase in measurement error should result in less accurate forecasts. This study examines the usefulness of disaggregated geographic information in forecasting sales, gross profit, and earnings. These three levels of operating performance, represented in the forecasting models by the variable Y_t, are not all measured with the same accuracy. Since gross profit is a function of sales while earnings is a function of both sales and gross profit, measurement error increases from sales to gross profit to earnings. Therefore, forecasting accuracy should decrease (i.e., the mean absolute percentage errors increase) from sales to gross profit to earnings. This results in the third and fourth hypotheses stated in the null form.

H_{03}: The accuracy of sales forecasts are no greater than the accuracy of gross profit forecasts.

H_{04}: The accuracy of gross profit forecasts are no greater than the accuracy of earnings forecasts.

CHAPTER IV

RESEARCH DESIGN

MNCs are formed by combining the annual operating results (sales, gross profit, and earnings) of six individual firms, one from each of six countries. The continent level consists of Europe (France, Germany, and the United Kingdom), North America (Canada and the United States), and Asia (Japan). Industry effects are controlled to some extent by combining firms from similar industries. This allows for the comparison of consolidated and segment forecasting models within, rather than across, industries. Size effects are controlled to more evenly distribute the potential impact of individual countries. This is done by combining firms of approximately the same size, measured in total sales, from each of the six countries. As mentioned in the previous chapter, combining firms of similar size creates a conservative bias towards finding no significant differences between the consolidated and segment models.

The advantages of combining the operating results of individual firms over the use of actual geographic segment disclosures are detailed in the first section of this chapter. Data collection procedures are addressed in section two. The forecast models used to test the hypotheses are specified in section three. Both year-ahead forecast models used in previous research (e.g., Roberts [1989] and BHS [1990]) and regression forecast models developed in this section are utilized. The final section outlines the test statistics used in comparing the forecast accuracy of country, continent, and consolidated levels.

Advantages of a Merger Approach

Combining the results of individual firms (i.e., a merger approach) offers several distinct advantages over the use of actual geographic segment disclosures. First, MNCs do not disclose actual geographic segment data on a consistent geographic segment level (i.e., country, continent, etc.), making the comparison of geographic segment levels difficult, if not impossible (Arnold, Holder and Mann [1980]; Bavishi and Wyman [1980]). The combination of operating results from individual firms allows for the comparison of country, continent, and consolidated levels. Second, since MNCs generally do not disclose geographic segment data at a country level under current generally accepted accounting principles (GAAP), actual geographic segment data cannot be used to determine the predictive ability of country level data. However, a merger approach can be used to examine whether geographic disaggregation by country provides greater predictive value than broader segment levels disclosed under current GAAP. Third, a merger approach makes it possible to test the predictive ability of information in addition to that already required under SFAS No. 14. Statement 14 requires the disclosure of sales, earnings, and assets by industry and geographic segments. Using a merger approach, the predictive ability of additional disaggregated information recommended by the AIMR and under consideration by the FASB, such as gross profit, can also be examined. Fourth, a merger approach makes it possible to study the predictive ability of disaggregated geographic information while controlling, to some extent, for the effects of disaggregated industry information by combining firms from similar industries. Finally, the usefulness of segment data as currently reported is obscured by the effects of transfer pricing and the allocation of common costs. By using a merger approach, the effects of transfer pricing, arbitrary common cost allocations, and other potential manipulations of geographic segment data in actual reporting, are eliminated.

Data

The sample consists of domestic firms from the following six countries: France, Germany, the United Kingdom, Canada, the United States, and Japan. U.S. income statement data was obtained from the Compustat database. Income statement data for the five non-U.S. countries was hand collected from the *Moody's International Manuals*. *Moody's International* has annual income statement and balance sheet data through December 31, 1993 for several hundred companies in each of the five non-U.S. countries included in this study. Firms included in the sample meet all of the following data constraints for fiscal years 1988 through 1992:

1.) Sales, gross profit, and earnings data consecutively from 1988 to 1992.

2.) Domestic firms defined as a firm with less than 20% foreign sales. Foreign earnings cannot be used because foreign earnings information was not available.

3.) Year end between October 31 and March 31. This is necessary since the forecasting variables are based on a calendar year.

4.) No losses in years prior to 1992. This constraint is due to the use of natural logarithms in the regression methodology.

5.) No significant mergers or acquisitions during the period.

6.) No changes in its year end during the period.

7.) The firm is not a financial institution, insurance company, or service company.

8.) U.S. firms using LIFO are excluded, to provide a more comparable computation of gross profit across countries. LIFO is seldom used or not allowed in the five non-U.S. countries.

The data collection began with France, the country with the fewest firms meeting the eight conditions. Companies from the remaining five countries were matched to the French companies by industry and firm size. The sample selection process resulted in a final sample of 55 companies from each of the six countries with sales, gross profit, and earnings data consecutively from 1988 to 1992.[2]

Sales is measured as total sales reported on the income statement. Gross profit is measured as sales minus cost of sales. Earnings is measured as net income before discontinued operations and extraordinary items. This provides for a comparable measure of company earnings across the six countries. For each of the non-U.S. firms, sales, gross profit, and earnings are translated to U.S. Dollars at the average exchange rate for the period. This is consistent with the practice of U.S. multinationals in SFAS No. 52.

Annual means and standard deviations for sales, gross profit, and earnings are presented in Table 1. The annual means are for the 55 MNCs, each representing the combination of six individual firms, one from each country. Average sales and gross profit increased each year. Earnings increased in 1989 and 1990, but decreased in 1991 and 1992 due to the worldwide recession experienced in the early 1990's.

Exchange Rates

Actual exchange rates for each of the five non-U.S. countries are obtained

[2]Approximately 60 French companies met all of the above data constraints. The final sample is 55 because good industry/size matches were not available for five French firms.

from *International Financial Statistics* (October 1994). An ECU rate, defined as a basket of European Union (EU) member currencies weighted by the respective country's GNP and foreign trade, represents the European continent exchange rate. An average of Canada and U.S. rates represents the North American continent exchange rate. In the absence of country level information, operations in Canada and the United States are assumed to be equal, consistent with the matching of companies by firm size discussed in the data section. Finally, the Multilateral Exchange Rate Model (MERM) is used to proxy for a worldwide exchange rate. The MERM is a weighted index that combines the exchange rates between the U.S. Dollar and the currencies of 17 other industrial countries. The weights take into account the size and direction of trade flows. An examination of the weights used in calculation of the MERM indicates that the rate is primarily influenced by France, Germany, the United Kingdom, Canada, and Japan, precisely the countries included in this study. Therefore, the MERM closely approximates a weighted average of the individual country exchange rates used in this study.

The expected change in exchange rates to be used for the perfect foresight model is computed as:

$$1+E[\Delta FX_{t+1}] = [1+\frac{FX_{t+1} - FX_t}{FX_t}] \tag{14}$$

$$= \frac{FX_{t+1}}{FX_t} \tag{15}$$

Where FX_t is the average exchange rate in U.S. Dollars per local currency unit.

Exchange rates are difficult to forecast. In forecasting *annual* exchange rates, empirical research demonstrates that a random walk model performs as well as any other model (Meese and Rogoff [1983] and Callan, Kwan, and Yip [1985]). A random walk forecast predicts next year's exchange rate to be equal to the current year's exchange rate (i.e., no change in exchange rates). BHS [1990] use both random walk forecasts and forecasts using the discount or premium on forward exchange rates. However, BHS [1990, p.317] conclude that the random walk forecasts of exchange rates are more accurate than forecasts based on forward exchange rates. Therefore, only random walk exchange rate forecasts are used in this study.

Inflation and Real GNP

Actual and forecasted inflation rates (GNP deflators) and percentage changes in real GNP for each of the six individual countries are obtained from the OECD Economic Outlook. A European Union (EU) rate, defined as a weighted average of the 12 EU countries, is used to represent inflation and percentage changes in real GNP for the European continent. An average of Canada and U.S. rates is used to represent inflation and percentage changes in real GNP for the North American continent. An OECD rate, defined as a weighted average of the 17 OECD countries, represents inflation and percentage changes in real GNP for the consolidated model.

Model Specification

This study uses both year-ahead forecast models as in Roberts [1989] and BHS [1990] and regression forecast models. For each of these forecast models, forecast accuracy using perfect foresight measures as well as forecasts of the macroeconomic variables are examined at the consolidated, continent, and country levels. The perfect foresight measures use actual year-ahead changes in exchange rates, inflation, and changes in real GNP. The use of perfect foresight measures controls for errors in forecasting exchange rates, inflation, and real GNP.

Year-Ahead Forecast Models

An advantage of the year-ahead forecast models is that they maximize the number of annual forecasts that can be made. Only one year of additional data is necessary, due to the lagged dependent variable, Y_{it}, in the models. With data from 1988 through 1992, four separate annual forecasts can be made for fiscal years 1989 through 1992.

The consolidated forecasting model taken from equation (9) is stated as:

$$E[Y_{t+1}] = Y_t(1+E[\Delta FX_{t+1}])(1+E[INFL_{t+1}])(1+E[\Delta GNP_{t+1}]) \qquad \textbf{(16)}$$

where

$E[Y_{t+1}]$	=	the expected value of sales, gross profit or earnings in period t+1.
Y_t	=	the actual value of sales, gross profit or earnings in period t.
$E[\Delta FX_{t+1}]$	=	the expected rate of change in exchange rates worldwide from period t to t+1.
$E[INFL_{t+1}]$	=	the expected rate of inflation worldwide in period t+1.
$E[\Delta GNP_{t+1}]$	=	the expected rate of change in real GNP worldwide from period t to t+1.

The segment forecasting model (country and continent levels) taken from equation (10) is stated as:

$$E[Y_{t+1}] = \sum_{i=1}^{n} Y_{it}(1+E[\Delta FX_{it+1}])(1+E[INFL_{it+1}])(1+E[\Delta GNP_{it+1}]) \quad \textbf{(17)}$$

where

$E[Y_{t+1}]$	=	the expected value of sales, gross profit or earnings in period t+1.
n	=	the number of geographic segments.
Y_{it}	=	the actual value of sales, gross profit or earnings for segment i in period t.
$E[\Delta FX_{it+1}]$	=	the expected rate of change in exchange rates for segment i from period t to t+1.
$E[INFL_{it+1}]$	=	the expected rate of inflation for segment i in period t+1.
$E[\Delta GNP_{it+1}]$	=	the expected rate of change in real GNP for segment i from period t to t+1.

