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AN EMPIRICAL EXAMINATION OF THE ASSOCIATION BETWEEN  
THE ADOPTION OF LONG-TERM PERFORMANCE PLANS AND THE  
SUBSEQUENT GROWTH OF RESEARCH AND DEVELOPMENT  
EXPENDITURES

presented by

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has been accepted towards fulfillment  
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Susan F. Haka  
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SUBSEQUENT GROWTH OF RESEARCH AND DEVELOPMENT  
EXPENDITURES**

**By**

**Parvez R. Sopariwala**

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## **ABSTRACT**

### **AN EMPIRICAL EXAMINATION OF THE ASSOCIATION BETWEEN THE ADOPTION OF LONG-TERM PERFORMANCE PLANS AND THE SUBSEQUENT GROWTH OF RESEARCH AND DEVELOPMENT EXPENDITURES**

**By**

**Parvez R. Sopariwala**

It is widely believed that the interests of corporate executives are divergent from their stockholders. As a result, decisions made by these executives need not always be in the stockholders' best interests. However, this divergence of interests is reduced by structuring incentive compensation schemes that align the interests of corporate executives and their stockholders by making management compensation dependent on the company's performance.

Of the many incentive compensation schemes used, long-term performance plans are a recent innovation. They reward executives for achieving accounting numbers based performance goals over three to six years. These long-term performance plans are designed to encourage executives to become long-term oriented. A signal that management has converted to a long-term orientation is a significant

growth in their research and development expenditures (here after called R&D) subsequent to the adoption of a long-term performance plan.

Fortune 500 companies that adopted performance plans during 1978-82 were matched with similar companies that had not adopted performance plans on the basis of financial year-end, industry SIC codes, sales and security market betas. It was hypothesized that the adopting companies' R&D growth would be significantly greater than that of non-adopting companies. The experimental design used was a variation of the Interrupted Time-Series design. The Wilcoxon Matched-Pairs, Signed-Ranks and t tests were used to test the hypothesis.

The empirical results of this research indicate that there was no significant difference in R&D growth between the adopting and non-adopting companies. Surprisingly, the non-adopting companies' R&D growth was greater, though not significantly, than that for adopting companies, indicating a direction opposite to that specified by the alternate hypothesis.

In an additional test, it was found that there was no significant difference in the growth of capital expenditures between adopting and non-adopting companies. Further, the non-adopting companies' growth in capital expenditures was greater, though not significantly, than that for adopting companies.

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## CHAPTER 1

### INTRODUCTION

A rational man must be guided by the incentive system within which he operates. No matter what his personal desires, he must be discouraged from certain activities if they carry large penalties and attracted towards others if they carry large rewards. The carrot and the stick guide scientists and politicians as well as donkeys.

George Stigler, The Citizen and the State:  
Essays in Regulation (The University of  
Chicago Press, Chicago, 1975), p. 171.

While it would be an exaggeration to suggest that individuals are at the mercy of the incentive systems within which they operate, it does not seem unreasonable to assume that their behavior is influenced by the particular incentive system they are subject to. The causal link between incentive systems and human behavior is difficult to establish in a complex world with complementary and conflicting incentive systems. It is more prudent to speculate about the association between an incentive system and a person's behavior. For example, Sowell (1980), while not suggesting that minimum wage laws have caused an increase in black youth unemployment, states that there is growing evidence of the association between the two.

Corporations are managed by professionals whose interests often diverge from those of the stockholders. Hence decisions made by corporate executives will not always be in the best interests of stockholders. It has been suggested that this divergence of interests can be reduced or eliminated by designing management compensation schemes that align the interests of corporate executives and their stockholders.

There exist a variety of incentive compensation schemes of which bonus and stock option plans are the most widely used. A bonus plan is a short-term incentive plan whose rewards are based on the company's performance measured by accounting numbers such as earnings per share (EPS). Since it is a short-term plan, it has been criticized for creating incentives for management to be short-sighted and to increase reported income without necessarily increasing the value of the company.

A stock option plan is a long-term incentive plan whose rewards are based on the company's performance measured through the fluctuations in that company's stock prices. This plan has been criticized on the ground that it reinforces the executive's risk-avoiding behavior since his human capital (i.e., the discounted present value of future compensation) and his non-human capital (i.e., stock in the company) are tied to the same company. In addition, many

corporate executives believe that stock prices often do not reflect the company's performance but are influenced by factors which are not under the control of corporate executives.

A new incentive compensation plan called the long-term performance plan (here after referred to as "performance plan(s)") has been introduced in the past ten years. This plan rewards executives on the extent to which their company achieves accounting numbers based performance goals set over a period of three to six years. The performance plan is designed to encourage executives to remain with the company and work towards the company's long-term success. An extract from the 1982 proxy statement of Textron (Table 1.1) reflects that company's expectations for the performance plan.

The null hypothesis is that growth in research and development expenditures (here after referred to as R&D) for adopting companies in the first three years of operation of the performance plans (i.e., the post-adoption period) as compared to the three years immediately preceding the year of adoption of the performance plans (i.e., the pre-adoption period), is not significantly different from the R&D growth for non-adopting companies over the same periods. This research expects to reject the null and conclude that the the adopting companies' R&D

Table 1.1

## Extract From Proxy Statement: Textron

"The Board of Directors believes that in order to attract, retain and motivate key employees, Textron's short-term incentive programs should be augmented by a long-term program which, through the grant of awards based on Textron's long-term performance, will increase the personal involvement of such employees in Textron's continued growth and success."

Source: Textron  
Proxy statement dated  
March 24, 1982, p. 16.

growth was significantly greater than that of the non-adopting companies over the same periods. This hypothesis presumes that executives of the adopting companies will become long-term oriented. A signal that these executives have become long-term oriented would be a significant increase in the growth in R&D subsequent to adoption of the performance plan.

Fortune 500 companies that adopted performance plans during the years 1978-82 were selected for this research. These companies were matched with similar companies that did not adopt performance plans. The matching criteria were industry (based on two digit SIC codes), size (sales for the year preceding the first year of operation of the plan), risk (security market beta) and financial year-end.

The experimental design chosen for this study was a variation of what Abdel-khalik and Ajinkya (1979) call "The Interrupted Time-Series Design". The strength of any experimental design is dependent on how carefully it circumvents possible violations of internal and external validity. This design controls for most violations of internal and external validity. However, there could be a self-selection bias which unfortunately is a problem with all such empirical studies.

Finally, the nonparametric Wilcoxon Matched-Pairs, Signed-Ranks test and the parametric t-test were used to determine the significance of the results.

This research is divided into eight parts. Chapter 2 briefly examines agency problems that confront a corporation and the usefulness of an effective incentive compensation package to reduce such agency problems. Chapter 2 also discusses the development of normative and positive theories of executive incentive compensation. Finally, an examination of positive theories is undertaken in Chapter 2.

Chapter 3 initially discusses two executive incentive compensation plans widely used by industry; bonus and stock option plans. Chapter 3 concludes with an examination of performance plans.

Chapter 4 evaluates the nature of R&D and discusses the distinction between R&D and capital expenditures. Chapter 4 suggests that R&D is a good surrogate for management's long-term oriented resource allocation decisions and then discusses why R&D is a better surrogate than capital expenditures.

Chapter 5 develops the general hypothesis about the association between adoption of performance plans and management's resource allocation decisions, (i.e. R&D).



Chapter 5 next develops the operational hypotheses that have been empirically examined. Finally, chapter 5 discusses the various assumptions that might limit the effectiveness of the results of this research.

Chapter 6 discusses methodology and explains the procedure for selection and matching of adopting companies with non-adopting companies. Next, chapter 6 proposes the experimental design and evaluates possible violations of internal and external validity. Finally, chapter 6 suggests appropriate statistical tests and discusses sources from which data was collected for this experiment.

Chapter 7 discloses the results obtained by applying the Wilcoxon and t-tests to the empirical data collected. Chapter 8 discusses the results presented in chapter 7 and evaluates several explanations for the results.

Chapter 9 concludes this research by discussing the implications of the results and offering several ideas for additional research in the field of executive incentive compensation.

## CHAPTER 2

### INCENTIVES AND MANAGEMENT BEHAVIOR

The directors of such (joint-stock) companies, however, being the managers rather of other people's money than of their own, it cannot well be expected, that they should watch over it with the same anxious vigilance with which the partners of a private copartnery frequently watch over their own. Like the stewards of a rich man, they are apt to consider attention to small matters as not for their master's honour, and very easily give themselves a dispensation from having it. Negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company.

Adam Smith, The Wealth of Nations,  
(Modern Library, 1937), p. 700.

In the opening quotation, Adam Smith suggests that the corporate form of organization, or the joint-stock company, is inherently inefficient. Fama and Jensen (1983) state that the organization that survives in any activity is one which delivers the product or service demanded by the customer at the lowest price. Hence, an inherently inefficient organization would not survive. However, the corporate form of organization (i.e., the corporation) has not only survived but has become widely prevalent. Researchers have long been interested in the reasons behind the survival of the corporation whose top executives'

interests do not always coincide with those of their stockholders.

## 2.1 Agency problems in a corporation

Fama and Jensen (1983) suggest that corporations survive because their contract structures separate the two important components of the decision process: the decision management (i.e., initiation and implementation of decisions) and decision control (i.e., ratification and monitoring) functions. Fama and Jensen (1983) also contend that separation of decision management and decision control at all levels of the corporation helps to limit the power of each individual agent to expropriate for himself a larger than deserved share of the corporation's wealth. In addition, the efficiency of such a separate decision system can be buttressed by incentive systems that reward agents fulfilling both the decision management and decision control roles.

This research is primarily concerned with incentive systems that reward agents fulfilling the decision management role at the very top of the corporation, i.e., its top corporate executives. Such incentive systems are expected to lead to goal congruence between the top executives (or agents) and the Board of

Directors (or principals) who alternatively are agents for the stockholders.

Though the ideal incentive structure might be one which rewards the agent on the basis of his effort, Jensen and Meckling (1976) point out that it is practically impossible for the agent's effort to be personally observed by the principal. Therefore, the principal may incur costs to monitor the agent's actions. On the other hand, an agent might expend resources (bonding costs) to protect the principal against any losses resulting from his aberrant activities. Finally, some output may still be lost through the divergence of the agent's actions because the costs of full enforcement exceed the benefits. This is called "the residual loss" and together with monitoring and bonding costs, makes up what Jensen and Meckling (1976) define as "agency costs".

Therefore, a good incentive system should minimize agency costs so that the residual claimants (the stockholders) get a larger portion of the wealth created. However, the design of an optimal incentive structure depends on a comprehensive theory of executive incentive compensation. Such a theory would guide companies as to what incentive structure would best fit their needs.

## 2.2 Theories of Executive Incentive Compensation

Raviv (1985) points out that research on incentive compensation schemes should explain the characteristics of compensation contracts observed in industry and various management decisions which could be induced by such compensation contracts. While theories could be normative or positive, this research is actually concerned with examining a positive theory which hypothesizes an association between the adoption of performance plans and subsequent growth in the adopting company's R&D. However, in order to better appreciate the overall framework of the theories of executive incentive compensation, it is useful to first briefly examine the existing normative theory and then discuss the positive theories of executive incentive compensation.

### 2.2.1 The Normative Theory of Executive Incentive Compensation

Keynes (1891) defines a "normative" science as a body of systematized knowledge discussing criteria of what ought to be. In the context of executive incentive compensation, a normative theory would explain why compensation contracts ought to be changed, why companies should use different schemes of incentive compensation or what contractual provisions should be adopted in certain

decision settings. However, as Larcker (1983) correctly points out, there is no such general or normative theory of incentive compensation.

### 2.2.2 The Positive Theories of Executive Incentive Compensation

Keynes (1891) again defines a "positive" science as a body of systematized knowledge concerning what is. This would imply that a positive theory is independent of any ethical or normative judgments. On the other hand, Friedman (1953) suggests, in terms of economics but equally applicable here, that normative economics cannot be independent of positive economics. Friedman (1953) adds, "Any policy conclusion necessarily rests on a prediction about the consequences of doing one thing rather than another, a prediction that must be based - implicitly or explicitly - on positive economics" (p. 5).

In the context of this research, Friedman's (1953) statement would imply that a normative theory of executive incentive compensation can only be established after examining how various alternative incentive systems react to a multitude of decision settings. As an analogy, Jensen (1983) considers normative and positive theories in the context of a decision process, where normative theory represents the objective function to be maximized and

positive theories represent the way the world works and are the constraints to the decision problem.

There are currently two branches of positive theories of incentive compensation based primarily on the methodology used. One branch is what Jensen (1983) calls the "principal-agent" literature and the second branch is what Chow (1984) calls the "economic consequences" literature. As Jensen (1983) states, "...both literatures address the contracting problem between self-interested maximizing parties and both use the same agency cost minimizing tautology (although not necessarily stated in that form)" (p. 334)

#### 2.2.2.1 The Principal-Agent Literature

Most principal-agent literature is non-empirical and analytical although some recent studies have empirically tested the analytical models constructed under this framework (Chow, 1983; Uecker, Schepanski and Shin, 1985; Waller and Chow, 1985). According to Jensen (1983), this literature is concerned with the impact of variables such as uncertainty in the environment, information structure and preferences of parties on observed contracting practices.

Baiman (1982) states that one part of this literature deals with the assessment of the ex-ante value

of information and the design of procedures to use that information. The value of information is studied in the context of pre-decision information, pre-contract information, public post-decision information etc.. For example, Penno (1984) developed conditions under which the agent would communicate his private pre-decision information to the principal.

Another part of this literature determines if the results of agency research concerning the use of information are consistent with observed business practices. Baiman (1982) cites several analytical studies on subjects such as responsibility accounting (Baiman and Demski, 1980), cost allocations (Zimmerman, 1979), participative budgeting (Baiman and Evans, 1981) and standards (Demski and Feltham, 1978). The analytical results of these studies were found to be consistent with many commonly used procedures.

Most of these analytical studies are vague about the role of incentive compensation. For example, Penno (1984) defines the agent's compensation as a function of the productive outcome and the agent's report. Baiman and Evans (1983) define the agent's compensation as a function of the company's outcome, the implementation of a certain information system and whether communication between the



parties is permitted. However, a few studies have considered incentive compensation in their models.

One such study by Demski and Feltham (1978) examined conditions under which use of budgetary control systems could be induced in an economic setting. They introduced a budget based incentive contract wherein the agent's compensation was based on a budgeted outcome which separated the set of possible outcomes into favorable (e.g., salary and bonus) and unfavorable (e.g., only salary). As mentioned earlier, recent studies have empirically tested the analytical models constructed under the principal-agent framework. Chow (1983) tested certain hypotheses analytically derived by Demski and Feltham (1978) and found them valid. Chow (1983) found that, given a choice between a budget-based contract and a fixed-pay contract, subjects with low skills tended to select the fixed pay contract whereas subjects with greater skills selected the budget-based contract. These studies illustrate the cause and effect relationship existing between incentive compensation schemes and employee behavior.

In another study, Lambert (1984) designed an optimal compensation structure that would encourage executives to smooth reported income. In that study, Lambert (1984) proposed a two-period contract wherein the

agent's compensation in the first period was dependent on the first period's production and the second period's compensation was based on the first and second period's production. Finally, Baber (1985) suggested a budget-based compensation, similar to that used by Demski and Feltham (1978), to induce executives to incur discretionary expenses that yield future cost savings. He argued that an executive on a budget-based compensation plan is more likely to invest in projects that yield future savings when the cost budgets are tight than when they are easy to achieve.

Inspite of the Demski and Feltham (1978), Lambert (1984) and Baber (1985) studies, there has been little emphasis in this principal-agent research on the issue of predicting executives' actions as a result of various incentive compensation schemes available. Perhaps, as Jensen (1983) suggests, tractability problems may limit the richness of input into these analytical models. Therefore, given the current state of development, it is unlikely that the present issue of an association between the adoption of a performance plan and the subsequent growth in R&D could be resolved using this analytical framework.

#### 2.2.2.2 The Economic Consequences Literature

The economic consequences literature which is mainly empirical "...seeks to explain how firm's accounting and resource allocation decisions are determined, and how these decisions affect selected economic agents or entities" (Chow 1984, p. 4). As most of the company's accounting and resource allocation decisions are made by management, this literature puts management at the center of its universe. Since this research examines the association of performance plan adoption with a change in managerial action, it falls within the purview of the economic consequences literature.

Chow (1984) suggests that an executive's utility could be a function of the following variables: income, wealth (human and nonhuman capital), leisure and psychological factors such as respect from one's peers. Since the income variable is objectively determined, it is most commonly used as a surrogate for an executive's utility. The determination of such income is specified by the executive's contract and is expected to be a function of the company's reported financial performance.

Further, Chow (1984) indicates that the reported financial performance of a firm is determined jointly by the realized outcomes of resource allocation decisions undertaken by management as well as accounting procedures

applied to such outcomes. Therefore, an executive whose income depends on his company's financial performance, might manipulate either the actual resource allocation decisions or the accounting methods that evaluate the outcomes of such decisions, or both. Since the decision to incur R&D is clearly a resource allocation decision, future discussion is limited to resource allocation decisions and not accounting methods.

Very few studies have sought to find an association between incentive compensation schemes and management's resource allocation decisions. Most of the studies that have considered incentive compensation have done so almost as an after-thought. They have often used the concept of incentive compensation in their thinking but have either ignored it or dealt with it casually in their methodology.

An ideal example of such studies is the research regarding the impact of SFAS No. 2 on resource allocation decisions. Dukes, Dyckman and Elliott (1980) and Horowitz and Kolodny (1980) attempted to examine the motivations of executives of R&D capitalizing companies who, pursuant to SFAS No. 2, were required to write off their R&D in the year of incurrence. It was expected that the R&D capitalizing companies would reduce R&D since expensing it would reduce net income and therefore management

compensation. However, Dukes, Dyckman and Elliott (1980) only mentioned that nearly all the companies in the experiment had incentive plans whereas Horowitz and Kolodny (1980) made no mention about the existence of incentive compensation schemes.

In other studies, the existence of incentive compensation schemes was treated as a dummy variable and used along with other criterion variables like size, leverage, etc., to explain managerial actions, such as choice of accounting techniques (Zmijewski and Hagerman, 1981; Holthausen, 1981; Bowen, Noreen and Lacey, 1981) and voting and lobbying behavior (Watts and Zimmerman, 1978). Holthausen and Leftwich (1983) state that the dummy variable representing the existence of management compensation plans such as bonus plans was significant at 5% in only one of the four above mentioned studies.

However, some recent studies have stopped using the existence of management compensation plans as a dummy variable. Abdel-khalik (1984) used the sum of salary and bonus paid to top executives while attempting to determine if executives chose income increasing accounting methods in situations where they expect their income-based bonus to increase as a result of that choice. Benston (1985), Coughlan and Schmidt (1985) and Murphy (1985) conducted studies seeking support for the hypothesis that executives

did act in their stockholder's interests. In these studies, Benston (1985) used salary, bonus, profit-sharing and fringe benefits, Coughlan and Schmidt (1985) used salary and bonus whereas Murphy (1985) used different definitions of executive compensation including salary, salary and bonus, deferred compensation, total compensation etc.. Summarizing the results of the last three studies, Jensen and Zimmerman (1985) state, "These three papers, taken collectively, suggest that executive compensation plans, board level discipline of poorly performing managers, and managers' shareholdings in their firms help align the interest of managers and shareholders." (p. 5).

Larcker (1983) used a different approach in studying the impact of a change in management compensation scheme on management's resource allocation decisions. Instead of considering management compensation as a combination of salary, bonus, stock options etc., he isolated the impact of just one ingredient of management compensation schemes, namely performance plans. The rationale was to examine if the adoption of a new incentive compensation scheme such as performance plans had the expected impact on management's actions. Larcker (1983) found that companies which adopted performance plans exhibited a significant growth in capital expenditure and a favorable market reaction in the period following adoption

of a performance plan. Larcker (1983) wanted to consider R&D and advertising along with capital expenditures but data on these two expenses were not readily available.

This research focuses on R&D to determine if a significant association can be established between the adoption of performance plans and R&D growth.

The next chapter analyzes the more widely-used incentive compensation schemes: bonus and stock option plans and leads into a discussion of performance plans which are the subject of this research.

## CHAPTER 3

### AN ANALYSIS OF EXECUTIVE INCENTIVE COMPENSATION SCHEMES

The executive incentive compensation schemes discussed in this chapter are widely used, either alone or in combination with other schemes, to reward top corporate executives. These schemes vary in two major ways. First, they are either based on accounting numbers such as Earnings per Share (EPS), Return on Investment (ROI) etc. or on stock prices. Second they either measure performance over one year (i.e., a short-term measure) or over a period of years (i.e., a long-term measure) (Larcker, 1983). The matrix in Table 3.1 should facilitate understanding of the major schemes.

#### 3.1 Bonus Plans

These plans usually compensate top executives in the form of a bonus which is accumulated in a bonus pool. The computation of the bonus pool is based on achieving desirable accounting numbers such as EPS, ROI etc.. For example, Kaplan (1982) reports that the General Motors Bonus Plan requires that earnings be greater than 7% of net capital before any bonus is credited to the pool. Second, 8% of the earnings that exceed 7% of net capital but not



Table 3.1

## A Matrix of Incentive Compensation Schemes

|                    | <u>Length of Period</u> |                             |
|--------------------|-------------------------|-----------------------------|
|                    | <u>Short Term</u>       | <u>Long Term</u>            |
| Accounting numbers | Bonus Plans             | Long-term performance plans |
| Stock prices       | NA                      | Stock options               |

where,

NA = Not applicable since stock prices cannot be considered short-term.

15% of net capital, is transferred to the pool. Third, 5% of the amount of earnings that exceed 15% of net capital is transferred to the pool. Finally, the total amount credited to the pool should not exceed the amount of common stock dividend paid that year.

Bonus plans are widely used by corporations. The Conference Board (1982) reports that bonus was the most popular incentive plan in 1981. Out of 1171 companies studied, about 78% of them had bonus plans as of May 1982. The amount of bonus paid as a percentage of salary varied between 49% in the construction industry to 29% in commercial banking.

Bonus plans, like other management compensation plans have been used primarily to alleviate the lack of goal congruence between top corporate executives and the stockholders of their company. Smith and Watts (1982) suggest that divergent motives of executives and stockholders can be controlled by establishing incentive compensation schemes which reward executives for taking actions that maximize the value of the company. Murphy's (1985) study found that market returns (used as a surrogate for the company's value) were strongly positively correlated with management compensation. He also found that a 10% increase in the rate of return raised the bonus awarded to executives by 12%. These results suggest that

bonus plans assist in aligning the interests of executives and stockholders.

Smith and Watts (1982) state that incentive provisions of compensation plans like bonus plans help control four problems commonly resulting from a divergence of interests between corporate executives and stockholders. These problems are the "horizon" problem, the "renegotiation" problem (partially considered under the "risk aversion" problem since incentive compensation could substitute for an upward renegotiation of salary), the "risk aversion" problem and the "underpayment of dividend" problem. This research considers the "risk aversion" and "horizon" problems as most important and believes that their alleviation is crucial for an effective incentive system.

The "risk aversion" problem arises when executives are only paid fixed salary with changes in the value of the company having no effect on their compensation. Smith and Watts (1982) argue that such executives are likely to undertake relatively safe projects that reduce the variance of cash flows and may even reject positive NPV projects. Such a choice of low risk projects could reduce the value of the company. However, company value would not concern fixed salary executives since they expect no benefit from the successes of the risky projects but could lose their jobs if these projects failed. Therefore, an incentive

compensation scheme should induce executives to undertake high-risk, high-return projects.

Smith and Watts (1982) suggest that bonus plans might be useful in lessening the "risk aversion" problem since bonus is usually paid after a certain level of income is earned. This might induce executives to undertake risky projects and attainment of that level of income above which bonus would be paid. On the other hand, it is argued that bonus, being a short-term plan, is unlikely to induce executives to look to the future. Their concern would be to maximize current year's income and they may not accept high-risk projects which might have high returns in the future. Actually, Smith and Watts (1982) themselves write off this option like provision in most bonus plans as a "blunt tool" in reducing the "risk aversion" problem. Therefore, the impact of bonus plans in lessening the "risk aversion" problem is debatable and, at best, minimal.

The "horizon" problem occurs because executives are normally rewarded for their contribution to the company's success only while in the employ of the company. This might induce them to turn down projects with positive NPV but long payback periods since cash inflows may materialize in the long-term after they have left their employer whereas cash outflows would be incurred in the near term. Kaplan (1982) suggests that such "horizon" problems can be avoided by designing "golden handcuffs"

empowering bonus committees to defer payment of bonus for a few years and forfeit the bonus if the employee leaves before a specified period is up. Towers, Perrin, Forster and Crosby (1980) report that about 64% of the largest industrial companies have adopted some form of the "golden handcuffs" provision.

Critics of bonus plans have suggested that these plans have created management incentives to increase reported income without necessarily increasing the economic value of the firm. However, a recent study by Healy (1985) suggests that bonus plans need not always lead to a desire to increase income. He found that executives were willing to increase net income through discretionary accruals if their bonus increased as well. However, in extreme situations where the net income before discretionary accruals was either too high or too low to affect bonus, he found that executives were willing to use discretionary accruals to decrease net income.

In addition, Kaplan (1982) suggests that bonus plans could induce maximizing of annual earnings via actions such as repurchasing debt, selling preferred stock at a discount, selling off assets whose market value is in excess of book value, underfunding R&D etc.. Banks and Wheelwright (1979) provide some evidence about executives attempting to reduce the negative effect of lower net income on their bonus by reducing capital expenditures,

R&D, product development, human resource development, customer service, maintenance and quality control.

### 3.2 Stock Options

A stock option confers upon an executive the right to purchase stock in his company at a certain price within a specified time period. Stock options are widely-used by large companies. Frederic W. Cook & Co., Inc. (1981) surveyed the Fortune 200 companies and found that 170 had stock option plans in 1980.

Stock options are also employed to lessen the conflicting aspirations of executives and stockholders caused by the "risk-aversion" and "horizon" problems (Smith and Watts, 1982). The "risk aversion" problem is controlled by conferring stock options to top executives. Since top executives are, or at least have the potential to be, stockholders in the company, they will choose to eliminate or lessen agency costs borne by stockholders.

In addition, since stock options can be converted into stock only if a certain price is attained, the executive has an incentive to accept high-risk, high-return projects. In a study of 29 large conglomerates, Benston (1985) found that the gains and losses of top executives was commensurate with stockholders' gains and losses. These executives' gains and losses from the company's stock price movements were much larger than their remuneration

(considered by the study to be salary, bonus, profit-sharing and an additional 20% for fringe benefits).

Finally, stock options also alleviate the "horizon" problem since owning stock permits executives to enjoy the rewards from their actions even after they have retired. As Kaplan (1982) explains, stock options are designed to motivate executives to strive for the company's long-term health instead of short-term profits.

However, stock options do have their critics. Kaplan (1982) suggests two factors which could limit the desirability of stock options. First, stock options would tend to reinforce an executive's risk-avoiding behavior because both, his human capital (i.e., the discounted present value of future compensation) and non-human capital (i.e., the company's stock) are tied to the same company with no opportunity to diversify. This might inhibit him from undertaking risky investments. Second, there is no direct causal relationship between management's performance and stock prices which are often influenced by factors beyond the control of management, e.g., the state of the economy, political factors, interest rates etc.. Bickford (1981) reports that stock prices were stagnant or even declining in the 1970s despite strong earnings performances.

In addition, Rappaport (1978) suggests that stock options may not be effective in influencing the executive

to be long-term oriented if he is able to earn larger rewards from short-term accounting numbers based compensation (i.e., bonus plans) than through stock options. In such a case he might devote his energies to activities which primarily inflate current accounting numbers.

### 3.3 Long-term Performance Plans

A performance plan could be defined as a long-term compensation plan where executives are rewarded on the extent to which their company achieves performance goals set over the period of the plan. A performance plan is designed to encourage executives to remain with the company and work toward the company's long-term success. According to Bickford (1981), the popularity of performance plans has increased substantially since 1971 when Akzona, Amstar, J. C. Penney and CBS received stockholder approval to introduce these plans. Rich and Larson (1984) report that nearly 40% of the Fortune 500 companies have some form of performance plan and that payments under these plans could exceed \$1.5 billion over the next ten years.

These plans are designed to avoid most of the pitfalls inherent in the bonus and stock option plans. They are expected to be an improvement over bonus plans since they consider a longer period of time than do bonus plans, thereby expanding the executives' decision horizon and



making them long-run oriented. In contrast to bonus plans, performance plans specify a certain goal (measured in accounting numbers), to be achieved in a period of three to six years. On the other hand, these plans are created partly as a result of the executives' frustration with the haphazard behavior of the stock market in the 1970s. As Bickford (1981) reports, companies found their stock prices remaining constant or even declining in spite of strong earnings performances. These plans also alleviate the "risk aversion" and "horizon" problems which cause a divergence between actions taken by corporate executives and actions preferred by stockholders.

The "risk aversion" problem is mitigated by permitting performance awards to be paid in addition to the executive's salary. These plans have an option-like characteristic since the amount of performance award depends on the percentage of the performance goal achieved. Therefore, an executive should be willing to undertake high-risk, high-return projects since that would allow him to earn larger awards. As an example, refer to Table 3.2 and the performance plan extract for Emerson Electric. It can be observed that 70% of the performance shares would be "earned" if EPS in 1981 was greater than or equal to \$3.55 but less than \$3.60. Hence, if an executive eligible for this plan has been allotted 100 performance shares whose market value at the end of the award period was determined

Table 3.2

## Characteristics of Selected Performance Plans

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| <u>Emerson Electric (1977 fiscal year adoption)</u> |                               |                                     |
|-----------------------------------------------------|-------------------------------|-------------------------------------|
| Type of plan:                                       | Performance share             |                                     |
| Award period:                                       | 5 years                       |                                     |
| Performance measure:                                | Earnings-per-share (EPS)      |                                     |
| Initial targets:                                    | <u>1981 EPS</u>               | <u>% of shares<br/>'earned out'</u> |
|                                                     | $\geq \$3.60$                 | 100                                 |
| (1976 EPS=\$2.05)                                   | $< \$3.60$ but $\leq \$3.55$  | 70                                  |
|                                                     | $< \$3.55$ but $\leq \$3.48$  | 50                                  |
|                                                     | $< \$3.48$                    | 0                                   |
| Form of payment:                                    | 20% cash and 80% common stock |                                     |

| <u>Toro (1976 fiscal year adoption)</u> |                                                                                                                             |                                    |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Type of plan:                           | Performance unit                                                                                                            |                                    |
| Award period:                           | 5 years                                                                                                                     |                                    |
| Performance measure:                    | Return-on-invested capital of<br>Toro compared to return-on-<br>invested capital for selected<br>competitors (relative ROI) |                                    |
| Initial targets:                        | <u>Relative ROI</u>                                                                                                         | <u>% of units<br/>'earned out'</u> |
|                                         | $\geq 75\%$                                                                                                                 | 100                                |
|                                         | $< 75$ , but $\geq 50$                                                                                                      | Prorated between                   |
|                                         | $< 50$                                                                                                                      | 0                                  |
| Value of unit:                          | Book value per common share at<br>the end of the award period                                                               |                                    |
| Form of payment:                        | Cash or common stock                                                                                                        |                                    |

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Source: Larcker (1983, p. 7)

at \$10 per share, then he would be entitled to \$700 [(0.70)(100)(10)] if the EPS was say, \$3.57.

The "horizon" problem is mitigated since performance plans usually reward executives after the award period (usually three to six years) has elapsed. Since the reward is determined only after the award period has elapsed, an executive leaving before the completion of the award period is usually entitled to nothing. In addition, Larcker (1983) points out that most of these plans are over-lapping (i.e., a new performance plan is introduced every year or every two years). Hence an executive participates in several over-lapping plans at the same time.