While the importance of exchange rate changes in a segment forecasting model is obvious, the reasonableness of including exchange rate changes in a consolidated model is not so clear. Exchange rates differ from inflation and real GNP in that exchange rates exhibit much greater variability and are much more difficult to forecast. Furthermore, whereas inflation and real GNP increase annually for all segments over the five year sample period, exchange rates do not exhibit any consistent direction across all segments. Unless geographic segment information is available, it is difficult, even with perfect foresight, to arrive at a reasonable expectation of exchange rate changes to include in a consolidated model. Roberts [1989] does not consider the effects of exchange rates. BHS [1990] omits exchange rate changes in the consolidated models, including exchange rate changes only in the segment models.

In this dissertation, the consolidated model, under perfect foresight, is run two ways: (1) excluding exchange rate changes as in the prior studies and (2) proxying global exchange rate changes using the MERM exchange rate index. Including the MERM exchange rate index in the consolidated model should increase forecast accuracy in this study since each MNC has approximately equivalent operations in France, Germany, the United Kingdom, Canada, and Japan and the MERM exchange rate index closely approximates an average of these five non-U.S. country exchange rates.[3] The consolidated model, using forecast variables, is run with a random walk forecast of exchange rates whereby the average exchange rate for next year is assumed to be equivalent to the average exchange rate for the current year.

Regression Forecast Models

Year-ahead forecast models implicitly assume that changes in exchange rates, inflation, and changes in real GNP are significant explanatory variables in forecasting operating results. Regression forecast models make it possible to test whether these three macroeconomic variables are useful in forecasting sales, gross profit, and earnings, by examining the significance of the coefficient estimates. In addition, year-ahead forecast models give equal weight to changes in exchange rates, inflation, and changes in real GNP. Year-ahead forecast models are equivalent to regression models

[3]While changes in the individual country exchange rates are as high as 22 percent in a particular year, the difference between an average of the five foreign country exchange rates and the MERM exchange rate index is less than one percent in each of the four years from 1989 to 1992 and less then one-half of one percent in three of the four years.

with each of the coefficients (i.e., weights) set equal to one. Regression forecast models relax this assumption, allowing the coefficients to vary between the three macroeconomic factors.

The year-ahead forecast models described in the previous two equations can be converted to linear regression models by taking the natural log of both sides. This procedure transforms the consolidated and segment models from a format in which the independent variables are multiplied to an additive linear regression format. The consolidated model is stated as:

$$\begin{aligned} \ln Y_{t+1} = \; & a_0 + a_1 \ln Y_t + a_2 \ln(1+E[\Delta FX_{t+1}]) \\ & + a_3 \ln(1+E[INFL_{t+1}]) + a_4 \ln(1+E[\Delta GNP_{t+1}]) \end{aligned} \qquad \textbf{(18)}$$

Where ln is the natural log, $a_0,\ldots,a_4$ are regression coefficients, and all other variables are as previously defined.

The segment model is stated as:

$$\begin{aligned} \ln Y_{it+1} = \; & a_0 + a_{1i} \ln Y_{it} + a_{2i} \ln(1+E[\Delta FX_{it+1}]) \\ & + a_{3i} \ln(1+E[INFL_{it+1}]) + a_{4i} \ln(1+E[\Delta GNP_{it+1}]) \end{aligned} \qquad \textbf{(19)}$$

Where the i subscript denotes the specific geographic segment and all other variables are as previously defined.

Y_t represents the actual value of sales, gross profit, or earnings. With the exception of Y_t, the right-hand side variables all represent percentage change variables. By subtracting $\ln Y_t$ from both sides of the consolidated and segment equations, the models can be converted into percentage change models. $\ln Y_{t+1} - \ln Y_t$ represents the percentage change in operating results. The consolidated model can be restated as:

$$\ln Y_{t+1} - \ln Y_t = a_0 + a_1 \ln(1+E[\Delta FX_{t+1}]) + a_2 \ln(1+E[INFL_{t+1}]) + a_3 \ln(1+E[\Delta GNP_{t+1}]) \quad (20)$$

The segment model can be restated as:

$$\ln Y_{it+1} - \ln Y_{it} = a_0 + a_{1i} \ln(1+E[\Delta FX_{it+1}]) + a_{2i} \ln(1+E[INFL_{it+1}]) + a_{3i} \ln(1+E[\Delta GNP_{it+1}]) \quad (21)$$

At least four years of data are necessary to estimate the coefficients of the consolidated and segment models since each model contains three independent variables[4]. An additional year of data is necessary due to the lagged dependent variable in each model. Therefore, sales, gross profit, and earnings data for two additional years, 1986 and 1987, were collected in order to test the forecast accuracy of the models on a holdout sample subsequent to the five years of sample data necessary to fit the models. Complete data meeting all data constraints for 1986 and 1987 was available for 45 of the 55 MNC's. Since the 1986 and 1987 data are used only to assist in the development of coefficient estimates, it is not necessary that 1986 and 1987 data be available for all 55 MNC's.

Data from 1986 through 1990 are used to estimate the coefficients of the consolidated and segment models. Forecasts of the percentage changes in operating results for 1991 are based on these estimated equations. The forecasted percentage

---

[4]The expected change in each of the three independent variables is the same for each of the 55 sample firms in a given year. The independent variables for each segment change from year to year, but not from firm to firm.

changes for 1991 are multiplied by the actual operating results in 1990 to arrive at forecasts of operating results in 1991. The equations are then updated to include 1991 data and reestimated to arrive at forecasts of operating results in 1992.

Simply taking the antilog of the forecasts made using natural logarithms does not result in optimal forecasts. The following transformation converts the forecasted percentage change in natural logarithms back into optimal base ten forecasts of operating results (SAS Manual, p.119).

$$E[Y_{it+1}] = [\exp(E[\ln Y_{it+1} - \ln Y_{it}])\exp(\frac{fcse^2}{2})]Y_{it} \qquad \textbf{(22)}$$

Where

exp	is the antilog.
fcse	is the forecast standard error.
$E[\ln Y_{it+1} - \ln Y_{it}]$	is the forecasted percentage change in operating results prior to transformation out of natural logarithms.
$\exp(fcse^2/2)$	is a necessary correction factor when forecasting log transformed data.

The segment forecasts are summed across the geographic regions to arrive at a consolidated forecast as follows:

$$E[Y_{t+1}] = \sum_{i=1}^{n} E[Y_{it+1}] \qquad \textbf{(23)}$$

Where n equals the number of geographic regions (n=6 for the country model and n=3 for the continent model).

Test Statistics

Statistical comparisons of forecast accuracy are made based on the mean absolute percentage error (MAPE) and the mean squared percentage error (MSPE). The MAPE weights errors equally while the MSPE weights large forecast errors more heavily than small ones.

$$MAPE_j^m = \frac{1}{T}\sum_{t=1}^{T} \left|\frac{E(Y_{t+1})-Y_{t+1}}{Y_{t+1}}\right| \tag{24}$$

$$MSPE_j^m = \frac{1}{T}\sum_{t=1}^{T} \left(\frac{E(Y_{t+1})-Y_{t+1}}{Y_{t+1}}\right)^2 \tag{25}$$

Where m is either the consolidated, continent, or country model, j represents the 55 MNCs, and t represents the time period.

The percentage errors are computed with actual operating results in the denominator and averaged over t periods consistent with prior studies on the predictive ability of disaggregated information (e.g., Collins [1976], Garrrod and Emmanuel [1988], BHS [1990]). Using actual operating results in the denominator, in contrast to expected operating results, is preferable as long as actual operating results do not approach zero. In this study, actual operating results do not approach zero because the sample consists of MNCs, each representing a combination of six profitable firms.

The difference in MAPE or MSPE between the consolidated model and the geographic segment model is computed as follows:

$$\text{DIFF}_j = \text{MAPE}_j^c - \text{MAPE}_j^s \qquad (26)$$
$$\text{DIFF}_j = \text{MSPE}_j^c - \text{MSPE}_j^s$$

A positive difference indicates that the predictive ability of the segment model exceeds the predictive ability of the consolidated model. The effects of outliers are examined by truncating differences at 100%, consistent with previous studies. The *t*-test of paired differences is used to determine whether the errors generated from each pair of forecasts come from a single population with the same mean. The test statistic is stated as:

$$t = \frac{d}{\frac{s_d}{\sqrt{n}}} \qquad (27)$$

where

- d is the mean difference between the paired observations.
- s_d is the standard deviation of the differences between the paired observations.
- n is the number of paired observations (55).

The *t*-test of paired differences assumes a normal distribution. The Jarque-Bera asymptotic Lagrange Multiplier Normality Test (Jarque and Bera [1980]) is used to test the normality assumption for each of the sixty *t*-tests reported in Chapter V. The Jarque-Bera test is preferable to individual tests of normality since it represents a joint test of both skewness and kurtosis. Based on the critical value from a Chi-square statistic with two degrees of freedom and a .05 level of significance, normality cannot be rejected for the majority (80%) of the differences in MAPE.[5]

Since the *t*-test is sensitive to violations of normality, the nonparametric sign test (Hollander and Wolfe [1973]) is also performed. The sign test does not require a distributional assumption. Furthermore, although the mean difference in MAPE is a useful indicator of predictive ability, a forecaster's primary concern is in finding the model that consistently provides the more accurate forecasts. The sign test does just that by testing for significance the number of positive differences (i.e., cases in which the predictive ability of the segment model exceeds the predictive ability of the consolidated model) out of the 55 total observations.

---

[5]The minority of cases where the normality assumption does not hold can be isolated almost entirely to extremely large differences in MAPE between the consolidated and segment models. Also, note that the results based on *t*-tests and the results based on the nonparametric sign tests are very consistent, indicating that the *t*-test results are not driven by violations of normality.

CHAPTER V

EMPIRICAL RESULTS

Test results based on year-ahead forecast models are presented first, using both (1) perfect foresight measures of exchange rates, inflation, and real GNP and (2) forecasts of exchange rates, inflation, and real GNP. Test results based on regression forecast models are presented in a similar manner in the following section. The findings for sales and gross profit forecasts are similar and will be discussed together. Earnings forecasts are discussed separately since the results differ from those for sales and gross profit.