In addition to reducing the "risk aversion" and "horizon" problems, performance plans have several other features. First, performance goals are based entirely on accounting measures, which as Bickford (1981) explains, could be either absolute measures (i.e., growth in the company's EPS) or relative measures (i.e., the company's EPS growth as compared either to EPS growth of a "peer" company or EPS growth for the entire industry). Table 3.2 gives two examples of performance goals chosen by companies. Bickford (1981) states that the use of performance goals based on accounting numbers circumvents the haphazard nature of stock prices by permitting executives to share in the company's growth and be rewarded

for achieving improvement in the company's performance in terms of accounting numbers.

Second, compensation earned by an executive is based on "units" or "shares" allotted to him before the award period begins. If "units" are allotted, then each of these units have a predetermined value based on accounting numbers (e.g. book value of a share when the award period lapses). These plans are called "performance units". On the other hand, if "shares" are allotted, then the compensation earned is based on the stock prices at the end of the award period. These plans are called "performance shares" and they do indirectly involve the influence of the stock market (Larcker, 1983). Finally, even though compensation may be determined using stock prices or book value of stock, the final payment could be made in cash, stock or both.

There is, however, some disagreement regarding the effectiveness of performance plans. Rich and Larson (1984) believe that many companies still have very generous bonus plans. Therefore, it is possible that executives may be motivated primarily by the bonus plans at the expense of performance plans. For example, Louis (1984) reports that the base salary of the chief executive of Holiday Inns was \$300,000 in 1983 and his bonus was nearly double that amount. Holiday Inns also has a long-term incentive plan which measures the company's performance over a five year

period. The chief executive's reward from such a plan averaged only \$46,000 a year over the past five years.

In addition, Rich and Larson (1984) found that about 85% of the companies using performance plans used EPS growth, either alone or in combination with some other measure, as their performance measure. Rich and Larson (1984) think that companies use EPS as a performance measure because they believe that an increase in EPS will drive up stock prices. In their view, these plans are not concentrating on the creation of economic value (which they define as the excess of a company's return on equity over its cost of capital) but on the creation of increased EPS and hence may not increase the economic value of the company in the long-term.

Finally, Louis (1984) suggests that financial goals should be replaced by an objective performance measure such as stock-price appreciation plus dividends. However, this suggestion is unlikely to be taken seriously since one of the primary reasons for the introduction of these plans was to remove the link between the performance measure and stock prices.

Therefore, performance plans, although based primarily on accounting numbers, do not rely on the haphazard nature of the stock market to evaluate management's performance (Bickford, 1981) and are not expected to turn executives into short-term income

maximizers. Since these plans are expected to be widely used and cost companies about \$1.5 billion over the next decade (Rich and Larson, 1984), it is necessary to evaluate their effectiveness in meeting their objectives.

Having discussed the major executive incentive compensation plans, performance plans have been chosen as the surrogate for long-term incentive plans. The next chapter evaluates R&D, contrasts it against capital expenditures and justifies why it is a better surrogate than capital expenditures for the long-term commitment of a company.

## CHAPTER 4

### AN EVALUATION OF RESEARCH AND DEVELOPMENT EXPENDITURES

As discussed in chapter 2, Larcker (1983) sought an association between adoption of performance plans and a change in management attitudes toward the long-run reflected by increased growth in capital expenditures. He matched companies adopting performance plans with non-adopting companies, compared their capital expenditures and found that adopting companies exhibited significant growth in capital expenditures after adoption as compared to non-adopting companies.

Although Larcker (1983) assumed that corporate investment included R&D, advertising expenses and capital expenditures, he was forced to use capital expenditures because data on the other two expenditures was not readily available. This is hardly surprising since SFAS No. 2, which set disclosure requirements for R&D, was applicable only to annual reports issued after January 1, 1975. While both, R&D and capital expenditures are considered surrogates of management's commitment to the long-run, this research adopts R&D because it is a better surrogate for

management's long-term orientation than capital expenditures.

In this chapter, capital expenditures and R&D are compared and arguments as to why R&D is a better surrogate than capital expenditures for management's long-term orientation are advanced.

#### **4.1 Capital vs. R&D Expenditures**

##### **4.1.1 Meaning of Capital and R&D Expenditures**

In general terms, capital expenditures are incurred on the acquisition, modification and improvement of tangible assets. These assets include plant and equipment, land, buildings, vehicles, pollution abatement equipment etc.. In addition, a substantial portion of capital expenditures represents replacement of assets every few years.

On the other hand, the Financial Accounting Standards Board (FASB) issued SFAS No. 2 in 1974 requiring the expensing of R&D in the year incurred. According to Bierman and Dukes (1975), the FASB's main reasons for promulgating SFAS No. 2 were the substantial risk of failure associated with R&D, the lack of causal relationship between specific R&D expenditures and the benefits accruing there from, R&D not meeting the accounting definition of an "asset", the problem of



matching R&D and revenues and finally, the usefulness of R&D data for investment decisions. While the FASB's reasons have been criticized by Bierman and Dukes (1975), they confess that requiring expensing of R&D may have been the most feasible solution to obtain comparability in the financial statements.

Research and development is defined in paragraph 8 of SFAS-2 as follows:

a. Research is planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service (hereinafter "product") or a new process or technique (hereinafter "process") or in bringing about a significant improvement to an existing product or process.

b. Development is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use. It includes the conceptual formation, design and testing of product alternatives, construction of prototypes, and operation of pilot plants. It does not include routine or periodic alterations to existing products, production lines, manufacturing processes, and other on-going operations even though those alterations may represent improvements and it does not include market research or market testing activities. (p. 1010) (emphasis in original)

While most capital expenditures are incurred for replacing or expanding facilities with existing technology, FASB considers R&D an investment in the discovery of new knowledge and technology.

#### 4.1.2 Risk and uncertainty

One reason why management would not be indifferent between spending a certain portion of its resources on R&D versus capital expenditures is the different amount of risk and uncertainty associated with each. Bisio and Gastwirt (1979) state that returns from R&D are more uncertain than from capital expenditures because R&D returns typically have a longer time horizon. Capital expenditures involve a certain outlay for an uncertain benefit. On the other hand, R&D involves an uncertain outlay for an uncertain benefit. The uncertainty also makes selecting a project difficult since neither the project's cost and time needed for completion (Mansfield, 1982) nor its expected profitability (Beardsley and Mansfield, 1978) can be accurately estimated.

In addition, Mansfield (1982) suggests that the risk of commercial failure is often greater than the risk of technical failure. He adds:

...an R&D project's likelihood of economic success is the product of three separate factors: (1) the probability of technical success, (2) the probability of commercialization (given technical success), and (3) the probability of economic success (given commercialization). (p. 24)

Mansfield (1982) suggests that commercial risks are often more substantial than technical risks. This appears reasonable considering that about 78% of total R&D costs are for development projects (National Science Foundation, 1979). Mansfield (1982) cites a study of three companies

where 60% of R&D projects were technically complete, 30% were commercialized but only 12% of all R&D projects were an economic success.

Mansfield et. al. (1977) state that some tentative and experimental estimates have been made of the marginal rate of return from R&D by including R&D as an input into the production function. They state that the return on R&D is quite high. For example, Bailey (1972) found pretax rates of returns from R&D investments were between 25% and 35% for the pharmaceutical companies that he studied. The high rate of return can be explained as a trade-off against the riskiness of the R&D projects. As Mansfield (1982) states,

The message to managers is clear: putting funds into R&D may prove an economically attractive use of resources over the long run, but short-term fluctuations in returns do occur. Successful management of innovation requires a generous time horizon. (p. 27)

Finally, every company faces the risk that it might not be able to enjoy the benefits from new information created through its successful R&D efforts since some company might either improve on the results obtained or duplicate the results with minor modifications. Arrow (1962) suggests that the owner of such information would need legal protection. In reality, no amount of legal protection is sufficient for an intangible like information which would be revealed once it is used. Patents and

copyrights cannot protect information completely since, as Arrow (1962) points out, "...there are enormous difficulties in defining in any sharp way an item of information and differentiating it from other similar sounding items" (p. 615). Thus short-term oriented executives will not undertake such risky projects.

#### 4.2 R&D as a superior surrogate for management's long-term orientation

Capital expenditures are an inferior surrogate for management's long-term orientation as compared to R&D because most capital expenditures are concerned with existing technology. Capital expenditures are usually incurred to replace or expand existing facilities at the existing level of technology. Such an expansion of existing facilities is hardly adequate to ensure the company of its long-term survival especially if it is competing in a dynamic world market. An appropriate example would be the U.S. steel industry with its out-moded factories. It is unlikely that an additional factory with the same technology would help U.S. steel companies compete with the Japanese. Such a company could only survive if it could use more technologically advanced factories than are being used by the Japanese.

Although some capital expenditures are incurred to build more technologically advanced factories, such

construction is usually the result of R&D efforts of the company or it's plant manufacturer. Therefore, all capital expenditures that contribute to a company's long-term survival do result from it's successful R&D efforts or those of other companies.

Mansfield (1982) puts the role of R&D in proper perspective as follows:

American companies usually have been at the forefront of new technology. Their long-term profitability as well as their present success in the marketplace have often come largely from new products and processes. And these products and processes have come largely, if not exclusively, from an active commitment to R&D. (p. 23)

First, Mansfield (1968) states that there is a close relationship between R&D and the total number of important inventions produced. In addition, Bailey (1972) found a relationship between earnings over time and the number of patents held. Therefore, there is an indirect relationship between R&D and future earnings.

Second, Terleckyj (1980) states that technical change can be induced because R&D leads to innovations which lead to more efficient production. Mansfield (1982) states that data from several industries show that a company's future productivity is closely associated, though with a time lag, to its R&D.

Third, Ross (1985) states that a company needs R&D to give it a competitive edge. Ross (1985) states that U.S.

companies have been slow in applying the product of their R&D efforts (e.g., robotics, processors, software) to the manufacturing process. Therefore, the United States needs new technology resulting from increased R&D effort to compete with less developed countries and their lower labor costs. Finally, R&D leads to improved products which increase future sales. A study by Parasuraman and Zeren (1983) found evidence of the lagged effects of R&D in sales.

Considering the previous discussion on the usefulness of R&D, corporations might be expected to spend an ever-increasing amount on R&D. However, Business Week (1976) reported that real R&D by industry actually declined by 12% for the decade 1965-75. The outlay for industrial research in 1968 was \$21.1 billion in constant dollars and did not exceed that amount until 1978, when the amount was \$22 billion (Business Week, 1980). Such a state of affairs indicates that there were circumstances, other than the corporation's inherent need to survive as an entity, which were influencing management's decisions on R&D.

Many reasons have been given for this decrease in industrial R&D. One reason is that management became extremely cautious and unwilling to spend large amounts on R&D which could help future profitability but gain nothing for the current year's income (Business Week, 1976). Alfred

Rappaport (Business Week, 1978) stated that one reason why the U.S lagged in R&D was because executive compensation systems were based on short-term earning results.

However, Business Week (1984) reports that R&D spending has rebounded and continues its steady climb. They report that companies in their study have, since the late 1970s, increased their R&D at a rate which outran inflation by about 6%. While a multitude of factors played a part in this rebound, it is possible that the adoption of performance plans was a major factor.

This concludes a brief evaluation of R&D which is the other variable in this research. The next chapter develops a theory associating adoption of performance plans with management's resource allocation decision regarding R&D.

## CHAPTER 5

### THE HYPOTHESIS

As was discussed in chapter 2, a comprehensive normative theory of executive incentive compensation has not yet been developed, nor is it the purpose of this research to undertake such an ambitious task. This research only proposes to put forth a positive theory of incentive compensation which if found to be valid may, along with other similar positive theories, permit future development of a comprehensive normative theory of executive incentive compensation. The positive question investigated here is if the adoption of performance plans is associated with managerial behavior in the form of increased R&D expenditures.

#### 5.1 The General Hypothesis

Smith and Watts (1982) state that the incentive provisions of executive compensation plans should lessen the divergence of interests between corporate executives and stockholders and induce executives to maximize the value of the company in the long-run. In addition, R&D has been established as a vital ingredient in maximizing the



company's value over the long-run. Therefore, the effect that the introduction of performance plans have on management behavior and in turn their expenditure on R&D is a subject of interest to researchers and designers of management compensation packages.

Performance plans are more successful than bonus and stock option plans in lessening the divergence of interests between corporate executives and stockholders. They are superior to bonus plans because they are more successful in alleviating the impact of the "risk aversion" and "horizon" problems.

The "risk aversion" problem occurs when executives are compensated via a fixed salary without any regard to the increase in value of the company. While bonus does represent incentive compensation in addition to a fixed salary, it is a short-term compensation plan and it encourages the selection of low-risk and even negative NPV projects instead of high-risk, high-return, positive NPV projects. Therefore, use of bonus plans as an incentive compensation scheme could result in a decline of expected cash flows and value of the company. On the other hand, performance plans are long-term plans and executives have an incentive to select high-risk, high-return R&D projects since they can expect to benefit from the success of these risky R&D efforts.

The "horizon" problem occurs because an executive would normally be rewarded for his contribution to the company's success only while in the employ of the company. This could induce him to turn down projects with positive NPV but long payback periods. These projects might result in cash inflows after he has left the company whereas the cash outflows would be incurred in the near term. Bonus plans suffer from this problem though many companies have recently started deferring bonus payments in order to keep executives interested in the long-term. On the other hand, awards under performance plans accrue after the completion of an award period of three to six years. In addition, most companies with performance plans have a forfeiture clause so that executives leaving before completion of the award period are entitled to nothing. Such conditions, under most performance plans, are expected to expand an executive's decision horizon and induce him to take long-range actions (e.g., increasing R&D) in order to maximize the value of the company.

Performance plans are superior to stock options because they lessen an executive's risk-avoiding behavior. Kaplan (1982) states that stock options could reinforce an executive's risk-avoiding behavior since he would have both, his human capital (i.e., the discounted present value of his future compensation) and non-human capital (i.e., his stock in the company) tied to the same company. On the

other hand, a performance plan would only tie in an executive's human capital to the future of the company whereas his non-human capital (i.e. stock in the company or cash) could be used to diversify his risk. In addition, corporate executives should prefer performance plans over stock options since performance plans evaluate the company's performance on the basis of accounting numbers over which they have more control. Stock options depend on the haphazard nature of the stock market.

Thus performance plans are expected to be more successful in reducing the divergence of interests between corporate executives and stockholders and their adoption should encourage increased expenditures on R&D. The general hypotheses are formulated as follows:

Ho: The adoption of a performance plan by a company will not be associated with a significant change in the level of its R&D for the period subsequent to the adoption of such a performance plan.

Ha: The adoption of a performance plan by a company will be associated with a significant growth in the level of its R&D for the period subsequent to the adoption of such a performance plan.

## 5.2 The Operational Hypotheses

This subsection is concerned with the development of the operational hypotheses to be statistically tested. First, measurement of the growth in R&D is discussed. Then,

operational hypotheses are constructed for each separate measurement.

#### 5.2.1 Measurement of R&D

The growth of R&D can be examined from two viewpoints. First, the growth of R&D can be studied in absolute terms (i.e., the dollar changes in R&D levels between years). Second, growth can be studied in relative terms (i.e., growth in the ratio of R&D to Sales). Using growth in the ratio of R&D to Sales, in addition to the growth in R&D, is useful for several reasons. First, it allows for additional control for the size effect. Second, the ratio of R&D to Sales reflects management's commitment to R&D activity (i.e., its research intensity) since it is willing to set aside a certain percentage of its sales dollar each year.

Both measures are used to test the hypotheses examined by this research, since each acts as a control for the other. For example, a decrease in R&D with a proportionately larger sales decrease (possibly due to a labor strike) would show the ratio of R&D to Sales to have increased. This would indicate an increase in the company's research intensity, although R&D expenditures were lower that year. On the other hand, an increase in R&D accompanied by a proportionately larger increase in sales

would show that R&D expenditures have increased. However, research intensity (i.e., the ratio of R&D to sales) would have declined inspite of the increase in the R&D expenditures.

#### 5.2.2 Hypothesis for the growth in R&D expenditures

This hypothesis examines if there is an association between performance plan adoption and growth in R&D expenditures.