All of the tests are run using both mean absolute percentage errors (MAPE) and mean squared percentage errors (MSPE). The results and the conclusions based on MAPEs and MSPEs are consistent throughout the study. Therefore, only the results using MAPEs are presented.

Year-Ahead Forecast Models

Year-ahead forecasts are made for 1989, 1990, 1991, and 1992. The absolute percentage forecast errors for each year are averaged over the four years to obtain MAPEs. Truncation of errors for sales and gross profit are not necessary, as all absolute errors are less than 100% and no significant outliers are noted. The likelihood of significant outliers in this study is lessened by the formation of MNCs, each representing the annual operating results of six individual firms. A single company with abnormal results is combined with the results of five other companies, decreasing the potential impact of an individual firm.

Table 2 presents the MAPEs and standard deviations for the sales and gross profit year-ahead forecast models. The MAPEs vary from 5%-7% while the standard deviations vary from 3%-5%. A comparison of MAPEs with prior geographic segment studies using year-ahead forecast models is difficult. Roberts [1989] does not examine sales or gross profit. BHS [1990] examine sales, but do not report MAPEs, only the mean differences. However, the MAPEs for sales do compare reasonably with those reported for industry segment studies (e.g., Collins [1976] and Garrod and Emmanuel [1988]).

Under perfect foresight, the mean absolute errors for both sales and gross profit consistently decrease, as hypothesized, from consolidated to continent to country levels. Using forecast variables, this relationship between consolidated, continent, and country levels is not as clear, especially for sales.

Based on the results in Table 2, several further observations can be made. First, the MAPEs for sales are less than the MAPEs for gross profit indicating that the forecasting accuracy of sales is greater than the forecasting accuracy of gross profit. Therefore, the third hypothesis which states that the accuracy of sales forecasts is no greater than the accuracy of gross profit forecasts is rejected. Second, as expected, predictions using perfect foresight variables consistently outperform those using forecasts of exchange rates, inflation, and real GNP. Finally, including the MERM exchange rate index in the consolidated model increases the accuracy of the consolidated forecasts.

Table 3 reports summary statistics for tests of differences, assuming perfect foresight, between the consolidated model (without exchange rates), the continent model, and the country model. All of the mean and median differences are positive, supporting the hypothesis that forecasting ability improves with greater geographic disaggregation. The consolidated/country and consolidated/continent comparisons are different at the < .01 level of significance, based on the *t*-test of paired differences and the nonparametric sign test. For these two comparisons, even the first quartile differences are positive, demonstrating that the disaggregated model gives better forecasts for over 75% of the observations. For each comparison, the actual number of positive differences out of the 55 total observations is listed in the far right column with the corresponding results of the sign test.

Mean and median differences between the continent and country models are also consistently positive, indicating that forecasts at the country level are more accurate than forecasts at the continent level, but the differences are not statistically significant with the exception of the sign test for gross profit. This is perhaps not surprising since the forecasting factors at the continent level approximate an average of the forecasting factors at the country level. Note that similar sized companies from each of the six countries are combined to form the MNCs. Moreover, a review of the forecasting factors used for Europe demonstrates that these forecasting factors approximate an average of those used for France, Germany, and the United Kingdom. By design, the forecasting factors for North America are an average of Canadian and U.S. factors. Due to the examination of only one country in Asia, the Asian continent and the country of Japan are exactly the same in this study. Therefore, the lack of significant differences between the continent and country levels may be at least partially attributable to the sample design (i.e., combination of similar sized companies from each of the six countries). This issue is discussed further in the summary and conclusions (Chapter VI).

Table 4 reports summary statistics for tests of differences, assuming perfect foresight, between the consolidated model (using the MERM exchange rate index), the continent model, and the country model.[6] The mean differences for the consolidated/country and consolidated/continent comparisons are positive. However, with the exception of the consolidated/country differences for gross profit, the mean differences are not statistically significant. Similarly, with the exception of the consolidated/continent differences for gross profit, the number of positive differences based on the nonparametric sign test are not significant.

The positive, but insignificant differences for the consolidated/country and consolidated/continent comparisons in Table 4 are based on a consolidated model with the MERM exchange rate index. In contrast, the significant results in Table 3 are based on a consolidated model without exchange rates, as in previous research. Including the MERM exchange rate index significantly increases the forecasting accuracy of the consolidated model, thereby decreasing the size and number of positive differences in MAPEs between the consolidated and geographic segment models.

The improvement in consolidated forecasting accuracy by including the MERM

---

[6]Continent/country comparisons are not reported in Table 4, since the results are exactly the same as reported in Table 3. Table 3 is based on a consolidated model without exchange rates, while Table 4 is based on a consolidated model using the MERM exchange rate index. Continent/country results are not affected by changes in the consolidated model.

exchange rate index is supported by comparisons of forecast errors for the two consolidated models. The mean difference in MAPEs between the consolidated model without exchange rates and the consolidated model using the MERM exchange rate index is significantly positive for both sales and gross profit at the < .01 level based on the *t*-test of paired differences and the sign test. The positive differences in the 25% quartile demonstrate that consolidated forecasts of sales and gross profit using the MERM are more accurate for over 75% of the sample firms.

Table 5 presents the results for tests of differences using a random walk forecast of exchange rates and OECD forecasts of inflation and real GNP. Overall, the results indicate that the errors introduced by forecasting changes in exchange rates, inflation, and changes in real GNP reduce the predictive power of disaggregated geographic data. Consistent with the results for sales found in BHS [1990], differences in sales forecasts between the consolidated and the segment models are generally not statistically significant. The results for gross profit provide some evidence supporting the superiority of forecasts using geographic data. While the mean differences for gross profit using forecast variables are less than the mean differences under perfect foresight, all of the differences are positive and several of the differences are statistically significant. The sign test is significant at the < .05 level for the consolidated/country comparison of gross profit forecasts. Both the *t*-test of paired differences and the sign test are significant at the < .01 level for the consolidated/continent comparison of gross profit forecasts.

The limited usefulness of geographic segment data in forecasting sales and gross profit may be attributable more to the role of exchange rates than to inflation or real GNP. The variability of exchange rates is much greater than the variability of inflation or real GNP, resulting in exchange rate changes having a greater potential impact on year-ahead forecasts. Second, as discussed in the research design chapter, exchange rates are extremely difficult to forecast. Whereas reasonably accurate forecasts of inflation and real GNP are available for the period examined in this study, accurate forecasts of annual exchange rates do not exist. Thus, exchange rates represent the variable with the greatest potential impact on forecast accuracy and the variable with the largest potential forecast errors. It is possible that the importance of disaggregated geographic information may progressively increase throughout the year as updated forecasts of macroeconomic factors, especially exchange rates, more closely reflect the results achieved assuming perfect foresight. This represents an interesting area for future research.

Earnings

Table 6 presents the MAPEs and standard deviations for the year-ahead earnings forecast models. The forecast errors for earnings are three to four times as large as those for sales and gross profit reported in Table 2, demonstrating that the accuracy of sales and gross profit forecasts are greater than the accuracy of earnings forecasts. Therefore, the fourth hypothesis which states that the accuracy of gross profit forecasts is no greater than the accuracy of earnings forecasts is rejected.

Under perfect foresight, the forecast errors consistently decrease, as hypothesized, from consolidated to continent to country levels. This relationship also holds when forecasts of the three macroeconomic variables are used as explanatory variables.

Table 6 also reports the forecast error for a simple random walk model whereby current year earnings are assumed to be the best estimate of next year earnings. Surprisingly, a random walk forecast model that excludes altogether the effects of exchange rates, inflation, and real GNP results in the lowest earnings forecast errors. In fact, further examination indicates that no combination of exchange rates, inflation, and/or real GNP results in lower MAPEs for earnings than a simple random walk model. With a simple random walk forecast, there is no forecasting advantage to geographic segment data since consolidated and geographic segment forecasts are identical.

Year-ahead forecast models assume that changes in exchange rates, inflation, and changes in real GNP are significant variables in forecasting. As discussed in the related literature chapter, previous studies utilizing year-ahead forecast models implicitly assume the predictive factors included in the models are significant in forecasting operating results. However, the predictive factors are not tested to determine whether they actually are effective in forecasting operating results.

The importance of exchange rates, inflation, and real GNP in forecasting are examined in this study by observing the significance of coefficient estimates using regression forecast models. The results are reported in the next section. Briefly, the coefficient estimates provide evidence that exchange rate changes, inflation, and real GNP growth are useful in forecasting annual sales and gross profit. Whereas, at least for this sample and this time period, exchange rate changes, inflation, and real GNP growth are not significant variables in forecasting annual earnings.

A comparison of annual changes in the forecasting factors with annual changes in sales, gross profit, and earnings further substantiates the above findings. Both worldwide inflation and real GNP increased each year from 1989 to 1992. Worldwide exchange rates, based on the MERM exchange rate index and/or an average of the six individual country exchange rates, also exhibit an overall increase with annual increases in all years except 1989. The summary statistics presented in Table 1 demonstrate that average sales and gross profit increased each year from 1989 to 1992, consistent with the pattern for the three forecasting factors. The pattern for earnings, however, is not consistent with the pattern for exchange rates, inflation, and real GNP. Earnings increased in 1989 and 1990, but decreased in 1991 and 1992.

Finally, note that the MAPEs for earnings in Table 6 are higher under perfect foresight than when forecasts of the three macroeconomic variables are used. The less accurate forecasts using perfect foresight indicate that these three factors may not be significant for earnings. Perfect foresight models include exact year-ahead exchange rate changes, inflation, and real GNP growth whereas the actual forecast models are based on a random walk exchange rate forecast and OECD forecasts of inflation and real GNP. Therefore, assuming the variables included in the forecasting model have explanatory power, forecasts using perfect foresight should equal or exceed forecasts using actual forecast variables.