The pre-adoption period consists of three years immediately preceding the year of adoption of the performance plans. The post-adoption period consists of the first three years of operation of the performance plans. The R&D data for the pre and post adoption periods for each company will be averaged to compute the pre-adoption average R&D and the post-adoption average R&D respectively. Throughout the remainder of this manuscript, growth in R&D is defined as the percentage increase (decrease) in a company's post-adoption average R&D as compared to it's pre-adoption average R&D. Growth in R&D can also be explained as follows:

- a. Pre-adoption average      =  $(RD1 + RD2 + RD3)/3$
- b. Post-adoption average    =  $(RD4 + RD5 + RD6)/3$
- c. Growth in R&D              =  $(b - a)/a$

where for example, RD1 = R&D expenditure in year 1

The averaging process is preferred to one year pre and post adoption periods since it, "...reduces the level of noise in the measure due to random fluctuation from year to year." (Elliott et. al., 1984; p. 88). Further, the averaging process permits the observation of two additional years of ex-post results. On the other hand, the averaging process could remove relevant non-random fluctuations. (Elliott et. al., 1984).

The operational hypotheses, also expressed in symbol form in Table 5.1, are as follows:

- Ho: The adopting companies' growth in R&D will not be significantly different than the non-adopting companies' growth in R&D.
- Ha: The adopting companies' growth in R&D will be significantly larger than the non-adopting companies' growth in R&D.

This research expects to reject the null and conclude that the adopting companies' growth in R&D is significantly larger than the non-adopting companies' growth in R&D.

Table 5.1

## Operational Hypothesis: R&amp;D Expenditures

---



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|            |             |     |              |
|------------|-------------|-----|--------------|
| $H_{O,1}:$ | $DIFF_{AD}$ | $=$ | $DIFF_{NAD}$ |
| $H_{A,1}:$ | $DIFF_{AD}$ | $>$ | $DIFF_{NAD}$ |

---

where,

$$DIFF_{AD} = \frac{1}{n} \sum_{i=1}^n \{ (AD_{i,a} - AD_{i,b}) / (AD_{i,b}) \} / n$$

$$DIFF_{NAD} = \frac{1}{n} \sum_{i=1}^n \{ (NAD_{i,a} - NAD_{i,b}) / (NAD_{i,b}) \} / n$$

$AD_{i,j}$  = average amount of R&D incurred by adopting company  $i$  in period  $j$ .

$NAD_{i,j}$  = average amount of R&D incurred by the company matched against company  $i$  in period  $j$ .

$j$  =  $a$ , first three years of operation of the performance plan.

$b$ , three years before the year of adoption of the performance plan.

$n$  = number of matched pairs.

### 5.2.3 Hypothesis for growth in the ratio of R&D to Sales

This hypothesis examines if there is an association between performance plan adoption and growth in the ratio of R&D to Sales for the adopting companies. The terms pre-adoption period, post adoption period and growth of R&D defined in section 5.2.2 are equally applicable here. The operational hypotheses, also expressed in symbol form in Table 5.2, are as follows:

Ho: The adopting companies' growth in the ratio of R&D to Sales will not be significantly different than the non-adopting companies' growth in the ratio of R&D to Sales.

Ha: The adopting companies' growth in the ratio of R&D to Sales will be significantly larger than the non-adopting companies' growth in the ratio of R&D to Sales.

This research expects to reject the null concluding that growth in the ratio of R&D to Sales of adopting companies is significantly greater than growth in the ratio of R&D to Sales for non-adopting companies.

### 5.3 Assumptions of the research

To conclude, this research makes the following three assumptions. First, it assumes that executives responsible for determining the level of R&D are risk averse. Second, using R&D could cause measurement problems



Table 5.2

**Operational Hypothesis: Ratio of R&D  
Expenditures to Sales**

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---

|            |               |   |                |
|------------|---------------|---|----------------|
| $H_{0,2}:$ | $\%DIFF_{AD}$ | = | $\%DIFF_{NAD}$ |
| $H_{A,2}:$ | $\%DIFF_{AD}$ | > | $\%DIFF_{NAD}$ |

---

where,

$$\%DIFF_{AD} = \frac{\sum_{i=1}^n \{(\%AD_{i,a} - \%AD_{i,b}) / (\%AD_{i,b})\}}{n}$$

$$\%DIFF_{NAD} = \frac{\sum_{i=1}^n \{(\%NAD_{i,a} - \%NAD_{i,b}) / (\%NAD_{i,b})\}}{n}$$

$\%AD_{i,j}$  = average ratio of R&D to sales for adopting company i in period j.

$\%NAD_{i,j}$  = average ratio of R&D to sales for the company matched against company i in period j.

j = a, first three years of operation of the performance plan.

b, three years before the year of adoption of the performance plan.

n = number of matched pairs.

because of certain inherent differences between the matched companies. As Dukes, Dyckman and Elliott (1980) state,

This variable (R&D expenditure) is not totally immune to measurement problems due to firm differences. Examples include differential use of leased assets, contracting of R&D activity, overhead allocation practices, and accounting for technical improvements. Government funding of R&D may also differ in a systematic way, across firms, that biases our comparisons...These issues are raised here so that the reader will be aware of them. We have no reason to expect these firm differences to develop biases in our tests, and thus, these issues are not to be addressed further. (p. 4)

In the absence of a reasonable method of verifying the concerns addressed in the above quote, this research assumes that company differences will not bias the results or will be washed out across the sample.

Finally, any hypothesis regarding association between performance plan adoption and growth of R&D is predicated on the performance plan's influence on R&D growth. However, in reality, it is not known if increased R&D growth is dependent on the adoption of performance plans. The Board of Directors may simultaneously arrive at decisions to adopt performance plans and raise the level of R&D. Larcker (1983) suggests another possible scenario where performance plans might be introduced after raising R&D levels thereby reminding executives that it is in their interest not to neglect R&D.

The next chapter discusses the methodology that is adopted to operationalize the hypotheses constructed in this chapter.

## CHAPTER 6

### METHODOLOGY

This chapter discusses the methodology used to statistically test the operational hypotheses developed in the previous chapter.

#### 6.1 Selection of the Sample

The companies selected for the sample are Fortune 500 manufacturing companies that adopted performance plans in the period 1978-82. The period 1978-82 was chosen to permit collection of R&D data for three years prior to adoption of the plan (i.e., the pre-adoption period) and the first three years of operation of the plan (i.e., the post-adoption period). Frederic W. Cook & Co., Inc., Compensation Consultants provided the list of names of 81 companies, disclosed in Appendix A.

Of these 81 companies, 34 companies were removed from the final sample for a variety of reasons, including non-availability of R&D data, inconsistent R&D data due to restatement etc.. Appendix B lists the 81 companies initially considered and provides explanations for the exclusion of 34 companies. The remaining 47 companies were

included in the final sample and were matched against control or non-adopting companies (i.e. companies that had not adopted the performance plan) on the basis of the following criteria:

#### 6.1.1 Matching on Industry SIC codes

SIC code matching was completed to avoid inter-industry differences in R&D expenditures. For example, Baker (1983) states that the largest R&D investment is in the automobile industry whereas petrochemicals and fuel industries place eighth and ninth respectively. On the other hand, Mansfield (1968) points out that some industries have a larger ratio of R&D to Sales than do other industries.

The adopting and non-adopting companies were matched on the basis of industry by comparing their 2 digit SIC codes (Table 6.1). The primary SIC codes for companies with fiscal years ending on or before December 31, 1980 were, for the most part, extracted from Ward's Directory of 55,000 Largest U.S. Corporations (1981 Edition). The exceptions occurred when a company's SIC code was 3981 (i.e. diverse conglomerates) in which case other sources were used. For companies whose fiscal years ended after January 1, 1981, the primary and secondary SIC codes were extracted from Ward's Directory of 51000 Largest U.S. Corporations (1984 Edition).

**Table 6.1**

| Company<br>(Adopting/non-adopting)   | Year of<br>adoption | Year of<br>operation | SIC codes<br>AD NON | Sales (\$million \$)<br>AD NON | FF used for switch<br>AD NON | Beta<br>AD NON | AB as a ratio of AD<br>Sales Beta |
|--------------------------------------|---------------------|----------------------|---------------------|--------------------------------|------------------------------|----------------|-----------------------------------|
| 1 A. E. Staley/Cellego               | 1978-80             | 1979-80              | 2045                | 2043                           |                              |                |                                   |
| 2 Allied Corp/Mobilization           | 1980                | 1980                 | 1311                | 1389                           |                              |                |                                   |
| 3 Armstrong Rubber/Goodyear Tire     | 1981-82             | 1981-82              | 3011, 2622          | 3011, 3049                     |                              |                |                                   |
| 4 Amstar Bt/DSMB                     | 1978-79             | 1978-79              | 2911                | 2911                           |                              |                |                                   |
| 5 Baxter International/Fisher Plough | 1982                | 1982                 | 2834, 3531          | 2834, 2844                     |                              |                |                                   |
| 6 Black & Veatch/Baker Int'l. Corp.  | 1979-80             | 1979-80              | 2546                | 2533                           |                              |                |                                   |
| 7 Bristol Myers/Sloan Products       | 1978                | 1978                 | 2044                | 2044                           |                              |                |                                   |
| 8 Brown/B&B                          | 1978                | 1978                 | 3901, 3319          | 3901, 3359                     |                              |                |                                   |
| 9 Brunswick/SEC                      | 1982                | 1982                 | 3373, 3374          | 3373, 3361                     |                              |                |                                   |
| 10 Ciba-Geigy/Merck & Co.            | 1980                | 1980                 | 2823                | 2823                           |                              |                |                                   |
| 11 Cincinnati Milacron/Hordell       | 1979                | 1979                 | 3541                | 3544                           |                              |                |                                   |
| 12 Combustion Eng/RHHeite            | 1978                | 1978                 | 3403                | 3421                           |                              |                |                                   |
| 13 Cooper Industries/Coram           | 1979                | 1979                 | 3423                | 3499                           |                              |                |                                   |
| 14 Cooper Labs/ICI Pharmaceuticals   | 1977-78             | 1978-79              | 2834                | 2834                           |                              |                |                                   |
| 15 Corning Glass/Warner              | 1979                | 1979                 | 3279                | 3291                           |                              |                |                                   |
| 16 Cummins Engine/Mills Choblers     | 1980                | 1980                 | 3519                | 3511                           |                              |                |                                   |
| 17 Delco/Genl/Ray Lub                | 1978-79             | 1978-79              | 3573                | 3573                           |                              |                |                                   |
| 18 Diamond Shamrock/Ethyl Corp.      | 1980                | 1980                 | 2812                | 2819                           |                              |                |                                   |
| 19 Easton Steel/Johnson & Johnson    | 1982                | 1982                 | 3641, 3643          | 3642, 3634                     |                              |                |                                   |
| 20 Edco/ProPack                      | 1981                | 1981                 | 2614, 2622          | 2614, 2713                     |                              |                |                                   |
| 21 Ferrovia Chemical                 | 1982                | 1982                 | 2899, 2816          | 2893, 2851                     |                              |                |                                   |
| 22 General Mills/Carrollton          | 1979-80             | 1979-80              | 2043                | 2023                           |                              |                |                                   |
| 23 General Motors/Ford               | 1982                | 1982                 | 3711, 3714          | 3711, 3714                     |                              |                |                                   |
| 24 Hershey Foods/Horant              | 1978                | 1978                 | 2046                | 2011                           |                              |                |                                   |
| 25 Honeywell/Alitton                 | 1978                | 1978                 | 3901, 3373          | 3901, 3373                     |                              |                |                                   |
| 26 Illinois Tool Works/Blount Barcor | 1980                | 1980                 | 3349                | 3349                           |                              |                |                                   |
| 27 Koppers/Kaiser Aluminum           | 1979                | 1979                 | 3312                | 3331                           |                              |                |                                   |
| 28 Macmillan/O.S. Byrnes             | 1978                | 1978                 | 3296                | 3275                           |                              |                |                                   |
| 29 Merck/Johnson                     | 1982                | 1982                 | 2833, 2834          | 2834, 2821                     |                              |                |                                   |
| 30 Monsanto Mining/TIM               | 1981                | 1981                 | 3901, 3291          | 3901, 3579                     |                              |                |                                   |
| 31 NCR/Beere                         | 1982                | 1982                 | 3374, 3379          | 3323, 3331                     |                              |                |                                   |
| 32 R. M. Industrial/Chalmerger       | 1978                | 1978                 | 3901, 1389          | 3901                           |                              |                |                                   |
| 33 Richard/Levy Indl.                | 1980                | 1981                 | 3441                | 3441                           |                              |                |                                   |
| 34 Robert's Marine/Biggs & Stralen   | 1981-82             | 1981-82              | 3019, 3234          | 3019, 3279                     |                              |                |                                   |
| 35 Sales Consulting/Libby Beans Ford | 1980                | 1980                 | 3296                | 3219                           |                              |                |                                   |
| 36 Phillips Petroleum/Cities Service | 1978                | 1978                 | 1311                | 1311                           |                              |                |                                   |
| 37 Reiter Belts/Int'l. Multilinks    | 1978-79             | 1978-79              | 3642                | 3641                           |                              |                |                                   |
| 38 Renner/Difran                     | 1981-82             | 1981-82              | 3546, 3332          | 3542, 3312                     |                              |                |                                   |
| 39 Sanders Associates/Tracer         | 1979-80             | 1979-80              | 3642                | 3642                           |                              |                |                                   |
| 40 Sealed Air/USC Inc., Inc.         | 1978                | 1978                 | 3972                | 3981                           |                              |                |                                   |
| 41 Shell/Standard Oil (Indiana)      | 1979                | 1979                 | 2911                | 2911                           |                              |                |                                   |
| 42 Tecon/Instron                     | 1980                | 1981                 | 3711, 1311          | 2911, 1311                     |                              |                |                                   |
| 43 Teco Instruments/Amytheon         | 1979                | 1980                 | 3574                | 3563                           |                              |                |                                   |
| 44 Tetra Tech                        | 1982                | 1982                 | 3901, 3771          | 3901, 3779                     |                              |                |                                   |
| 45 United Technologies/Boeing        | 1979                | 1979                 | 3779                | 3779                           |                              |                |                                   |
| 46 Warner Lambert/Calgate Palmolive  | 1982                | 1982                 | 2834, 2831          | 2841, 2844                     |                              |                |                                   |
| 47 Westphalen/SEA                    | 1979                | 1979                 | 3621                | 3621                           |                              |                |                                   |

Mean  
Std. Dev.  
0.21  
0.09

AD = Adopting companies  
NON = Non-adopting companies

(1) **Non-occupancy** = Non-occupancy  
 (2) **Building occupancy** = Building occupancy

### 6.1.2 Matching on size

The adopting and non-adopting companies were matched on size to alleviate inter-company differences within the same industry. Dean and Goldhar (1980) suggest that company size is the most important determinant affecting the R&D budget. Link (1981) states, "Firm size is a prerequisite for successful R&D activity. Larger firms earn, at the margin, a relatively larger rate of return on their R&D expenditures than do smaller firms." (p. 92). Mansfield (1968) states that there is a tendency for companies to maintain a steady and constant ratio of R&D to Sales in the short run. However, they do change the ratio over the long-run in response to changes in the prospective profitability of R&D. Therefore, sales were chosen as the surrogate for size.

The sales dollar amounts were obtained from the Valueline Investment Surveys, Ratings and Reports. The matching was done on the basis of sales in the year of adoption of the performance plan. The year of adoption for a company was the fiscal year during which stockholder approval to the plan was sought. In cases where there was no mention in the proxy that stockholder approval was needed, the year of adoption was the fiscal year in which the Board of Directors approved the plan. The company's fiscal year was emphasized instead of the calendar year to avoid confusion in cases where the fiscal year ended on a

date other than December 31. For example, a company with fiscal year ended September 30, 1982 could have sought stockholder approval via a proxy dated December 21, 1982. In such a case, the year of adoption could be represented as 1982 which would indicate the year ended September 30, 1982. However, the correct year of adoption would be the year ended September 30, 1983.

The year of adoption of the performance plan for four out of 47 companies preceded the first year of operation of the performance plan (Table 6.1). In these cases, the match on sales occurred in the year of adoption. For the remaining 43 companies, the year of adoption coincided with the first year of operation of the performance plan and the match on sales occurred in the year preceding the year of adoption.

Table 6.1 shows that the ratio of the adopting company's sales to that of its matched non-adopting company is within the range 0.50 - 2.00 for all but one case. The mean of all sales ratios is 1.12 with a standard deviation of 0.40 indicating on average that adopting companies were slightly larger than non-adopting companies.

#### 6.1.3 Matching on risk

The adopting and non-adopting companies were matched on risk because R&D projects are typically high-risk, high-reward projects. The matching on risk was



expected to alleviate the inter-company differences within the same industry. The surrogate selected for risk was the security market beta. Foster (1978) submits evidence regarding the correlation of the security market beta with the firm's capital structure, its operating leverage, its operating risk and accounting variables such as earnings variability, dividend payout ratio, growth, size, liquidity etc.. Hence, matching on risk was expected to allow additional control that was not provided by matching on size and industry.

The betas were extracted from the Valueline Investment Surveys, Ratings and Reports for the second quarter following the company's year-end. For example, the betas for two companies with fiscal years ending November 30, 1981 and December 31, 1981 would be extracted from the Survey for the second quarter of 1982. The second quarter following the fiscal year-end was chosen in order to allow the market adequate time to obtain all relevant information about the companies' operations for the recently completed year. The years were selected for matching purposes in a manner similar to that outlined in section 6.1.2.

Table 6.1 shows that the ratio of the adopting company's beta to that of its matched non-adopting company is within the range 0.67 - 1.50 for all but one case. The mean of all ratios of betas is 1.07 with a standard deviation of 0.21.

#### 6.1.4 Matching on fiscal year-end

The adopting and non-adopting companies have fiscal years that end near each other to alleviate the problems associated with changing events (i.e., history) and learning or maturation. Table 6.1 shows that, of the 47 companies that were matched, 31 had the same fiscal year-end, 11 had fiscal years ending within 3 months of each other and the remaining five had fiscal years ending within 4-6 months of each other.

#### 6.2 The Experimental Design

The experimental design chosen for this experiment is a variation of designs that Abdel-khalik and Ajinkya (1979) call "The Interrupted Time-Series Design" and Campbell and Stanley (1963) call "The Multiple Time-Series Design." Section 6.1.2 pointed out that the year of adoption preceded the first year of operation for only four out of 47 adopting companies. The year of adoption for the remaining 43 companies in the sample coincided with the first year of operation of the performance plan. The design for the first four companies is shown in Table 6.2 whereas the design for the remaining 43 companies is shown in Table 6.3.

The strength of any experimental design is dependent on how carefully it circumvents violations of internal and external validity. As Kerlinger (1973)

Table 6.2

**The Experimental Design**  
**(Year of adoption precedes**  
**first year of operation)**

| <u>Year</u>            | <u>-3</u> | <u>-2</u> | <u>-1</u> | <u>0</u> | <u>+1</u> | <u>+2</u> | <u>+3</u> |
|------------------------|-----------|-----------|-----------|----------|-----------|-----------|-----------|
| Adopting companies     | 0         | 0         | 0         | X        | 0         | 0         | 0         |
| Non-adopting companies | 0         | 0         | 0         |          | 0         | 0         | 0         |

where,

X = treatment or intervention (i.e., the adoption of the performance plan in year 0 which precedes the first year of operation of the plan)

0 = observations or data collected (i.e., R&D expenditures or ratio of R&D expenditures to Sales)

Table 6.3

**The Experimental Design**  
**(Year of adoption coincides with**  
**first year of operation)**

| <u>Year</u>            | <u>-3</u> | <u>-2</u> | <u>-1</u> | <u>+1</u> | <u>+2</u> | <u>+3</u> |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Adopting companies     | 0         | 0         | 0         | X0        | 0         | 0         |
| Non-adopting companies | 0         | 0         | 0         | 0         | 0         | 0         |

where,

- X = treatment or intervention (i.e., the adoption of the performance plan in year +1 which is the first year of operation of the plan)
- 0 = observations or data collected (i.e., R&D expenditures or ratio of R&D expenditures to Sales)

suggests, internal validity is concerned with the question, "...Did X, the experimental manipulation, really make a significant difference?" (p. 325). Campbell and Stanley (1963) mention eight extraneous variables that might produce confounding effects. Analyzing the possible violations, it is noted that testing, regression, reactivity, mortality and instrumentation cause no problems since this research does not deal in pre-testing etc. of live subjects. History and maturation problems are avoided by selecting well-matched companies so that the impact of history and maturation would evenly affect the adopting and non-adopting companies.

The most important threat to internal validity is the self-selection bias and its interaction with the maturation variable. Kerlinger (1973) states that the self-selection bias could occur in experiments where it is not possible to assign subjects to groups at random or to assign treatments to the groups randomly. Kerlinger (1973) adds, "The subjects can 'assign themselves' to groups, can 'select themselves' into the groups on the basis of characteristics other than those in which the investigator may be interested." (p. 381). Unfortunately, self-selection is a potential problem with all such empirical studies and it could prevent a conclusion that the impact on the dependent variable was caused solely by the independent variable.

On the other hand, external validity is concerned with the representativeness or generalizability of the results. Violations of external validity affect the treatment whereas violations of internal validity affect the observations. According to Campbell and Stanley (1963), threats to external validity are interaction effects involving the treatment and some other variable. There could be a multitude of violations. For example, there could be a possible interaction between testing and treatment (i.e., sensitizing the subjects in pre-tests) which is not applicable here because this research does not use live subjects. There could also be a possible interaction between history and the adoption of the performance plan. This again is not applicable since there was no particular event in the period under study, as compared to any other period, which made the adoption of performance plans more likely. For example, Table 6.1 shows that the number of companies in the sample that adopted performance plans in the years 1978-82 were 12, 9, 11, 3 and 12 respectively. It is difficult to attribute any specific reason why only three companies adopted plans in 1981. An important possible interaction is the one between selection and treatment. This violation is possible since this study has potential problems with self-selection bias anyway.

### 6.3 Statistical Tests

A nonparametric test, the Wilcoxon Matched-Pairs, Signed-Ranks Test is chosen because it is appropriate for experiments involving matched pairs. As Siegel (1956) suggests, this test utilizes information about the direction and magnitude of the difference between pairs as compared to the Sign test which only utilizes information about the direction of the differences.

The Wilcoxon test is appropriate for large and small samples. Since this research has a total of 47 matched pairs, the Wilcoxon test is appropriate as its distribution becomes practically normal for sample sizes greater than 25. However, the Wilcoxon test is less powerful than the t-test for large samples and hence t-test is chosen as a back-up for large samples. On the other hand, the Wilcoxon test is also appropriate for sample sizes below 25 and can be used to test alternate hypotheses requiring smaller samples.

Finally, one-tailed tests are chosen with  $\alpha = 0.05$  since the subject of interest is to ascertain if growth in R&D and ratio of R&D to Sales for adopting companies is significantly greater than that for non-adopting companies and not vice-versa.

#### 6.4 Collection of data

The data on R&D expenditures and the ratio of R&D to Sales for the 47 matched pairs was collected and computed for the pre-adoption and post-adoption periods of three years each from the Compustat and Valueline Databases. In case of a conflict or absence of updated R&D data, the appropriate annual reports and/or 10K statements were examined. Tables 6.4 (R&D expenditures) and 6.5 (Ratio of R&D to Sales) display the following: R&D and ratio of R&D to Sales data for the pre and post-adoption periods, the growth in R&D and ratio of R&D to Sales for the portfolios of adopting and non-adopting companies and the differences in growth in R&D and ratio of R&D to Sales for the portfolios of adopting and non-adopting companies.

This concludes a review of the methodology used to obtain the results. The next chapter examines the results of the tests performed.



Table A.1  
R&D EXPENDITURES

| Company                 | Applying Companies |         |         |        | Non-applying Companies |         |         |        | Difference |
|-------------------------|--------------------|---------|---------|--------|------------------------|---------|---------|--------|------------|
|                         | Year -3            | Year -2 | Year -1 | Year 0 | Year -3                | Year -2 | Year -1 | Year 0 |            |
|                         | (1)                | (2)     | (3)     | (4)    | (10)                   | (11)    | (12)    | (13)   |            |
| 1 A.E. Waterfalling     | 4.89               | 5.38    | 4.19    | 3.49   | 5.39                   | 4.99    | 4.49    | 4.49   | 22.28      |
| 2 Allied Chemicals      | 55.42              | 57.92   | 76.28   | 68.51  | 105.08                 | 122.08  | 106.08  | 102.47 | 31.77      |
| 3 Eastman Kodak Company | 5.38               | 5.79    | 4.27    | 18.13  | 12.34                  | 11.28   | 77.45   | 77.45  | 5.97       |
| 4 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 5 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 6 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 7 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 8 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 9 Inland Petroleum      | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 10 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 11 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 12 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 13 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 14 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 15 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 16 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 17 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 18 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 19 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 20 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 21 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 22 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 23 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 24 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 25 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 26 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 27 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 28 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 29 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 30 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 31 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 32 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 33 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 34 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 35 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 36 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 37 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 38 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 39 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 40 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 41 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 42 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 43 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 44 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 45 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 46 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 47 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 48 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 49 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |
| 50 Inland Petroleum     | 4.27               | 4.27    | 4.27    | 4.27   | 4.27                   | 4.27    | 4.27    | 4.27   | 5.97       |

R&amp;D expressed in millions of dollars

Table 4-3

RATIO OF RISK-ADJUSTED RETURNS TO SALES

| Companies<br>(Mapping to row-adapted) | Adapting Capabilities |                |                |                | Non-adapting Capabilities |                 |                 |                 | Difference<br>(10)-(11)-(12)-(13) |
|---------------------------------------|-----------------------|----------------|----------------|----------------|---------------------------|-----------------|-----------------|-----------------|-----------------------------------|
|                                       | Year -3<br>(1)        | Year -2<br>(2) | Year -1<br>(3) | Average<br>(4) | Year -3<br>(10)           | Year -2<br>(11) | Year -1<br>(12) | Average<br>(13) |                                   |
| 1 E. I. du Pont de Nemours & Co.      | 1.83                  | 1.47           | 1.42           | 1.54           | 0.26                      | 0.32            | 0.42            | 0.33            | -17.18                            |
| 2 Allied Chemical Corp.               | 1.32                  | 1.04           | 1.42           | 1.26           | 0.26                      | 0.42            | 0.72            | 0.44            | -10.48                            |
| 3 Eastman Kodak Corp.                 | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 4 Baxter International Inc.           | 5.94                  | 6.18           | 6.26           | 6.26           | 5.46                      | 5.46            | 5.46            | 5.46            | -1.17                             |
| 5 Eastman Chemical Corp.              | 5.94                  | 6.18           | 6.26           | 6.26           | 5.46                      | 5.46            | 5.46            | 5.46            | -1.17                             |
| 6 Hook & Russell Chemical Corp.       | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 7 Eastman Chemical Corp.              | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 8 Eastman Chemical Corp.              | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 9 Eastman Chemical Corp.              | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 10 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 11 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 12 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 13 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 14 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 15 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 16 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 17 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 18 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 19 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 20 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 21 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 22 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 23 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 24 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 25 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 26 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 27 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 28 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 29 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 30 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 31 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 32 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 33 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 34 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 35 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 36 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 37 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 38 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 39 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 40 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 41 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 42 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 43 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 44 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 45 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 46 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |
| 47 Eastman Chemical Corp.             | 1.45                  | 1.41           | 1.36           | 1.41           | 1.07                      | 1.20            | 1.49            | 1.23            | -20.38                            |

## CHAPTER 7

### THE RESULTS

The operational hypotheses formulated in chapter 5 for R&D (ratio of R&D to Sales) are as follows:

- Ho: The adopting companies' growth in R&D (ratio of R&D to Sales) will not be significantly different than the non-adopting companies' growth in R&D (ratio of R&D to Sales).
- Ha: The adopting companies' growth in R&D (ratio of R&D to Sales) will be significantly larger than the non-adopting companies' growth in R&D (ratio of R&D to Sales).

As discussed in Chapter 6.3, the nonparametric Wilcoxon Matched-Pairs, Signed-Ranks test and the parametric t-test were to be used to ascertain if the null hypothesis was rejected at an one-tailed  $\alpha = 0.05$ . The results of these tests follow.

#### 7.1 The Wilcoxon test on R&D Expenditures

The Wilcoxon test was performed on the differences in R&D growth between the portfolios of adopting and non-adopting companies. Table 7.1 shows that the sum of the ranks of negative R&D growth differences (i.e., where the non-adopting companies' R&D growth exceeds that of adopting

Table 7.1  
THE WILCOXON TEST ON R&D EXPENDITURES

| Company                              | A       | B       | C      | D  |
|--------------------------------------|---------|---------|--------|----|
| 1 A. C. Gilbert/elling               | -22.34  | -702.14 | 352.14 | 47 |
| 2 Allied Corp/Halliburton            | 31.77   | -42.43  | 152.43 | 44 |
| 3 Armstrong Rubber Company/Tire      | 11.44   | -42.43  | 152.43 | 42 |
| 4 B. F. Goodrich/Goodrich            | 22.37   | -42.43  | 152.43 | 40 |
| 5 Baker Vermeer/Baker Vermeer Pump   | 22.37   | -42.43  | 152.43 | 40 |
| 6 Black & Veatch/Black Int'l. Corp   | -74.26  | -79.45  | 79.45  | 39 |
| 7 Bristol Perfection Products        | -32.49  | -74.26  | 74.26  | 38 |
| 8 Burt's Candy Co./Burt's Candy Co.  | -42.43  | -74.26  | 74.26  | 37 |
| 9 Burroughs/DEC                      | -42.43  | -74.26  | 74.26  | 37 |
| 10 Calumet/Mercedes Inc.             | -36.44  | -50.19  | 51.17  | 35 |
| 11 Cincinnati Milacron/Milacron      | -7.14   | -42.49  | 42.49  | 34 |
| 12 Cooper Industries/Cooper          | 123.74  | -32.49  | 32.49  | 33 |
| 13 Cooper Industries/Cooper          | 123.74  | -32.49  | 32.49  | 33 |
| 14 Cooper Labs/CD Pharmaceuticals    | 123.74  | -32.49  | 32.49  | 33 |
| 15 Corning/Bausch & Lomb             | -36.44  | -50.19  | 51.17  | 35 |
| 16 Corning/Bausch & Lomb             | -36.44  | -50.19  | 51.17  | 35 |
| 17 Helipoint/Helipoint               | -252.14 | -25.26  | 25.26  | 17 |
| 18 Helipoint/Helipoint               | -252.14 | -25.26  | 25.26  | 17 |
| 19 Helipoint/Helipoint               | -252.14 | -25.26  | 25.26  | 17 |
| 20 Helipoint/Helipoint               | -252.14 | -25.26  | 25.26  | 17 |
| 21 Ferrel/Chemical                   | -76.55  | -15.15  | 15.15  | 11 |
| 22 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 23 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 24 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 25 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 26 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 27 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 28 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 29 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 30 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 31 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 32 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 33 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 34 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 35 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 36 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 37 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 38 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 39 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 40 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 41 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 42 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 43 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 44 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 45 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 46 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |
| 47 General Electric/General Electric | 8.29    | -7.76   | 7.76   | 5  |

Index:

- A = Difference in growth of R&D between adopting and non-adopting companies (column 19 of Table 4.4).
- B = Difference in growth of R&D between larger R&D growth for a non-adopting company as compared to its adopted company and vice-versa.
- C = Column A serial in ascending order.
- D = Median value for the assets in column B.
- E = Median value in column C ranked in ascending order.
- F = Size of the ratio of supplier assets in column B.
- G = Number of adopted pairs.

1 = S.M. model parallel rejection of  $H_0$  at alpha = 0.05 (11,800 = 0.2504). However, since the test is asymptotic and sample size is not infinite.