Summary statistics for tests of differences in MAPEs using year-ahead earnings forecast models are reported in Table 7. Consistent with the results found in Roberts [1989] and BHS [1990], the accuracy of earnings forecasts significantly improve with greater geographic disaggregation. All mean and median differences are positive and significant based on the *t*-test of paired differences and the sign test. However, these results should be interpreted with caution since (1) a simple random walk model significantly outpredicts the consolidated, continent, and country level models and (2) the coefficient estimates reported for earnings regression models in the next section, provide evidence that exchange rate changes, inflation, and real GNP growth are not significant variables in forecasting annual earnings.

Regression Forecast Models

As discussed in the previous chapter on research design, at least five years of consecutive annual data are necessary to estimate the coefficients of the regression forecast models. Data from 1986 through 1990 are used to forecast 1991 operating results. Data from 1986 through 1991 are used to forecast 1992 operating results.

All tests for sales and gross profit use both (1) a lagged dependent variable in the consolidated and segment forecast models as stated in equations 18 and 19, and (2) percentage change forecasts for the consolidated and segment models as stated in equations 20 and 21. The models provide similar forecasts, since the coefficient on the lagged dependent variable, Y_t, is significant and close to one in every model. The results using the two models are nearly identical and therefore, only the results using the percentage change models are reported.

Heteroskedasticity causes ordinary least squares to be inefficient and produces biased estimates of the covariance matrix. The consolidated, continent, and country models for sales and gross profit are examined for heteroskedasticity using a variety of tests in Shazam [1993]. Three of these tests, the Breusch-Pagan, Harvey, and Glejser tests are discussed in Judge [1985, Chapter 11]. Based on these tests, the null hypothesis of homoskedasticity can not be rejected. Therefore, no adjustments for heteroskedasticity are made.

A primary advantage in using regression forecast models is the ability to test whether exchange rate changes, inflation, and real GNP growth are useful in forecasting operating results. This is done by examining the statistical significance of the coefficient estimates. If the three forecasting factors are related to changes in operating results, then the coefficients for the three forecasting factors should be significantly positive and close to one in regressions of forecasting factors on changes in operating results (see equations 20 and 21 in the research design chapter). Furthermore, an F statistic is computed to examine the null hypothesis that all the coefficients are equal to zero. A significant F statistic, therefore, provides evidence that the three forecast factors are related to changes in operating results.

Table 8 reports the regression results for sales (Panel A) and gross profit (Panel B), run using perfect foresight variables and data for all sample years. The coefficient estimates for nine regression models are presented: six country-level, two continent-level (Europe and North America), and one consolidated-level regression. The coefficient estimates for changes in exchange rates and real GNP are close to one[7] and significant in almost every regression, providing evidence that these two variables are useful in forecasting sales and gross profit. The coefficient estimates for inflation demonstrate greater fluctuation and are not always significant. However, as in

[7]The year-ahead models implicitly assume a coefficient of one for each of the three forecast factors. A joint F test examining the null hypothesis that the coefficients equal one could not be rejected for 16 of the 18 regression forecast models, providing support for the use of year-ahead forecast models for sales and gross profit.

Roberts [1989] and BHS [1990], including inflation as an explanatory variable consistently increases forecasting accuracy for both sales and gross profit. The F statistic testing whether all the coefficients equal zero is significant for for all nine sales regressions and all nine gross profit regressions providing further evidence that exchange rate changes, inflation, and GNP growth are useful in forecasting changes in sales and gross profit. Therefore, all three forecasting variables are included in the sales and gross profit regression forecast models discussed below.

Table 9 presents the MAPEs and standard deviations for the sales (Panel A) and gross profit (Panel B) regression forecast models. The MAPEs for the sales forecasts are less than the the MAPEs for the gross profit forecasts. Under perfect foresight, the forecast errors for both sales and gross profit decrease, as hypothesized, from consolidated to continent to country levels, consistent with the findings based on year-ahead forecast models reported earlier in Table 2. Using forecast variables, the hypothesized relationships between consolidated, continent, and country levels continue to hold with one exception, the continent/country relationship for gross profit in 1992 (Panel B).

In 1991, continent and country predictions using actual forecast variables exceed predictions using perfect foresight variables. A more intuitively reasonable result is found in 1992 when forecasts based on perfect foresight variables are more accurate than forecasts based on actual forecast variables. This somewhat surprising result for 1991 can be partially explained by changes in exchange rates for 1991. As discussed earlier for year-ahead forecast models, exchange rates exhibit greater variability than inflation or real GNP, increasing the potential impact of exchange rate changes on the accuracy of forecasts. Perfect foresight models use actual year-ahead exchange-rate changes whereas forecast models use a random walk model that assumes next year's exchange rates are equivalent to the current year's exchange rates (i.e., no change). In 1991, the actual year-ahead exchange-rate changes approximate no change in exchange rates. Changes in exchange rates averaged over the five non-U.S. countries and changes in exchange rates averaged over the three continents weighted by the number of countries in each continent, are very close to zero. This situation is unique to 1991 and is not the case for 1992 or years prior to 1991. Thus, perfect foresight exchange rate changes are essentially equivalent to random walk exchange rate changes in 1991, diminishing the potential benefits of perfect foresight for that particular year.

As discussed in Chapter IV, the consolidated model under perfect foresight, is run two ways: (1) excluding exchange rate changes as in the prior studies and (2) proxying global exchange rate changes using the MERM exchange rate index. The forecast errors for the consolidated sales and gross profit models under perfect foresight, excluding exchange rate changes, are considerably greater using regression forecast models (Table 9) than using year-ahead forecast models (Table 2). Year-ahead forecast models implicitly assume a coefficient of one for inflation and real GNP, while regression forecast models allow the coefficients on inflation and changes in real GNP to vary. The reduced predictive value for consolidated regression forecast models may be attributable to the omission of a significant explanatory variable - - exchange rates. Omitting exchange rates in the consolidated model results in biased forecasts. This bias is much greater in the regression forecast models since it impacts the coefficient estimates for inflation and real GNP, in contrast to the year-ahead forecast models where the coefficients for inflation and changes in real GNP are fixed at one.

Table 10 reports summary statistics for tests of differences, assuming perfect foresight, between the consolidated model (without exchange rates), the continent model, and the country model. The results for sales are presented in Panel A and the results for gross profit are presented in Panel B. Clearly, country and continent level forecasts are superior to consolidated forecasts made without exchange rate information. All mean and median differences between consolidated and geographic segment models are positive and all statistical tests are significant at the $< .01$ level.

The differences between the continent and country levels are also positive, indicating better country level forecasts, but the differences are smaller than those for consolidated/country and consolidated/continent comparisons. This is consistent with the year-ahead forecast results reported in Table 3. The 1991 differences between the continent and country levels are significant for both sales and gross profit at the $< .01$ level of significance based on the *t*-test of paired differences and the sign test. The 1992 differences between the continent and country levels are significant at the $< .05$ level based on the nonparametric sign test.

Table 11 reports summary statistics for tests of differences, assuming perfect foresight, between the consolidated model (using the MERM exchange rate index), the continent model, and the country model. The mean and median differences for the consolidated/country and consolidated/continent comparisons are all positive, indicating increasing forecasting accuracy with disaggregated geographic data. While the differences are smaller than those reported for the consolidated model without exchange rates in Table 10, several of the positive differences are significant. Regarding sales, reported in Panel A, the 1991 difference between the consolidated level and the country level is significant at the < .01 level. Regarding gross profit, reported in Panel B, nearly all of the differences are significant at the < .01 level.

Consistent with the results for year-ahead forecasts in Table 4, including the MERM exchange rate index in the consolidated regression forecast models significantly increases forecasting accuracy. The mean and median differences in absolute forecast errors between the consolidated model without exchange rates and the consolidated model using the MERM exchange rate index are all positive. The differences between the two consolidated models are all significant at the < .01 level.

Table 12 reports for sales (Panel A) and gross profit (Panel B) the results for tests of differences using forecasts of the macroeconomic variables. All of the mean and median differences are positive, as hypothesized, with one exception: the mean difference between the continent and the country levels for gross profit in 1992, with a difference of -.0002. Furthermore, with the exception of the continent/country comparison in 1992, all of the differences are significant. The evidence supports the first two hypotheses that the accuracy of forecasts improve as sales and gross profit are disclosed at a more disaggregated geographic level. The hypothesized relationship, while much stronger under perfect foresight, continues to hold when the assumption of perfect foresight is relaxed to include forecasts of changes in exchange rates, inflation, and changes in real GNP.

Earnings

Table 13 reports the regression results for earnings using perfect foresight variables and data for all sample years. The coefficient estimates for nine earnings regression models are presented: six country-level, two continent-level (Europe and North America), and one consolidated-level regression. If exchange rate changes, inflation, and real GNP growth are related to changes in earnings, then the regression coefficients for the three forecasting factors are expected to be significantly positive and close to one.

In contrast to the results for sales and gross profit regressions reported in Table 8, the earnings regressions do not demonstrate a consistent pattern across the nine regression models. The coefficients appear to be almost random with approximately an equal number of significantly negative and significantly positive coefficients. Furthermore, the coefficients cover a very wide range from -202 to +28. Coefficients for exchange rate changes and inflation are not significantly positive for any of the nine regressions. Coefficients for changes in real GNP are significantly positive in five of the nine models, but none of the coefficients are close to one.[6] Furthermore, the F statistics, testing whether all the coefficients equal zero, are much smaller for the earnings than for sales and gross profit reported in Table 8.

The results for earnings regression models support the results discussed earlier for year-ahead earnings forecast models. Specifically, for this sample and in this time period, exchange rate changes, inflation, and real GNP growth are not significant

---

[6]A joint F test examining the null hypothesis that the coefficients equal one is rejected for eight of the nine earnings regression forecast models at the $< .01$ level and all nine earnings regression forecast models at the $< .10$ level.

variables in forecasting annual earnings. Therefore, tests examining the forecasting accuracy of earnings between consolidated, continent, and country levels using regression forecast models are not reported.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

This study examines whether geographic information disclosed at an increasingly disaggregated level (specifically, consolidated vs. continent vs. country) results in increased predictive ability of company operations (specifically, sales, gross profit, and earnings). MNCs are formed by combining the annual operating results of six individual firms, one from each of six countries. This approach makes it possible to compare the forecasting accuracy of data disclosed at the country, continent, and consolidated levels, not possible using current geographic segment disclosures. Furthermore, this approach makes it possible to examine the predictive ability of information, such as gross profit, that is currently being considered for segment disclosure by national and international regulatory authorities.

The study uses year-ahead forecast models as in prior studies (i.e., Roberts [1989] and BHS [1990]) and regression forecast models. For each of these forecast models, forecasting accuracy using perfect foresight measures and forecasts of exchange rate changes, inflation, and GNP growth are examined at the consolidated, continent, and country levels.

The findings for sales and gross profit are consistent for both year-ahead and regression forecast models. The results indicate that the accuracy of forecasts increase as sales and gross profit are disclosed at a more disaggregated geographic level. The hypothesized relationship between consolidated, continent, and country levels, while holding strongly under perfect foresight, holds to a lesser extent using forecasts of exchange rates, inflation, and real GNP. The difficulty in forecasting these factors, especially exchange rates, over a long period of time such as a year, may restrict the usefulness of the geographic segment data.

The findings for earnings using year-ahead forecast models are consistent with the results found in Roberts [1989] and BHS [1990]. The accuracy of earnings forecasts significantly improve with greater geographic disaggregation. However, these results should be interpreted with caution since (1) a simple random walk model for earnings outpredicts a year-ahead forecast model using exchange rate changes, inflation, and real GNP growth and (2) the coefficient estimates using regression models provide evidence that these three forecasting factors are not significantly related to forecasts of annual earnings.

Previous studies using year-ahead forecast models implicitly assume the predictive factors included in the models are significant in forecasting operating results. Using regression forecast models, this study tests whether the predictive factors included in the models are effective in forecasting operating results by examining the direction, size, and significance of the regression coefficient estimates. The coefficients provide evidence that exchange rate changes, inflation, and real GNP growth are useful in forecasting annual sales and gross profit. Whereas, at least for this sample and this time period, exchange rate changes, inflation, and real GNP growth are not significant variables in forecasting annual earnings.

A secondary purpose of the study is to examine the accuracy of forecasts between sales, gross profit, and earnings. The results demonstrate that, as hypothesized, sales forecasts are more accurate than gross profit forecasts, which in turn, are more accurate than earnings forecasts.

Implications

The findings indicate that greater geographic disaggregation results in more accurate forecasts of operating results. From the viewpoint of regulators currently addressing this issue, the results provide evidence for increasing disaggregation of geographic segment disclosures. The results support the recommendation made by the Financial Accounting Standards Committee that geographic segments be defined along country boundaries for operations in each of the major industrialized countries. The results also support the disclosure of gross profit by geographic segment as recommended by the AIMR and under consideration by the FASB and the AcSB.

There are several factors developed in this study affecting the usefulness of disaggregated geographic information. These factors also have important implications for regulators. Based on the proof discussed in Chapter III and stated mathematically in the Appendix, differences between aggregate and disaggregate forecasting models and likewise, the usefulness of disaggregated geographic information, increases due to three factors. First, the usefulness of disaggregated geographic information increases as the deviation in segment weights increases. In this study, firms of similar size are combined to form MNCs, creating a conservative bias towards finding no significant differences between aggregate and disaggregate forecast models. Regulators, therefore, should be careful in setting materiality guidelines for segments, in order to assure that adequate deviation in reported segments is achieved.

Second, based on the proof, the usefulness of disaggregated geographic information increases as the deviation in explanatory variables increases. The deviations in exchange rates, inflation, and real GNP are much smaller over the sample period studied (i.e., 1989 to 1992) than during the early 1980's when the previous studies were performed. Furthermore, this study examines the six most industrialized countries. The variation in exchange rates, inflation, and real GNP between these six countries is less than the variation between developed, developing, and third world countries, potentially reducing the differences between the aggregate and disaggregate forecast errors in the study. This second point encourages regulation requiring the disclosure of segment information between segments where financial, economic, and political differences are greatest (i.e., a risk and rewards approach).

Finally, the usefulness of disaggregated geographic information increases as the accuracy of the forecast variables increases. The difficulty in forecasting inflation, real GNP, and especially, exchange rates, over a time period as long as one year, reduces the potential forecasting advantages of disaggregated geographic information. This finding points regulators to the potential usefulness of interim segment information requested so forcefully over the years by financial analysts (FASB [1993], AICPA [1994]). The importance of segment information should increase throughout the year as updated and more accurate forecasts of financial, economic, and political factors for the various segments become available.

Limitations and Extensions

This study examines the benefits of disaggregated geographic information in terms of predictive ability. The study does not consider the administrative and competitive costs associated with these disclosures. Therefore, from a regulatory perspective, any benefits of more disaggregated geographic information must be balanced with the potential costs of these disclosures.

Operating results prepared under different national accounting principles are combined in forming the MNCs. The impact on sales and gross profit is negligible since the accounting principles used in the reporting of sales and gross profit are similar across the six countries. However, the accounting principles used in computing earnings varies across countries. The impact of combining different GAAP on earnings forecasts is difficult to determine. Measurement differences may reduce the association between the forecasting factors (i.e., exchange rate changes, inflation, and real GNP growth) and changes in earnings for the continent and consolidated forecasting models, thereby increasing the likelihood of significant differences in forecasting accuracy between disaggregate and aggregate models. However, the earnings regression models reported in Table 13 do not indicate a higher association for the country models, based on individual country GAAP, than for the continent and consolidated models based on a combination of different GAAP.

Several issues remain for future research. First, there has been very little analytical research in the area of disaggregated disclosures. Developing a mathematical model to explain the potential benefits of disaggregated disclosures offers future promise. Second, financial statement users desire three major changes to the current requirements for segment disclosures; (1) greater disaggregation, (2) interim segment disclosures, and (3) disclosure of segment information in a matrix format (i.e. combination of industry and geographic disclosures). These latter two areas especially need to be further explored. Finally, if the necessary data can be located, the impact of developing country information on the usefulness of disaggregated disclosures, including the potential influence of political risk forecasts, needs further research.

REFERENCES

Abuaf, N., and P. Jorion. 1990. Purchasing Power in the Long Run. *Journal of Finance* (March): 157-174.

Adler, M., and B. Dumas. 1983. International Portfolio Choice and Corporation Finance: A Synthesis. *Journal of Finance* (June): 725-789.

Adler, M., and B. Lehmann. 1983. Deviations from Purchasing Power Parity in the Long Run. *Journal of Finance* (December): 1471-1487.

Ahadiat, N. 1993. Geographic Segment Disclosure and the Predictive Ability of the Earnings Data. *Journal of International Business Studies* (Second Quarter): 357-371.

AICPA Special Committee on Financial Reporting. 1994. *Improving Business Reporting-A Customer Focus-Meeting the Informational Needs of Investors and Creditors.* New York.

Aigner, D., and S. Goldfeld. 1974. Estimation and Prediction from Aggregate Data when Aggregates are Measured More Accurately than their Components. *Econometrica.* (Vol 42): 113-134.

Ajinkya, B. B. 1980. An Empirical Evaluation of Line-of-Business Reporting. *Journal of Accounting Research* (Autumn): 343-361.

American Institute of Certified Public Accountants. Special Committee on Financial Reporting. 1994. *The Information Needs of Investors and Creditors.* New York, NY: AICPA.

Arnold, J., and P. Moizer. 1984. A Survey of the Methods Used by Investment Analysts to Appraise Investments in Ordinary Shares. *Accounting and Business Research* (Summer): 195-207.

Arnold, J., W. W. Holder, and M. H. Mann. 1980. International Reporting Aspects of Segment Disclosure. *International Journal of Accounting: Education and Research* (Fall): 125-135.

Association for Investment Management and Research. Financial Accounting Policy Committee. 1992. *Financial Reporting in the 1990's and Beyond: A Position Paper of the Association for Investment Management and Research.* Charlottesville, Va. (October).

Bahmani-Oskooee, M., and S. P. Das. 1985. Transaction Costs and the Interest Parity Theorem. *Journal of Political Economy* (August): 793-799.

Balakrishnan, R., T. S. Harris, and P. K. Sen. 1990. The Predictive Ability of Geographic Segment Disclosures. *Journal of Accounting Research* (Autumn): 305-325.

Baldwin, B. A. 1984. Segment Earnings Disclosure and the Ability of Security Analysts to Forecast Earnings Per Share. *The Accounting Review* (July): 376-389.

Bao, D.H., M.T. Lewis, W.T. Lin, and J.G. Manegold. 1983. Applications of Time-Series Analysis in Accounting: A Review. *Journal of Forecasting* (December): 405-423.

Barefield, R., and E. E. Comiskey. 1975. Segmental Financial Disclosure by Diversified Firms and Security Prices: A Comment. *The Accounting Review* (October): 818-821.

Barth, M. 1994. Response to the FASB Discussion Memorandum "Reporting Disaggregated Information by Business Enterprises." *Accounting Horizons* (September): 75-82.

Bavishi, V. B., and H. E. Wyman. 1980. Foreign Operations Disclosures by U.S.-Based Multinational Corporations: Are They Adequate? *International Journal of Accounting: Education and Research* (Fall): 153-168.

Binkley, J., and C. H. Nelson. 1990. How Much Better is Disaggregate Data? *Economic Letters*. (Vol 32): 137-140.

Boatsman, J. R., B. K. Behn, and D. H. Patz. 1993. A Test of the Usefulness of Geographical Segment Disclosures. *Journal of Accounting Research* (Supplement): 46-74.

Clinton, K. 1988. Transaction Costs and Covered Interest Arbitrage: Theory and Evidence. *Journal of Political Economy* (April): 358-370.

Collins, D. W. 1975. SEC Product-Line Reporting and Market Efficiency. *Journal of Financial Economics* (June): 125-164.

Collins, D. W. 1976. Predicting Earnings with Sub-Entity Data: Some Further Evidence. *Journal of Accounting Research* (Spring): 163-177.

Demski, J. 1977. The General Impossibility of Normative Accounting Standards. *The Accounting Review* (October): 719-723.

Emmanuel, C. R., and R. H. Pick. 1980. The Predictive Ability of UK Segment Reports. *Journal of Business Finance & Accounting* (Summer): 201-218.

FASB Financial Accounting Series. January 5, 1995. Page 7

FASB Invitation to Comment. 1993. *Reporting Disaggregated Information by Business Enterprises*. Norwalk, Conn: FASB.