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon test is computed as follows:

$$T = \frac{1}{2} \left( \frac{1}{n} \sum_{i=1}^n (R_i - \frac{1}{2}(n+1)) \right) = \frac{1}{2} \left( \frac{1}{n} \sum_{i=1}^n R_i - \frac{1}{2}(n+1) \right)$$

0.44

74.26

425

544

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

0.44

74.26

companies) exceeds the mean of the ranks. This is confirmed in Figures 7.1 and 7.2 which are based on the information contained in Table 7.2. Table 7.2 is a trend statement based on the R&D expenditures data in Table 6.4 with year - 3 (i.e., the third year preceding the year of adoption) as the base year and subsequent years expressed as percentages of the base year. Figure 7.1 shows that the non-adopting companies' R&D increased at a faster rate in the post-adoption period than did R&D for the adopting companies. Figure 7.2 shows the negative R&D growth differences increasing substantially in the post-adoption period.

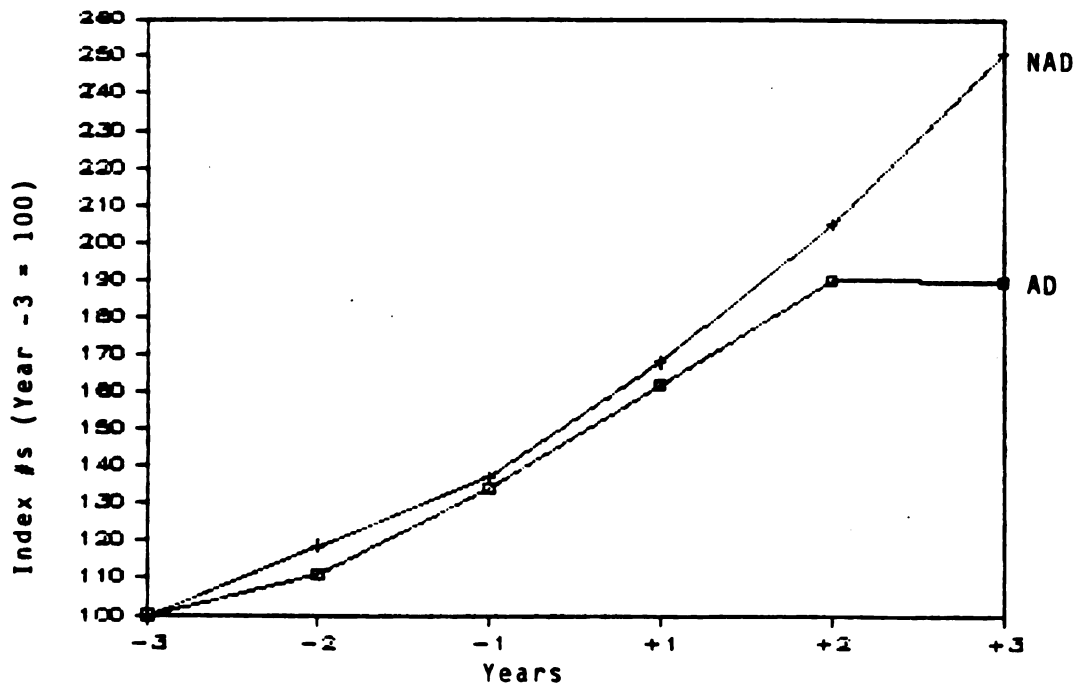
The computed test statistic resulted in the observed significance level of  $\alpha = 0.7454$  as compared to the desired  $\alpha = 0.05$  (Table 7.1). Therefore, the null hypothesis is not rejected. This research concludes that the difference in R&D growth between adopting and non-adopting companies is not significant.

## 7.2 The Wilcoxon test on the ratio of R&D to Sales

The Wilcoxon test was performed on the differences in the growth of the ratio of R&D to Sales between the portfolios of adopting and non-adopting companies. Table 7.3 shows that the sum of the ranks of negative growth differences in the ratio of R&D to Sales (i.e., where the non-adopting companies' growth in ratio of R&D to Sales

Figure 7.1

**Trend Graph for R&D Expenditures  
(Yearly Portfolio Averages)**

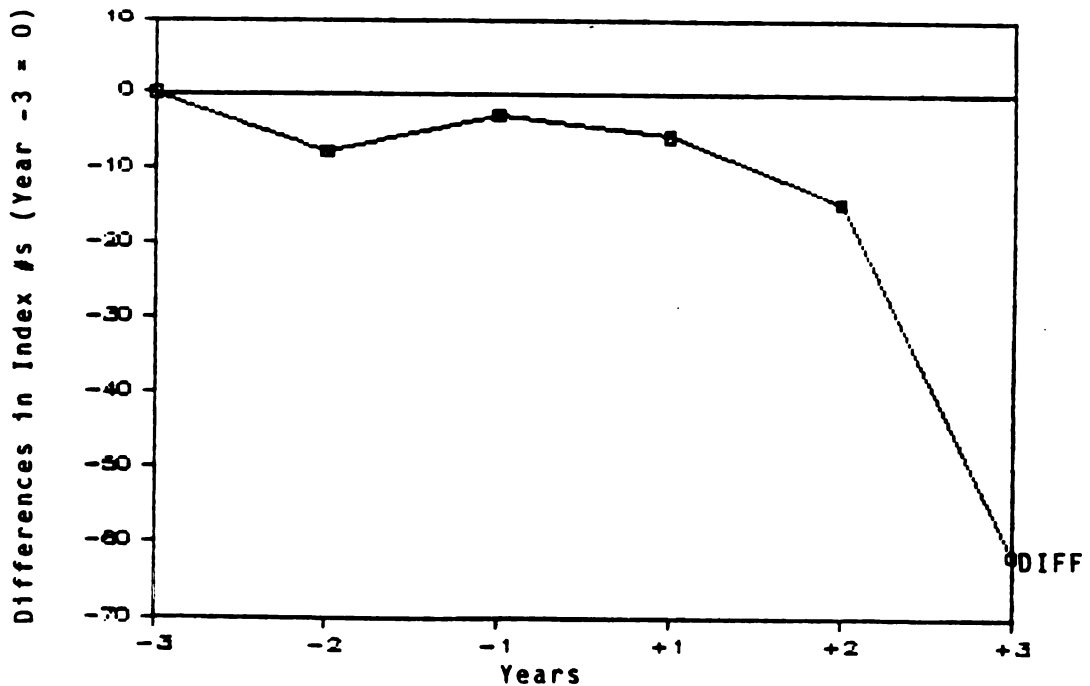


AD = Index #s of yearly average R&D for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 7.2)

NAD = Index #s of yearly average R&D for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 7.2)

Figure 7.2

**Trend Graph for R&D Expenditures**  
**(Differences: Yearly Portfolio Averages)**



$$\text{DIFF} = \text{AD} - \text{NAD}$$

**AD** = Index #s of yearly average R&D for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 7.2)

**NAD** = Index #s of yearly average R&D for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 7.2)





Table 7.3  
THE WILCOXON TEST ON THE RATIO OF R&D EXPENDITURES TO SALES

| Companies<br>(Adopting/non-adopting)  | A      | B      | C     | D  | The Wilcoxon Test:                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------|--------|--------|-------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 A. E. Healey/Kellogg                | -19.16 | -49.00 | 19.00 | 07 | According to Siegel (1956), the Wilcoxon test is computed as follows:<br>$T = \frac{1}{2} \left[ \frac{N(N+1)}{2} - \sum R_i \right]$<br>Bk.d. Dev. $\frac{1}{2} \left[ \frac{N(N+1)}{2} - \sum R_i \right]$<br>$= \frac{645 - 564}{2} = 40$<br>$= 94.50$<br>$z = 0.06$<br>would permit rejection of $H_0$ at $\alpha = 0.001$ (1,0000 - 0.1909). However, $\alpha = 0.05$ is acceptable and hence $H_0$ is not rejected. |
| 2 Allied Corp/Millerton               | -16.46 | -46.37 | 46.37 | 44 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3 Armstrong Rubber/Congo Tire         | 26.30  | -42.61 | 42.61 | 43 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4 Baidar 81/20018                     | 12.06  | -39.37 | 39.37 | 42 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5 Baiter Traveler/Kellogg Plough      | -5.17  | -35.10 | 35.10 | 40 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 6 Black & Decker/Baker Intl. Corp     | 12.16  | -36.23 | 36.23 | 39 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 7 Bristol Myers/Novo Products         | -4.93  | -36.24 | 36.24 | 38 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 8 Brunswick/Edart                     | -8.34  | -34.06 | 34.06 | 37 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9 Burroughs/BEC                       | -26.24 | -31.73 | 31.73 | 36 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 10 Calumet/Mercator Inc.              | -21.73 | -28.34 | 28.34 | 35 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 11 Cincinnati Milacron/Machit         | -26.34 | -19.16 | 19.16 | 34 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 12 Combustion Eng/Millette            | -15.22 | -15.22 | 15.22 | 26 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 13 Cooper Industries/Crow             | 9.33   | -13.03 | 13.03 | 24 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 14 Cooper Labs/ICI Pharmaceuticals    | 26.30  | -12.97 | 12.97 | 23 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15 Corning Glass/Corning              | -2.20  | -11.07 | 11.07 | 20 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16 Cummins Engine/Allis Chalmers      | 30.07  | -10.40 | 10.40 | 19 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 17 Delco/Ram Corp                     | -4.04  | -9.41  | 9.41  | 17 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18 Diamond Shamrock/Allyl Corp        | -25.14 | -8.26  | 8.26  | 15 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 19 Easton Kodak/Danaher & Johnson     | -6.79  | -8.29  | 8.29  | 14 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20 Eaton/Frederick                    | 66.92  | -6.00  | 6.00  | 13 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 21 Ferro/Van Chemical                 | 16.40  | -7.76  | 7.76  | 11 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 22 General Mills/Correlation          | -2.36  | -6.37  | 6.37  | 8  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 23 General Motors/Ford                | 8.40   | -5.17  | 5.17  | 6  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 24 Harley Foods/Barnard               | -20.23 | -3.09  | 3.09  | 5  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 25 Harpeth/Alitex                     | 6.09   | -4.93  | 4.93  | 4  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 26 Illinois Tool Works/Pittman Warner | -7.76  | -2.26  | 2.26  | 3  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 27 Koppers/Kaiser Aluminum            | 13.93  | -2.20  | 2.20  | 2  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 28 Kurlitz/R.S. System                | -24.06 | -0.90  | 0.90  | 1  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 29 Kurlitz/John                       | -3.09  | 3.09   | 3.09  | 7  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 30 Kinsale Mining/IBM                 | -39.37 | 6.40   | 6.40  | 9  |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 31 KOD/Boers                          | -12.59 | 6.09   | 6.09  | 10 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 32 K. Industries/Schlumberger         | -4.00  | 7.97   | 7.97  | 12 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 33 Kuhn/Henry Intl.                   | -42.61 | 8.40   | 8.40  | 16 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 34 Kuhn/Henry Intl.                   | 7.97   | 9.33   | 9.33  | 18 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 35 Kuhn/Henry Intl. & Borden          | 7.97   | 12.06  | 12.06 | 21 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 36 Kuhn/Henry Intl. & Borden          | 26.22  | 12.14  | 12.14 | 22 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 37 Kuhn/Henry Intl. & Borden          | 16.20  | 13.93  | 13.93 | 23 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 38 Kuhn/Henry Intl. & Borden          | -13.03 | 16.40  | 16.40 | 27 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 39 Kuhn/Henry Intl. & Borden          | -46.37 | 16.20  | 16.20 | 28 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 40 Kuhn/Henry Intl. & Borden          | 53.72  | 16.40  | 16.40 | 29 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 41 Kuhn/Henry Intl. & Borden          | -4.57  | 16.40  | 16.40 | 29 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 42 Kuhn/Henry Intl. & Borden          | 6.40   | 16.41  | 16.41 | 30 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 43 Kuhn/Henry Intl. & Borden          | 16.40  | 26.22  | 26.22 | 32 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44 Kuhn/Henry Intl. & Borden          | -4.90  | 26.30  | 26.30 | 33 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 45 Kuhn/Henry Intl. & Borden          | 3.09   | 26.30  | 26.30 | 34 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 46 Kuhn/Henry Intl. & Borden          | -19.00 | 31.07  | 31.07 | 41 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 47 Kuhn/Henry Intl. & Borden          | 16.41  | 46.37  | 46.37 | 44 |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 48 Kuhn/Henry Intl. & Borden          | -11.07 | 53.72  | 53.72 | 45 |                                                                                                                                                                                                                                                                                                                                                                                                                           |

T = 445  
B = 47

Index:

- A = Differences in growth of the ratio of R&D to sales between adopting and non-adopting companies (column 19 of Table 6.3). A negative amount would signify a larger growth in the ratio of R&D to sales for a non-adopting company as compared to its selected adopting company and vice-versa.
- B = Column A sorted in ascending order.
- C = Absolute values for the amounts in column B.
- D = Absolute values in column C sorted in ascending order.
- E = One of the ranks of negative amounts in column D.
- F = Number of switched pairs.

exceeds that of adopting companies) exceeds the mean of the ranks.

This is confirmed in Figures 7.3 and 7.4 which are based on the information contained in Table 7.4. Table 7.4 is a trend statement based on the ratio of R&D to Sales data in Table 6.5 with year -3 (i.e., the third year preceding the year of adoption) as the base year and subsequent years expressed as percentages of the base year. Figure 7.3 shows that the non-adopting companies' ratio of R&D to Sales increased at a faster rate in the post-adoption period than did the ratio of R&D to Sales for the adopting companies. Figure 7.4 shows the negative growth differences of the ratio of R&D to Sales increased in the post-adoption period.

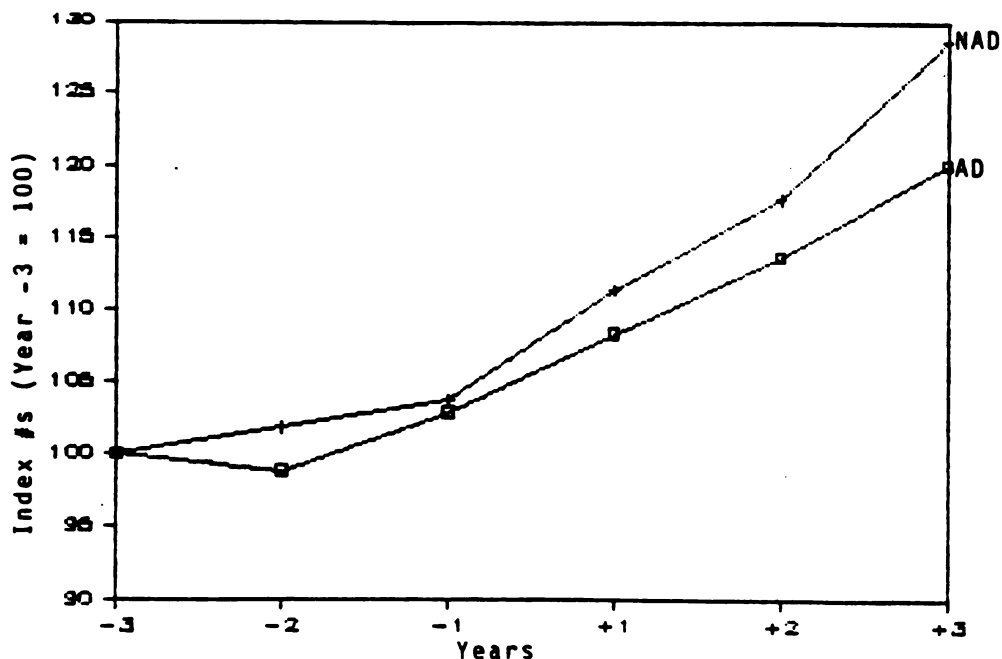
The computed test statistic resulted in the observed significance level of  $\alpha = 0.8051$  as compared to the desired  $\alpha = 0.05$  (Table 7.3). Therefore, the null hypothesis is not rejected. This research concludes that the difference in growth in the ratio of R&D to Sales between adopting and non-adopting companies is not significant.

### 7.3 The t-test on R&D Expenditures

In addition to the Wilcoxon test, the t-test was also performed on the differences in R&D growth between the portfolios of adopting and non-adopting companies. Since

Figure 7.3

**Trend Graph for Ratio of R&D to Sales  
(Yearly Portfolio Averages)**

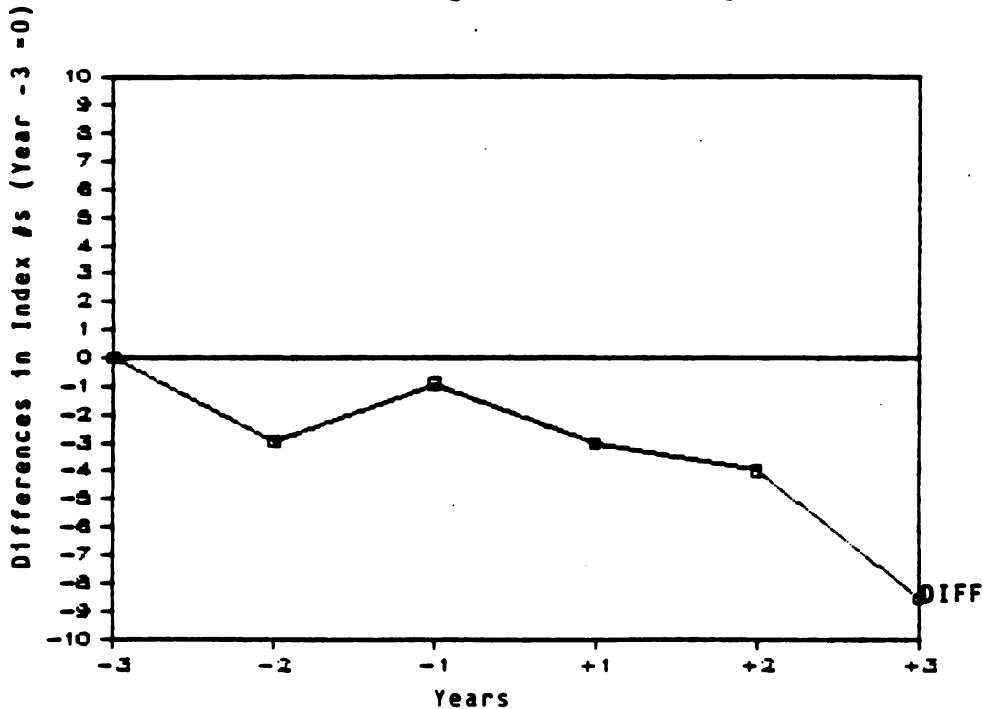


AD = Index #s of yearly average ratio of R&D to Sales for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 7.4)

NAD = Index #s of yearly average ratio of R&D to Sales for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 7.4)

Figure 7.4

**Trend Graph for Ratio of R&D to Sales**  
**(Difference: Yearly Portfolio Averages)**



$$\text{DIFF} = \text{AD} - \text{NAD}$$

**AD** = Index #s of yearly average ratio of R&D to Sales for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 7.4)

**NAD** = Index #s of yearly average ratio of R&D to Sales for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 7.4)

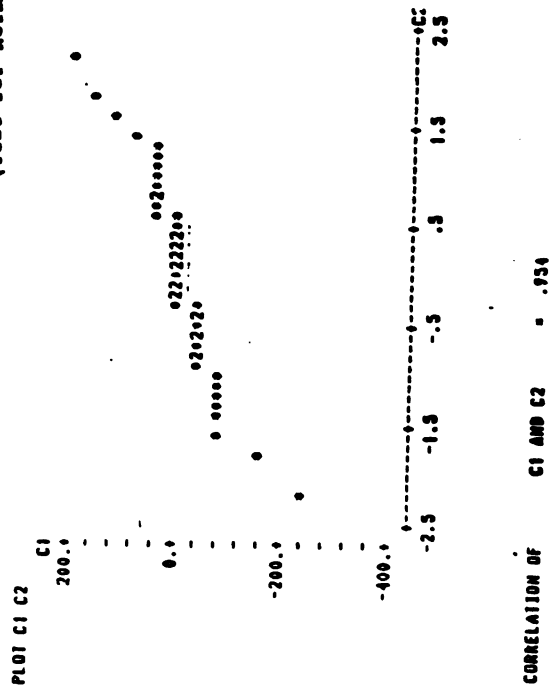


the t-test assumes normality, a test of normality was performed on the distribution of differences in R&D growth (Table 7.5). It was found that the correlation between the growth differences and the normal curve was 0.954. The hypothesis of normality was rejected at  $\alpha = 0.05$  and the t-test results should be regarded with caution. Fortunately, the Wilcoxon test, which does not require a normal distribution, provided nearly identical results (Table 7.1) as those in the t-test (Table 7.6).

Table 7.6 discloses that the mean of the R&D growth differences is negative. This would indicate that on average the non-adopting companies' growth in R&D exceeds that of adopting companies. This observation is consistent with the results obtained in Figures 7.1 and 7.2.

The computed test statistic resulted in an observed interpolated significance level of  $\alpha = 0.7135$  as compared to the desired  $\alpha = 0.05$  (Table 7.6). Therefore, the null hypothesis that the mean difference in R&D growth of adopting companies as compared to non-adopting companies would not be significantly different from zero, is not rejected. In addition, the alternate hypothesis that the mean difference in R&D growth of adopting companies as compared to non-adopting companies would be significantly greater than zero, is not confirmed. Hence, this research concludes that the R&D growth for the portfolio of adopting companies was not significantly

Table 7.5

R&D Expenditures  
(Test for Normality)

Index:

$C_1$  - Differences in growth of R&D between adopting and non-adopting companies (Column 19 of Table 6.4). A negative growth would signify a larger R&D growth for a non-adopting company as compared to an adopting company and vice-versa.

$C_2$  - Normal scores for the amounts in column C1 computed by a Minitab program designed by Ryan, Joiner and Ryan (1981).

This distribution of growth differences is not normal since the observed correlation of 0.954 is less than the critical correlation at  $\alpha = 0.05$  for sample size = 47 (rounded off to 50) of 0.9764 (Ryan, Joiner and Ryan, 1981). Therefore, the hypothesis of normality is rejected.

Table 7.6  
T TEST ON R&D EXPENDITURES

| Companies<br>(Adopting/non-adopting)   | A      | B      | C       | The t test: | Index:                                                                                                                                                                                                                                       |
|----------------------------------------|--------|--------|---------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 A. E. Staley/Kellogg                 | 168.49 | 82.86  | -22.36  |             |                                                                                                                                                                                                                                              |
| 2 Allied Corp/Mallinckrodt             | 166.65 | 112.20 | 31.77   |             | A = Growth of R&D for adopting companies (column 9 of Table 6.4).                                                                                                                                                                            |
| 3 Armstrong Rubber/Cooper Tire         | 77.45  | 58.41  | 19.04   |             | B = Growth of R&D for non-adopting companies (column 10 of Table 6.4).                                                                                                                                                                       |
| 4 Ashland Btl/SONIB                    | 84.99  | 167.04 | -82.05  |             | C = Differences in growth of R&D between adopting and non-adopting companies (column 11 of Table 6.4). A negative amount would signify that a non-adopting company had a larger R&D growth than its matched adopting company and vice-versa. |
| 5 Brierley Ironworks/Eschering Plough  | 81.21  | 56.83  | 22.37   |             |                                                                                                                                                                                                                                              |
| 6 Black & Veatch/Water Int'l. Corp     | 57.65  | 133.63 | -76.26  |             |                                                                                                                                                                                                                                              |
| 7 Bristol Myers/Siem Products          | 47.87  | 81.76  | -33.89  |             |                                                                                                                                                                                                                                              |
| 8 Brunswick/General                    | 36.19  | 186.34 | -142.15 |             |                                                                                                                                                                                                                                              |
| 9 Burlington/NEC                       | 56.87  | 152.36 | -95.43  |             |                                                                                                                                                                                                                                              |
| 10 Calmar/Mercator Inc.                | 19.05  | 69.48  | -50.43  |             |                                                                                                                                                                                                                                              |
| 11 Cincinnati Milacron/Moetel          | 12.30  | 78.47  | -66.16  |             |                                                                                                                                                                                                                                              |
| 12 Construction Eng/Grillite           | 25.30  | 33.64  | -7.74   |             |                                                                                                                                                                                                                                              |
| 13 Cooper Industries/Crane             | 156.40 | 14.92  | 135.76  |             |                                                                                                                                                                                                                                              |
| 14 Cooper Labs/ICI Pharmaceuticals     | 109.62 | -43.35 | 152.96  |             |                                                                                                                                                                                                                                              |
| 15 Corning Glass/Borcon                | 48.65  | 119.44 | -51.19  |             |                                                                                                                                                                                                                                              |
| 16 Cummins Engine/Allis Chalmers       | 44.25  | 13.91  | 52.46   |             |                                                                                                                                                                                                                                              |
| 17 Datapoint/Dang Lab                  | 266.76 | 511.00 | -245.14 |             |                                                                                                                                                                                                                                              |
| 18 Diamond Shamrock/Ethyl Corp         | 66.12  | 35.06  | 31.05   |             |                                                                                                                                                                                                                                              |
| 19 Eastman Kodak/Johnson & Johnson     | 63.87  | 67.92  | -24.05  |             |                                                                                                                                                                                                                                              |
| 20 Eaton/Frenchair                     | 57.99  | 28.20  | 37.39   |             |                                                                                                                                                                                                                                              |
| 21 Ferro/Sue Chemical                  | -2.99  | 23.56  | -26.55  |             |                                                                                                                                                                                                                                              |
| 22 General Mills/Coronation            | 46.90  | 38.70  | 8.20    |             |                                                                                                                                                                                                                                              |
| 23 General Motors/Ford                 | 22.25  | 6.20   | 16.05   |             |                                                                                                                                                                                                                                              |
| 24 Hershey Foods/Marvel                | 59.24  | 48.46  | 10.58   |             |                                                                                                                                                                                                                                              |
| 25 Hewlett/Avco                        | 79.49  | 18.43  | 61.06   |             |                                                                                                                                                                                                                                              |
| 26 Illinois Tool Works/Steelcase       | 36.47  | 5.77   | 24.96   |             |                                                                                                                                                                                                                                              |
| 27 Joppers/Kaiser Aluminum             | 66.16  | 24.71  | 41.24   |             |                                                                                                                                                                                                                                              |
| 28 Knoxville/O.S. Epsilon              | 26.56  | 58.38  | -31.75  |             |                                                                                                                                                                                                                                              |
| 29 Kirt/Upjohn                         | 53.40  | 52.40  | 1.20    |             |                                                                                                                                                                                                                                              |
| 30 Minnesota Mining/3M                 | 43.37  | 85.74  | -42.37  |             |                                                                                                                                                                                                                                              |
| 31 M&S Beers                           | 32.21  | 3.49   | 28.73   |             |                                                                                                                                                                                                                                              |
| 32 M. Industries/Schlumberger          | 65.10  | 124.74 | -79.65  |             |                                                                                                                                                                                                                                              |
| 33 Michels/Avco Int'l.                 | -17.12 | 48.38  | -65.50  |             |                                                                                                                                                                                                                                              |
| 34 Outboard Marine/Briggs & Stratton   | 39.17  | 18.79  | 19.47   |             |                                                                                                                                                                                                                                              |
| 35 Owens Corning/Fibers Owens Ford     | 75.85  | 26.88  | 48.95   |             |                                                                                                                                                                                                                                              |
| 36 Phillips Petroleum/Citizens Service | 74.13  | 46.32  | 27.81   |             |                                                                                                                                                                                                                                              |
| 37 Rustar Bats/Int'l. Multifoods       | 17.39  | 11.44  | 5.95    |             |                                                                                                                                                                                                                                              |
| 38 Sarnoff/Tektron                     | 16.22  | 54.21  | -43.99  |             |                                                                                                                                                                                                                                              |
| 39 Sanders Associates/Tracer           | 225.83 | 54.97  | 204.86  |             |                                                                                                                                                                                                                                              |
| 40 Sealed Air/UNC Ind. Inc.            | 47.94  | 67.10  | -19.16  |             |                                                                                                                                                                                                                                              |
| 41 Shell/Standard Btl (Indiana)        | 44.85  | 59.46  | -5.79   |             |                                                                                                                                                                                                                                              |
| 42 Teacore/Essex                       | 91.89  | 74.91  | 16.98   |             |                                                                                                                                                                                                                                              |
| 43 Texas Instruments/Raytheon          | 139.65 | 83.56  | 56.09   |             |                                                                                                                                                                                                                                              |
| 44 Teetrum/Avco                        | -25.36 | 31.16  | -56.76  |             |                                                                                                                                                                                                                                              |
| 45 United Technologies/Boeing          | 66.37  | 218.27 | -143.49 |             |                                                                                                                                                                                                                                              |
| 46 Warner Lambert/Calgate Palmolive    | 45.26  | 53.74  | -11.52  |             |                                                                                                                                                                                                                                              |
| 47 Westinghouse/GEA                    | 34.00  | 48.93  | -12.93  |             |                                                                                                                                                                                                                                              |
|                                        | Mean   | -5.85  |         |             |                                                                                                                                                                                                                                              |
|                                        | SE     | 76.56  |         |             |                                                                                                                                                                                                                                              |
|                                        | N      | 47     |         |             |                                                                                                                                                                                                                                              |

Index:

The t test:

According to Bhattacharyya and Johnson (1977), the t-test is computed as follows:

$$t = \frac{\text{Mean}}{\text{SE/} \sqrt{N}}$$

$$= \frac{-5.85}{16.79}$$

$$= -0.37$$

Mean = Sample mean of differences (A-B), the sum of the amounts in column C.

SE = Sample standard error of differences (i.e., the standard error of the amounts in column C).

N = Number of matched pairs.

The critical t value at alpha = 0.05 for a one-tailed test with df = 46 (rounded off to 40) is 1.684. An observed t = -0.37 would be significant at an interpolated value of alpha = 0.7135. However, since alpha = 0.05 is desired, the  $H_0$  is not rejected.



different from the R&D growth for the portfolio of non-adopting companies.

#### 7.4 The t test on the ratio of R&D to Sales

In addition to the Wilcoxon test, the t-test was also performed on the differences in growth in ratio of R&D to Sales between the portfolios of adopting and non-adopting companies. First, a test to determine if the data are normally distributed was performed on the growth differences for the ratio of R&D to Sales (Table 7.7). It was found that the correlation between these growth differences and the normal curve was 0.981 and the hypothesis of normality was not rejected at  $\alpha = 0.05$ . Therefore, the t-test, which assumes normality, can be used with confidence.

Table 7.8 discloses that the mean of the growth differences in the ratio of R&D to Sales is negative. This would indicate that on average the non-adopting companies' growth in ratio of R&D to Sales exceeds that of adopting companies. This observation is consistent with the results obtained in Figures 7.3 and 7.4.