FASB Research Report. 1993. *Reporting Disaggregated Information*, Norwalk, Conn: FASB.

FASB Statement No. 14. 1976. *Financial Reporting for Segments of a Business Enterprise*. Stamford, Conn: FASB.

Finger, C. A. 1994. The ability of Earnings to Predict Future Earnings and Cash Flow. *Journal of Accounting Research*. (Autumn): 210-223.

Fisher, I. 1930. *The Theory of Interest*. New York, NY: Macmillan.

Fried, D., M. Schiff, and A. C. Sondhi. 1992. Quarterly Segment Reporting: Impact on Analysts' Forecasts and Variability of Security Price Returns. Working paper, New York University, New York, NY.

Garrod, N. W., and C. R. Emmanuel. 1988. The Impact of Company Profile on the Predictive Ability of Disaggregated Data. *Journal of Business Finance & Accounting* (Summer): 135-154.

Genberg, H. 1978. Purchasing Power Parity under Fixed and Flexible Exchange Rates. *Journal of International Economics* (May): 247-267.

Grunfeld, Y. and Z. Griliches. 1960. Is Aggregation Necessarily Bad? *The Review of Economics and Statistics*. (February): 1-13.

Hopwood, W. S., J. C. Mckeown, and P. Newbold. 1982. The Potential for Gains in Predictive Ability Through Disaggregation: Segmented Annual Earnings. *Journal of Accounting Research*. (Autumn): 343-49.

Hussain, S., and L. C. L. Skerratt. 1992. Gains from Disaggregation and the Definition of a Segment: A Note on SSAP 25. *Accounting and Business Research* (Autumn): 370-376.

Jarque, C. M., and A. K. Bera. 1980. Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals. *Economic Letters*. Vol. 6: 255-259.

Kane, E., and L. Rosenthal. 1982. International Interest Rates and Inflationary Expectations. *Journal of International Money and Finance* (April).

Kinney, W. R. 1971. "Predicting Earnings: Entity Versus Subentity Data." *Journal of Accounting Research* (Spring): 127-136.

Kochanek, R. F. 1974. Segmental Financial Disclosure by Diversified Firms and Security Prices. *The Accounting Review* (April): 245-258.

Kravis, I. B., A. Heston, and L. Summers. 1982. *World Production and Income: International Comparisons of Real GDP*. Baltimore, MD: John Hopkins University Press.

Kravis, I. B., and R. E. Lipsey. 1978. Price Behavior in the Light of Balance of Payments Theories. *Journal of International Economics* (May): 193-246.

Levi, M. 1990. *International Finance: The Markets and Financial Management of Multinational Business*. 2d ed. New York, NY: McGraw-Hill.

Meek, G. K., and S. M. Saudagaran. 1990. A Survey of Research on Financial Reporting in a Transnational Context. *Journal of Accounting Literature* 145-182.

Nichols, D. L. 1992. SFAS 14's Geographic Segment Disclosures and the Ability of Security Analysts to Forecast Earnings. Ph.D. dissertation, Oklahoma State University.

Overturf, S.F. 1982. Risk, Transaction Charges, and the Market for Foreign Exchange Services. *Economic Inquiry* (April): 291-302.

Radebaugh, L. H. 1987. *International Aspects of Segment Disclosures: A Conceptual Approach*. Research Monograph No. 2. Glasgow, Scotland: University of Glasgow.

Richardson, J. D. 1978. Some Empirical Evidence on Commodity Arbitrage and the Law of One Price. *Journal of International Economics* (May): 341-351.

Roberts, C. B. 1989. Forecasting Earnings Using Geographical Segment Data: Some UK Evidence. *Journal of International Financial Management and Accounting* (Summer): 130-151.

Shapiro, A. C. 1992. *Multinational Financial Management*. 4th ed. Boston, MA: Allyn and Bacon.

SHAZAM. 1993. *User's Reference Manual*. Version 7.0. McGraw-Hill.

Silhan, P. A. 1982. Simulated Mergers of Existent Autonomous Firms: A New Approach to Segmentation Research. *Journal of Accounting Research* (Spring): 255-262.

Silhan, P. A. 1983. The Effects of Segmenting Quarterly Sales and Margins on Extrapolative Forecasts of Conglomerate Earnings: Extension and Replication. *Journal of Accounting Research* (Spring): 341-347.

Silhan, P. A. 1984. Company Size and the Issue of Quarterly Segment Reporting. *Journal of Accounting and Public Policy* (Fall): 185-197.

Solnik, B. 1991. *International Investments*. 2d ed. Reading, MA: Addison-Wesley.

Swaminathan, S. 1991. The Impact of SEC Mandated Segment Data on Price Variability and Divergence of Beliefs. *The Accounting Review* (January): 23-41.

Thygesen, N. 1978. Inflation and Exchange Rates: Evidence and Policy Guidelines for the European Community. *Journal of International Economics* (May): 301-317.

Tse, S. 1989. Attributes of Industry, Industry Segment and Firm-Specific Information in Security Valuation. *Contemporary Accounting Research* (Spring): 592-614.

APPENDIX

The following proof demonstrates that the consolidated and segment models will arrive at equivalent forecasts if the expected change in each of the four global factors is equal to the weighted average of the segment factors.

The consolidated forecasting model is expressed as

$$E[Y_{t+1}] = Y_t(1+E[\Delta FX_{t+1}])(1+E[INFL_{t+1}])(1+E[\Delta GNP_{t+1}]) \qquad (A.1)$$

The segment forecasting model is expressed as

$$E[Y_{t+1}] = \sum_{i=1}^{n} Y_{it}(1+E[\Delta FX_{it+1}])(1+E[INFL_{it+1}])(1+E[\Delta GNP_{it+1}]) \qquad (A.2)$$

Setting the right hand side of (A.1) equal to the right hand side of (A.2), multiplying through by Y_t in equation (A.1) and multiplying through by Y_{it} in equation (A.2) one obtains

$$\begin{aligned}&(Y_t+Y_tE[\Delta FX_{t+1}])(Y_t+Y_tE[INFL_{t+1}])(Y_t+Y_tE[\Delta GNP_{t+1}])\\ =&\sum_{i=1}^{n}(Y_{it}+Y_{it}E[\Delta FX_{it+1}])(Y_{it}+Y_{it}E[INFL_{it+1}])(Y_{it}+Y_{it}E[\Delta GNP_{it+1}])\end{aligned} \qquad (A.3)$$

Equation (A.3) will only hold if

$$Y_t+Y_tE[\Delta FX_{t+1}] = \sum_{i=1}^{n}(Y_{it}+Y_{it}E[\Delta FX_{it+1}]) \qquad (A.4)$$

and

$$Y_t + Y_t E[INFL_{t+1}] = \sum_{i=1}^{n} (Y_{it} + Y_{it} E[INFL_{it+1}]) \quad \text{(A.5)}$$

and

$$Y_t + Y_t E[\Delta GNP_{t+1}] = \sum_{i=1}^{n} (Y_{it} + Y_{it} E[\Delta GNP_{it+1}]) \quad \text{(A.6)}$$

Given by definition that

$$\sum_{i=1}^{n} Y_{it} = Y_t$$

Equations (A.4) through (A.6) can be restated as

$$Y_t + Y_t E[\Delta FX_{t+1}] = Y_t + \sum_{i=1}^{n} (Y_{it} E[\Delta FX_{it+1}]) \quad \text{(A.4)}$$

$$Y_t + Y_t E[INFL_{t+1}] = Y_t + \sum_{i=1}^{n} (Y_{it} E[INFL_{it+1}]) \quad \text{(A.5)}$$

$$Y_t + Y_t E[\Delta GNP_{t+1}] = Y_t + \sum_{i=1}^{n} (Y_{it} E[\Delta GNP_{it+1}]) \quad \text{(A.6)}$$

Finally, subtract Y_t from both sides of equations (A.4) through (A.6) and divide through by Y_t to obtain

$$E[\Delta FX_{t+1}] = \sum_{i=1}^{n} (\frac{Y_{it}}{Y_t}) E[\Delta FX_{it+1}] \quad \text{(A.4)}$$

$$E[INFL_{t+1}] = \sum_{i=1}^{n} (\frac{Y_{it}}{Y_t}) E[INFL_{it+1}] \tag{A.5}$$

$$E[\Delta GNP_{t+1}] = \sum_{i=1}^{n} (\frac{Y_{it}}{Y_t}) E[\Delta GNP_{it+1}] \tag{A.6}$$

Figure 1

Exchange Rate Movements, Inflation Rate Differentials, and Interest Rate Differentials

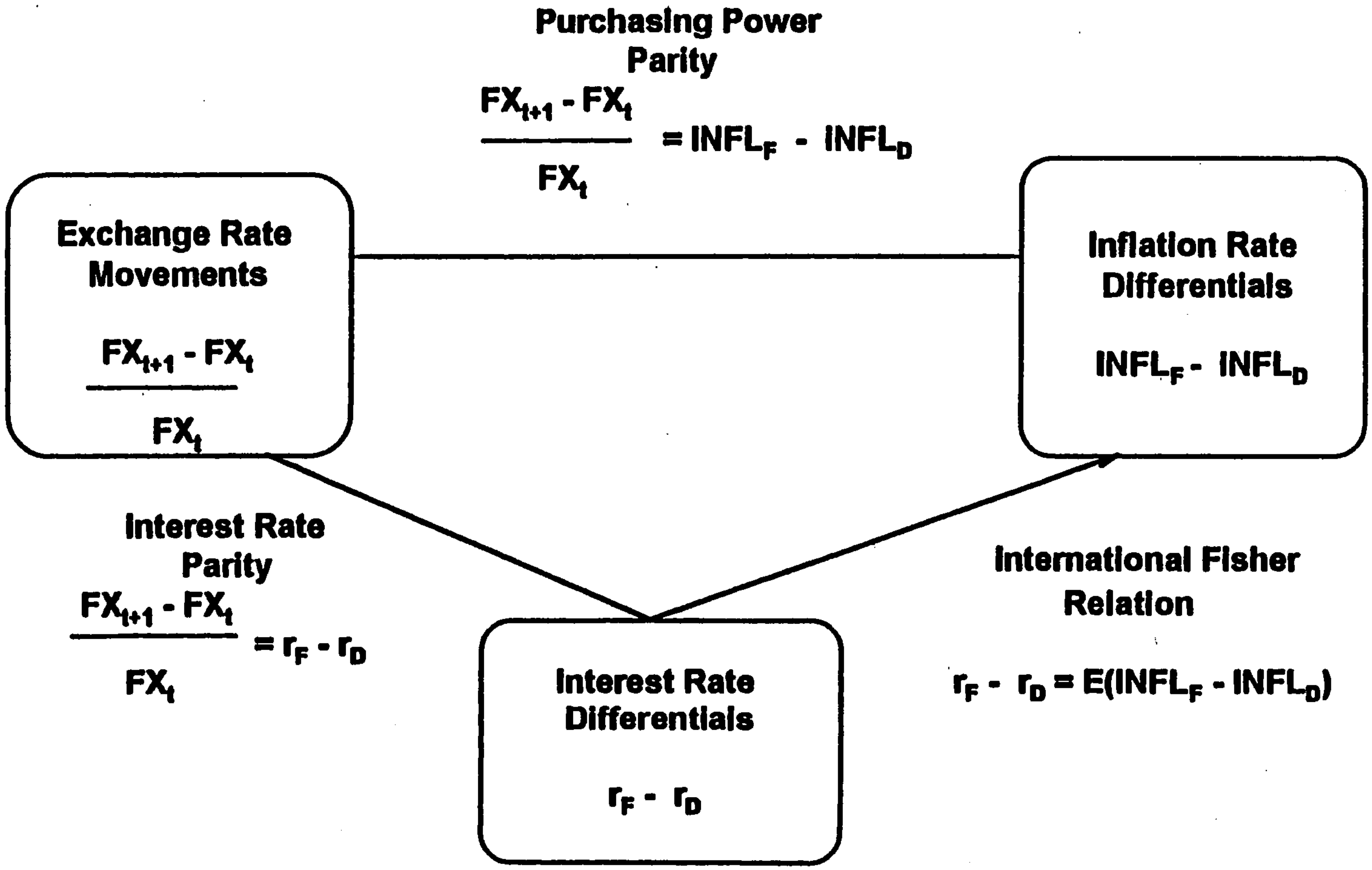

TABLE 1

Annual Means and Standard Deviations for
Sales, Gross Profit and Earnings (n=55)
(in Billions of U.S. Dollars)

	1988	1989	1990	1991	1992
Sales					
Mean	8.110	8.603	10.065	10.823	11.656
Standard Deviation	7.015	7.573	8.764	9.733	10.611
Gross Profit					
Mean	2.370	2.458	2.996	3.238	3.586
Standard Deviation	1.919	2.036	2.684	3.124	3.439
Earnings					
Mean	.410	.436	.478	.448	.433
Standard Deviation	.303	.340	.409	.376	.362

TABLE 2

Mean Absolute Percentage Errors and Standard Deviations
for Year-Ahead Sales and Gross Profit Forecast Models (n=55)

Model	Perfect Foresight		Forecast Variables	
	Mean	Std. Deviation	Mean	Std. Deviation
Sales				
Consolidated (No FX)	.0649	.0556	N/A	N/A
Consolidated (MERM)	.0543	.0547	.0636	.0498
Continent	.0533	.0555	.0635	.0494
Country	.0521	.0534	.0641	.0475
Gross Profit				
Consolidated (No FX)	.0777	.0483	N/A	N/A
Consolidated (MERM)	.0638	.0468	.0747	.0374
Continent	.0614	.0466	.0743	.0373
Country	.0608	.0460	.0743	.0371

TABLE 3

Summary Statistics for Tests of Differences for Year-Ahead Forecast Models
Assuming Perfect Foresight and Consolidated Model Without Exchange Rates

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Sales						
Consolidated - Country	.0127	5.08**	.0055	.0141	.0229	44/55**
Consolidated - Continent	.0116	4.56**	.0058	.0155	.0245	42/55**
Continent - Country	.0011	.94	-.0044	.0006	.0041	29/55
Gross Profit						
Consolidated - Country	.0169	5.42**	.0041	.0208	.0332	46/55**
Consolidated - Continent	.0163	5.41**	.0065	.0205	.0290	45/55**
Continent - Country	.0006	.80	-.0049	.0014	.0046	33/55*

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 4

Summary Statistics for Tests of Differences for Year-Ahead Forecast Models
Assuming Perfect Foresight and Consolidated Model (MERM)

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Sales						
Consolidated - Country	.0022	1.31	-.0060	.0007	.0060	29/55
Consolidated - Continent	.0010	.87	-.0044	-.0001	.0069	27/55
Cons (No FX)- Cons (MERM)	.0106	4.55**	.0016	.0122	.0249	42/55**
Gross Profit						
Consolidated - Country	.0030	1.73*	-.0043	.0023	.0106	31/55
Consolidated - Continent	.0024	1.43	-.0063	.0037	.0100	34/55*
Cons (No FX)- Cons (MERM)	.0139	6.34**	.0053	.0191	.0256	45/55**

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 5

Summary Statistics for Tests of Differences for Year-Ahead Forecast Models
Using Forecast Variables

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Sales						
Consolidated - Country	-.0006	-.78	-.0024	-.0011	.0008	24/55
Consolidated - Continent	.0001	.29	-.0011	.0002	.0010	35/55*
Continent - Country	-.0006	-.87	-.0030	-.0008	.0007	23/55
Gross Profit						
Consolidated - Country	.0005	1.31	-.0014	.0010	.0020	35/55*
Consolidated - Continent	.0005	2.44**	-.0003	.0004	.0012	37/55**
Continent - Country	.0000	.12	-.0015	.0005	.0015	31/55

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 6

Mean Absolute Percentage Errors and Standard Deviations
for Year-Ahead Earnings Forecast Models (n=55)

Model	Perfect Foresight		Forecast Variables	
	Mean	Std. Deviation	Mean	Std. Deviation
Earnings				
Consolidated (MERM)	.1989	.1568	.1895	.1509
Continent	.1961	.1593	.1886	.1501
Country	.1936	.1564	.1869	.1488
Random Walk	.1766	.1333	.1766	.1333

TABLE 7

Summary Statistics for Tests of Differences
for Year-Ahead Earnings Forecast Models

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Earnings - Perfect Foresight						
Consolidated - Country	.0053	3.12**	-.0019	.0044	.0126	35/55*
Consolidated - Continent	.0028	1.72*	-.0049	.0026	.0097	34/55*
Continent - Country	.0025	2.78**	-.0026	.0021	.0080	35/55*
Earnings - Forecast Variables						
Consolidated - Country	.0026	5.19**	-.0001	.0025	.0045	40/55**
Consolidated - Continent	.0009	2.83**	-.0007	.0005	.0025	37/55**
Continent - Country	.0017	3.98**	.0000	.0011	.0034	42/55**

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 8

Coefficient Estimates and Significance Tests
for Sales Regression Forecast Models (n=310)

Variable	France	Germany	United Kingdom	Canada	United States	Japan
Panel A: Sales						
ln(1+E[ΔFX])	.762[1]	.943	.576	.882	N/A	1.121
	(7.63)**	(10.01)**	(3.71)**	(1.74)*		(4.60)**
ln(1+E[INFL])	1.830	-.097	.957	-.283	1.671	2.092
	(.60)	(-.14)	(.89)	(-.17)	(1.72)*	(.83)
ln(1+E[ΔGNP])	1.326	1.203	2.680	2.319	2.219	3.633
	(2.08)*	(2.69)**	(7.09)**	(4.74)**	(6.04)**	(4.43)**
Constant	.014	.014	.007	.032	-.025	-.118
	(.16)	(.42)	(.10)	(.71)	(-.65)	(-1.48)
F statistic[2]	77.99**	76.13**	70.08**	44.21**	92.59**	38.49**
Adj. R^2	.153	.244	.259	.216	.151	.168

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(*t*-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

TABLE 8 (Continued)

Coefficient Estimates and Significance Tests
for Sales Regression Forecast Models (n=310)

Variable	Europe	North America	World
Panel A: Sales			
ln(1+E[ΔFX])	.848	.731	1.189
	(9.62)**	(1.37)	(7.80)**
ln(1+E[INFL])	1.745	.681	3.422
	(1.04)	(.56)	(2.61)**
ln(1+E[ΔGNP])	1.818	1.854	1.972
	(2.67)**	(6.44)**	(4.30)**
Constant	-.359	.009	-.123
	(-.42)	(.25)	(-1.99)*
F statistic[2]	110.02**	87.67**	140.95**
Adj. R^2	.248	.238	.235

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(*t*-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

TABLE 8 (Continued)

Coefficient Estimates and Significance Tests
for Gross Profit Regression Forecast Models (n=310)

Variable	France	Germany	United Kingdom	Canada	United States	Japan
Panel B: Gross Profit						
ln(1+E[ΔFX])	.948	1.017	.787	1.071	N/A	.984
	(7.69)**	(8.88)**	(2.67)**	(1.78)*		(7.31)**
ln(1+E[INFL])	3.704	-.030	1.221	.911	-2.303	-1.691
	(.99)	(-.04)	(.60)	(.20)	(-1.03)	(-1.21)
ln(1+E[ΔGNP])	1.224	1.827	3.355	3.757	2.281	2.564
	(1.56)	(2.38)*	(4.68)**	(2.85)**	(2.69)**	(5.65)**
Constant	-.041	.011	-.030	-.081	.116	-.010
	(-.39)	(.26)	(-.25)	(-.67)	(1.28)	(-.27)
F statistic[2]	58.68**	58.20**	23.17**	8.88**	16.38**	144.41**
Adj. R^2	.157	.201	.135	.191	.126	.348

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(*t*-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

TABLE 8 (Continued)

Coefficient Estimates and Significance Tests
for Gross Profit Regression Forecast Models (n=310)

Variable	Europe	North America	World
Panel B: Gross Profit			
ln(1+E[ΔFX])	1.007	.493	1.453
	(10.48)**	(.60)	(9.08)**
ln(1+E[INFL])	2.458	.064	2.620
	(1.34)	(.03)	(1.90)*
ln(1+E[ΔGNP])	.890	1.791	1.494
	(1.20)	(6.32)**	(3.10)**
Constant	-.044	.012	-.077
	(-.47)	(.20)	(-1.18)
F statistic[2]	108.12**	38.47**	146.02**
Adj. R^2	.268	.163	.185

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(*t*-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

TABLE 9

Mean Absolute Percentage Errors and Standard Deviations
for 1991 and 1992 Sales Regression Forecast Models

Model	Perfect Foresight		Forecast Variables	
	Mean	Std. Deviation	Mean	Std. Deviation
Panel A: Sales				
1991				
Consolidated (No FX)	.1613	.0667	N/A	N/A
Consolidated (MERM)	.0680	.0669	.1843	.0666
Continent	.0672	.0677	.0609	.0670
Country	.0629	.0678	.0593	.0669
1992				
Consolidated (No FX)	.1047	.1112	N/A	N/A
Consolidated (MERM)	.0531	.1026	.1301	.1127
Continent	.0530	.1050	.0546	.1016
Country	.0518	.1040	.0523	.1023

TABLE 9 (Continued)

Mean Absolute Percentage Errors and Standard Deviations
for 1991 and 1992 Gross Profit Regression Forecast Models

Model	Perfect Foresight		Forecast Variables	
	Mean	Std. Deviation	Mean	Std. Deviation
Panel B: Gross Profit				
1991				
Consolidated (No FX)	.2336	.0901	N/A	N/A
Consolidated (MERM)	.0960	.0805	.2621	.0919
Continent	.0875	.0772	.0757	.0744
Country	.0805	.0750	.0727	.0726
1992				
Consolidated (No FX)	.1064	.0856	N/A	N/A
Consolidated (MERM)	.0724	.0886	.1385	.0823
Continent	.0626	.0878	.0624	.0864
Country	.0605	.0894	.0626	.0862

TABLE 10

Summary Statistics for Tests of Differences
for 1991 and 1992 Sales Regression Forecast Models
Assuming Perfect Foresight and Consolidated Model Without Exchange Rates

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Panel A: Sales						
1991						
Consolidated - Country	.0984	12.15**	.0934	.1228	.1305	49/55**
Consolidated - Continent	.0941	12.89**	.1026	.1157	.1211	49/55**
Continent - Country	.0043	3.34**	-.0033	.0068	.0102	38/55**
1992						
Consolidated - Country	.0529	6.80**	.0384	.0739	.0913	44/55**
Consolidated - Continent	.0517	6.52**	.0332	.0703	.0901	45/55**
Continent - Country	.0012	.90	-.0047	.0017	.0052	34/55*

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 10 (Continued)

Summary Statistics for Tests of Differences
for 1991 and 1992 Gross Profit Regression Forecast Models
Assuming Perfect Foresight and Consolidated Model Without Exchange Rates

	Mean[1]		Difference[2]			Sign Test
Relationship	Difference	t Value	25%	Median	75%	(+'s) / n
Panel B: Gross Profit						
1991						
Consolidated - Country	.1530	19.14**	.1464	.1699	.1829	53/55**
Consolidated - Continent	.1461	20.14**	.1477	.1598	.1715	53/55**
Continent - Country	.0070	5.72**	.0003	.0076	.0140	43/55**
1992						
Consolidated - Country	.0459	6.56**	.0106	.0613	.0795	45/55**
Consolidated - Continent	.0437	7.89**	.0302	.0619	.0692	44/55**
Continent - Country	.0022	.71	-.0146	.0006	.0148	29/55

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 11

Summary Statistics for Tests of Differences
for 1991 and 1992 Sales Regression Forecast Models
Assuming Perfect Foresight and Consolidated Model (MERM)

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Difference[2] Median	Difference[2] 75%	Sign Test (+'s) / n
Panel A: Sales						
1991						
Consolidated - Country	.0051	2.46**	-.0059	.0077	.0178	39/55**
Consolidated - Continent	.0008	.60	-.0056	.0013	.0070	32/55
Cons (No FX)- Cons (MERM)	.0933	13.75**	.1081	.1117	.1171	50/55**
1992						
Consolidated - Country	.0012	.72	-.0055	.0001	.0100	28/55
Consolidated - Continent	.0001	.04	-.0076	.0023	.0074	31/55
Cons (No FX)- Cons (MERM)	.0516	5.94**	.0242	.0790	.0996	49/55**

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 11 (Continued)

Summary Statistics for Tests of Differences
for 1991 and 1992 Gross Profit Regression Forecast Models
Assuming Perfect Foresight and Consolidated Model (MERM)

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Panel B: Gross Profit						
1991						
Consolidated - Country	.0155	5.61**	.0049	.0188	.0279	45/55**
Consolidated - Continent	.0086	4.33**	.0024	.0121	.0167	44/55**
Cons (No FX)- Cons (MERM)	.1375	21.29**	.1403	.1467	.1565	53/55**
1992						
Consolidated - Country	.0120	1.87*	-.0158	.0226	.0470	37/55**
Consolidated - Continent	.0098	1.32	-.0584	.0280	.0563	34/55*
Cons (No FX)- Cons (MERM)	.0339	2.99**	-.0354	.0252	.1089	36/55**

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 12

Summary Statistics for Tests of Differences
for 1991 and 1992 Sales Regression Forecast Models
Using Forecast Variables

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Panel A: Sales						
1991						
Consolidated - Country	.1249	13.19**	.1098	.1539	.1676	51/55**
Consolidated - Continent	.1234	13.66**	.1179	.1528	.1607	50/55**
Continent - Country	.0015	1.88*	-.0036	.0019	.0059	33/55
1992						
Consolidated - Country	.0779	8.95**	.0560	.1073	.1153	47/55**
Consolidated - Continent	.0755	7.52**	.0455	.1021	.1339	46/55**
Continent - Country	.0024	1.03	-.0135	.0088	.0150	32/55

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 12 (Continued)

Summary Statistics for Tests of Differences
for 1991 and 1992 Gross Profit Regression Forecast Models
Using Forecast Variables

Relationship	Mean[1] Difference	t Value	Difference[2] 25%	Median	75%	Sign Test (+'s) / n
Panel B: Gross Profit						
1991						
Consolidated - Country	.1894	19.56**	.1793	.2035	.2276	53/55**
Consolidated - Continent	.1864	20.12**	.1763	.2060	.2214	52/55**
Continent - Country	.0030	2.59**	-.0032	.0018	.0097	31/55
1992						
Consolidated - Country	.0759	9.67**	.0625	.0921	.1153	48/55**
Consolidated - Continent	.0761	7.84**	.0351	.1070	.1328	44/55**
Continent - Country	-.0002	-.08	-.0238	.0085	.0178	31/55

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Represents the mean over 55 observations of the difference in mean absolute percentage errors (MAPEs) between the aggregate and disaggregate models. A positive difference indicates that the predictive ability of the disaggregate model exceeds the predictive ability of the aggregate model.

[2] Represents the first quartile, median, and 3rd quartile differences, respectively.

TABLE 13

Coefficient Estimates and Significance Tests
for Earnings Regression Forecast Models (n=310)

Variable	France	Germany	United Kingdom	Canada	United States	Japan
ln(1+E[ΔFX])	.349	.583	-.606	-15.809	N/A	.764
	(.79)	(1.29)	(-.82)	(-2.05)*		(1.17)
ln(1+E[INFL])	-202.920	-3.847	-16.186	-23.393	1.845	-14.362
	(-3.46)**	(-.56)	(-1.77)	(-1.26)	(.24)	(-2.09)*
ln(1+E[ΔGNP])	-7.449	4.074	6.604	28.457	7.349	2.528
	(-1.65)	(.94)	(4.90)**	(2.57)**	(3.54)**	(.48)
Constant	6.410	.006	.962	1.001	-.167	.179
	(3.50)**	(.04)	(1.65)	(1.36)	(-.52)	(.59)
F statistic[2]	3.90*	4.90**	7.38**	3.05*	6.23**	10.39**
Adj. R^2	.023	.049	.079	.029	.038	.094

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(t-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

TABLE 13 (Continued)

Coefficient Estimates and Significance Tests
for Earnings Regression Forecast Models (n=310)

Variable	Europe	North America	World
ln(1+E[ΔFX])	.307	-4.987	.524
	(1.32)	(-.92)	(1.35)
ln(1+E[INFL])	-23.141	-5.053	-11.206
	(-4.17)**	(-.62)	(-2.70)**
ln(1+E[ΔGNP])	1.703	9.426	6.722
	(.57)	(2.61)**	(5.91)**
Constant	1.159	.157	.415
	(3.52)**	(.49)	(1.98)*
F statistic[2]	5.02**	8.74**	32.69**
Adj. R^2	.144	.089	.171

* Significant at $p < .05$ / ** Significant at $p < .01$.

[1] Coefficient
(*t*-statistic)

[2] Tests the null hypothesis that all three coefficients are equal to zero.

VITA

Donald Richard Herrmann

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE PREDICTIVE ABILITY OF GEOGRAPHIC SEGMENT INFORMATION AT THE COUNTRY, CONTINENT, AND CONSOLIDATED LEVELS

Major Field: Business Administration

Biographical:

Personal Data: Born in Lincoln, Nebraska, October 21, 1963, the son of Richard A. and Doris M. Herrmann

Education: Graduated from Northeast High School, Lincoln, Nebraska in May, 1982; received Bachelor of Science Degree in Business Administration from John Brown University, Siloam Springs, Arkansas in April, 1985; received Master of Accountancy Degree from Kansas State University, Manhattan, Kansas in May, 1987; completed the requirements for the Doctor of Philosophy Degree at Oklahoma State University in July, 1995.

Experience: Auditor, Deloitte & Touche, Colorado Springs, Colorado, 1987 to 1989; Accounting Instructor, University of Southern Colorado, 1989 to 1991; Graduate Teaching Assistant, Oklahoma State University, 1991 to 1995.

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 11-17-94 **IRB#:** BU-95-009

Proposal Title: THE PREDICITVE ABILITY OF DISAGGREGATED GEOGRAPHIC INFORMATION: A SIMULATED MERGER APPROACH

Principal Investigator(s): Gary K. Meek, Don Herrmann

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: John H. Wycoff Date: November 18, 1994

Chair of Institutional Review Board