The computed test statistic resulted in an observed interpolated significance level of  $\alpha = 0.8425$  as compared to the desired  $\alpha = 0.05$  (Table 7.8). Therefore, the null hypothesis that the mean difference in growth of ratio of R&D to Sales of adopting companies as



Table 7.8

T-TEST ON THE RATIO OF R&amp;D EXPENDITURES TO SALES

| Companies<br>(adopting/non-adopting)  | The t-Test: |        | Index: |  |
|---------------------------------------|-------------|--------|--------|--|
|                                       | A           | B      | C      |  |
| 1 A. E. Staley/Welltopp               | 15.38       | 34.55  | -19.16 |  |
| 2 Allied Corp/Halliburton             | 39.46       | 50.26  | -10.40 |  |
| 3 Westinghouse/Cooper Tire            | 36.73       | 10.36  | 26.38  |  |
| 4 Ashland Oil/SDHIO                   | 1.85        | -10.26 | 12.04  |  |
| 5 Batur Travenol/Schering Plough      | 39.25       | 44.42  | -5.17  |  |
| 6 Black & Becker/Baker Intl. Corp.    | 17.81       | 5.67   | 12.14  |  |
| 7 Bristol Myers/Avon Products         | 7.87        | 12.00  | -4.13  |  |
| 8 Brunswick/Dehart                    | 5.11        | 13.47  | -8.36  |  |
| 9 Burroughs/BEC                       | 7.89        | 34.13  | -26.24 |  |
| 10 Calsonic/Mercedes Inc.             | -5.41       | 16.32  | -21.73 |  |
| 11 Cincinnati Milacron/Merch          | 3.81        | 23.55  | -20.34 |  |
| 12 Combustion Engineering/Eldec       | -15.22      | 6.46   | -15.22 |  |
| 13 Cooper Industries/Crane            | -3.43       | -12.56 | 9.33   |  |
| 14 Cooper Labs/ICI Pharmaceuticals    | 16.79       | -9.71  | 26.50  |  |
| 15 Corning Glass/Morton               | 16.34       | 16.54  | -2.20  |  |
| 16 Cummins Engine/Morris Chalmers     | 47.37       | 7.99   | 39.47  |  |
| 17 Dalapoint/Mang Labs                | 34.32       | 43.34  | -9.01  |  |
| 18 Diamond Shamrock/Ethyl Corp.       | -20.38      | 14.76  | -35.14 |  |
| 19 Easton Kodak/Johanson & Johnson    | 26.14       | 36.13  | -9.29  |  |
| 20 Elcom/Finch                        | 81.09       | 32.17  | 48.92  |  |
| 21 Ferro/Sun Chemical                 | 3.81        | -12.67 | 16.48  |  |
| 22 General Mills/Carnation            | 1.61        | 3.37   | -2.36  |  |
| 23 General Motors/Ford                | 3.85        | -4.63  | 8.48   |  |
| 24 Hershey Foods/Morrell              | -1.82       | 20.41  | -20.23 |  |
| 25 Honeywell/Aviation                 | 6.22        | 1.33   | 4.89   |  |
| 26 Illinois Tool North/Stewart Warner | 3.23        | 10.99  | -7.76  |  |
| 27 Ingersoll-Rand Aluminum            | 6.40        | -13.93 | 13.93  |  |
| 28 Knoxville/US Gypsum                | -19.47      | 5.39   | -24.86 |  |
| 29 Koch/Upjohn                        | 25.77       | 30.46  | -5.09  |  |
| 30 Monsanto Mining/IBM                | 15.39       | 54.95  | -39.57 |  |
| 31 RCA/Deere                          | 14.16       | 26.73  | -12.59 |  |
| 32 M. Industries/Schlumberger         | 2.86        | 16.80  | -14.06 |  |
| 33 Ashland/Arco Intl.                 | -28.24      | 14.37  | -42.61 |  |
| 34 Oakwood Marine/Briggs & Stratton   | 23.46       | 15.49  | 7.97   |  |
| 35 Ovens Corning/Libby Owens Ford     | 46.33       | 20.12  | 26.22  |  |
| 36 Phillips Petroleum/Cities Service  | 2.80        | -15.48 | 18.28  |  |
| 37 Rauter Guts/Intl. Multifoods       | -20.84      | -7.62  | -13.63 |  |
| 38 Renard/Finlen                      | 34.46       | 103.03 | -68.57 |  |
| 39 Sanders Associates/Tracor          | 45.15       | -8.57  | 53.72  |  |
| 40 Scaled Power/IME Ind. Inc.         | -9.75       | 5.82   | -14.57 |  |
| 41 Shell/Standard Oil (Indiana)       | -9.37       | -15.96 | 6.40   |  |
| 42 Texaco/Union                       | 45.16       | 64.76  | -19.60 |  |
| 43 Telex Instruments/Raytheon         | 14.17       | 15.07  | -0.90  |  |
| 44 Telex/Arco                         | -17.16      | -22.84 | 5.49   |  |
| 45 United Technologies/Boeing         | -18.51      | 50.49  | -69.00 |  |
| 46 Warner Lambert/Calgate Palmolive   | 75.30       | 50.89  | 18.41  |  |
| 47 Westinghouse/RCA                   | 1.15        | 13.01  | -11.07 |  |
|                                       | Mean        | -3.44  |        |  |
|                                       | SE          | 21.59  |        |  |
|                                       | N           | 47     |        |  |

According to Bhattacharyya and Johnson (1977), the t-test is computed as follows:

$$t = \frac{\text{Mean}}{\text{SE}/\sqrt{N}}$$

Mean = -3.44  
SE/√N = 3.59  
t = -1.02

The critical t value at alpha = 0.05 for a two-tailed test with df = 46 (rounded off to 40) is 1.684. An observed t = -1.02 would be significant at an interpreted value of alpha = 0.0425. However, since alpha = 0.05 is desired, the  $H_0$  is not rejected.

Notes:

A = Growth of R&D for adopting companies (column 9 of Table 4.3).

B = Growth of R&D for non-adopting companies (column 10 of Table 4.3).

C = Differences in growth of ratio of R&D to Sales between adopting and non-adopting companies (column 19 of Table 4.3). A negative amount would signify that a non-adopting company had a larger growth in its ratio of R&D to Sales than the adopting company and vice-versa.

Mean = Sample mean of differences (i.e., the mean of the amounts in column C).

SE = Sample standard error of differences (i.e., the standard error of the amounts in column C).

N = Number of selected pairs.

compared to non-adopting companies would not be significantly different from zero, is not rejected. In addition, the alternate hypothesis that the mean difference in growth of ratio of R&D to Sales of adopting companies as compared to non-adopting companies would be significantly greater than zero, is not confirmed. Hence, this research concludes that the growth in ratio of R&D to Sales for the portfolio of adopting companies was not significantly different from the R&D growth for the portfolio of non-adopting companies.

This chapter concludes with both the Wilcoxon and t tests failing to reject the null hypothesis at  $\alpha = 0.05$  for R&D expenditures and the ratio of R&D to Sales, as summarized in Table 7.9. It is noteworthy that the results from the Wilcoxon tests (Tables 7.1 and 7.3) show that the portfolio of non-adopting companies had a larger, though not significant, growth in R&D and ratio of R&D to Sales as compared to the portfolio of adopting companies. In addition, the t-tests (Tables 7.6 and 7.8) disclose that the mean of the growth differences is negative, implying that on average the non-adopting companies' growth in R&D and ratio of R&D to Sales exceeds that of adopting companies. These results are discussed in the next chapter and various alternative explanations for the results are evaluated.

Table 7.9

Summary of the Results of the  
Main Operational Hypotheses

| <u>Measure</u>           | <u>Test</u> | <u>Significance<br/>level</u> | <u>Conclusion</u>                             |
|--------------------------|-------------|-------------------------------|-----------------------------------------------|
| R&D                      | Wilcoxon    | 0.7454                        | Failed to reject<br>the null at<br>alpha=0.05 |
| Ratio of R&D<br>to Sales | Wilcoxon    | 0.8051                        | Failed to reject<br>the null at<br>alpha=0.05 |
| R&D                      | t-test      | 0.7135                        | Failed to reject<br>the null at<br>alpha=0.05 |
| Ratio of R&D<br>to Sales | t-test      | 0.8425                        | Failed to reject<br>the null at<br>alpha=0.05 |

## CHAPTER 8

### DISCUSSION OF THE RESULTS

The tests conducted in chapter 7 failed to reject the null hypotheses which stated that there was no statistically significant difference in the growth in R&D or ratio of R&D to Sales between the portfolios of adopting and non-adopting companies. This chapter evaluates some alternate or rival hypotheses for the failure to reject the null.

#### 8.1 Amendment to bonus plans in the year of adoption

Chapter 3 suggested that the impact of newly introduced performance plans would be limited if the adopting companies already had lucrative bonus plans. Therefore, it was anticipated that companies adopting performance plans would adjust their bonus plans downward to make the performance plans more effective by comparison. Such an adjustment was expected to encourage a shift in management's behavior toward the long-run. On the other hand, failure to reject the null (i.e., failure to find a significantly larger growth in R&D and ratio of R&D to Sales for adopting companies as compared to non-adopting

companies) might have resulted from including adopting companies that did not adjust their bonus plans downward. Therefore those companies that did adjust their bonus plans in the desired direction (i.e. downwards) were tested to see if the results were any different from those obtained in chapter 7.

The hypotheses for this test on R&D (the ratio of R&D to Sales) are as follows:

Ho: The growth in R&D (ratio of R&D to Sales) for the adopting companies that adjusted their bonus plans downward, will not be significantly different than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies.

Ha: The growth in R&D (ratio of R&D to Sales) for the adopting companies that adjusted their bonus plans downward, will be significantly larger than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies.

Tables 8.1 and 8.2 show that four adopting companies adjusted their bonus plans downwards. Of the remaining 43 adopting companies, 38 did not adjust their bonus plans or adjusted them upwards whereas the other five did not disclose their actions. The information about adjustments to bonus plans was extracted from Appendix C which includes information about adopting companies obtained from Frederic W. Cook & Co., Inc., the companies' proxy statements and responses to questionnaires.

Questionnaires were sent to companies adopting performance plans in the period 1978-82. These

Table 6.1  
THE WILCOXON TEST ON R&D EXPENDITURES  
(Adjustment of Means in the year of adoption)

| Companies<br>(Adopting/non-adopting)      | A | B       | C | D      | E     | F |
|-------------------------------------------|---|---------|---|--------|-------|---|
| 1 A. E. Staley/Wellington                 | 3 | -22.34  | 2 | -79.45 | 79.45 | 4 |
| 2 Allied Corp/Mallinckrodt                | 3 | 31.37   | 2 | 5.79   | 5.79  | 1 |
| 3 Armstrong Rubber/Cooper Tire            | 3 | 19.44   | 2 | 16.45  | 16.45 | 2 |
| 4 Mohndel Oil/GM/BP                       | 3 | -42.45  | 2 | 28.73  | 28.73 | 3 |
| 5 Baiter Tractor/Chering Plough           | 3 | 22.37   |   |        |       |   |
| 6 Black & Becker/Baker Intl. Corp         | 9 | -76.20  |   |        |       |   |
| 7 Bristol Myers/Avon Products             | 9 | -33.89  |   |        |       |   |
| 8 Brunswick/Emhart                        | 3 | -42.15  |   |        |       |   |
| 9 Burroughs/BEC                           | 1 | -73.43  |   |        |       |   |
| 10 Calumet/Mercator Inc.                  | 3 | -36.44  |   |        |       |   |
| 11 Cincinnati Milacron/Boettch            | 3 | -16.18  |   |        |       |   |
| 12 Combustion Eng/Gillette                | 3 | -7.74   |   |        |       |   |
| 13 Cooper Industries/Crane                | 3 | 125.76  |   |        |       |   |
| 14 Cooper Labs/ICI Pharmaceuticals        | 9 | 122.76  |   |        |       |   |
| 15 Corning Glass/Marton                   | 3 | -81.19  |   |        |       |   |
| 16 Cummins Engine/Allis Chalmers          | 3 | 82.44   |   |        |       |   |
| 17 Delmont/Rang Labs                      | 3 | -265.14 |   |        |       |   |
| 18 Diamond Shamrock/Ethyl Corp            | 3 | 5.95    |   |        |       |   |
| 19 Eastman Kodak/Johnson & Johnson        | 3 | -71.48  |   |        |       |   |
| 20 Eaton/Freuhuf                          | 3 | 37.37   |   |        |       |   |
| 21 Ferro/Sun Chemical                     | 3 | -28.35  |   |        |       |   |
| 22 General Mills/Coronation               | 3 | 8.20    |   |        |       |   |
| 23 General Motors/Ford                    | 2 | 16.03   |   |        |       |   |
| 24 Hershey Foods/Maroon                   | 1 | 10.30   |   |        |       |   |
| 25 Honeywell/Alticon                      | 3 | 61.46   |   |        |       |   |
| 26 Illinois Tool Works/Smart Warner       | 3 | 29.99   |   |        |       |   |
| 27 Ingersoll Rand/Aluminum                | 3 | 14.24   |   |        |       |   |
| 28 Knoxville/B.S. Hyphen                  | 3 | -31.73  |   |        |       |   |
| 29 Merc/Upjohn                            | 3 | 1.20    |   |        |       |   |
| 30 Minnesota Mining/3M                    | 3 | -42.37  |   |        |       |   |
| 31 MGS/Bever                              | 2 | 28.73   |   |        |       |   |
| 32 M. Industries/Schlumberger             | 2 | -79.45  |   |        |       |   |
| 33 Nashua/Inry Intl.                      | 3 | -65.50  |   |        |       |   |
| 34 Outboard Marine/Briggs & Stratton      | 3 | 19.47   |   |        |       |   |
| 35 Queens Canning/Clifford Burns Ford     | 3 | 48.95   |   |        |       |   |
| 36 Phillips Petroleum/Citrus Service      | 9 | 33.81   |   |        |       |   |
| 37 Quaker Oats/Intl. Multifoods           | 3 | 3.95    |   |        |       |   |
| 38 Renner/Tyson                           | 3 | -43.97  |   |        |       |   |
| 39 Sanders Associates/Tracor              | 9 | 200.46  |   |        |       |   |
| 40 Sealed Air/ABC Ind. Inc.               | 3 | -19.14  |   |        |       |   |
| 41 Shell/Standard Oil (Indiana)           | 2 | 5.79    |   |        |       |   |
| 42 Teac/Corning                           | 3 | 16.98   |   |        |       |   |
| 43 Texas Instruments/Raytheon             | 3 | 44.96   |   |        |       |   |
| 44 Telectronics                           | 3 | -56.70  |   |        |       |   |
| 45 United Technologies/Boeing             | 3 | -163.49 |   |        |       |   |
| 46 Warner Lambert/Calgate Pharmaceuticals | 3 | 11.52   |   |        |       |   |
| 47 Westinghouse/GEA                       | 3 | -12.93  |   |        |       |   |

# The Wilcoxon Test:

According to Siegel (1956), the null hypothesis is rejected if the observed  $T$  is equal to or less than the critical  $T$  (Table 6 in Siegel, 1956). In this competition, the observed  $T$  was 4. Given the critical  $T$  at  $n = 9$  and a one-tailed alpha = 0.05 was 6. In addition, using the methodology in Gibbons (1971),  $T = 9$  would permit rejection of alpha = 0.0375. However, since alpha = 0.05 is acceptable, the test is not rejected.

# Notes:

- A = Change to bonus plan in the year of adoption of performance plan:  
1 = Bonus plan made more lucrative  
2 = Bonus plan made less lucrative  
3 = No consistent to bonus plan  
9 = No information available
- B = Differences in R&D growth between adopting and non-adopting companies (column 19 of Table 6.1). A negative amount would signify that a non-adopting company had a larger R&D growth as compared to its selected adopting company and vice versa.
- C = Companies sorted on the basis of code 2 in column B.
- D = Differences in R&D growth for selected pairs sorted in ascending order.
- E = Absolute values for the amounts in column B.
- F = Ranking of absolute values in column E in ascending order.
- T = Sum of the ranks of negative amounts in column B.
- n = Number of selected pairs.



Table 6.2

THE WILCOXON TEST ON THE RATIO OF R&D EXPENDITURES TO SALES  
(Adjustment of Means in the year of adoption)

| Companies<br>(adopting/non-adopting)  | A | B      | C | D      | E     | F |
|---------------------------------------|---|--------|---|--------|-------|---|
| 1 A. E. Staley/Mellott                | 3 | -19.16 | 2 | -12.59 | 12.59 | 4 |
| 2 Allied Corp/Mallinor                | 3 | -16.46 | 2 | -8.00  | 8.00  | 2 |
| 3 Armstrong Rubber/Cooper Tire        | 3 | 26.30  | 2 | 6.40   | 6.40  | 1 |
| 4 Ashland Oil/SOHIO                   | 3 | 12.06  | 2 | 8.00   | 8.00  | 3 |
| 5 Baiter Invenol/Scherling Plough     | 3 | -5.17  |   |        |       |   |
| 6 Black & Veatch/Mater Intl. Corp     | 9 | 12.16  |   |        | T = 6 |   |
| 7 Bristol Myers/Mon Products          | 9 | -4.93  |   |        | B = 4 |   |
| 8 Brunswick/Fahrt                     | 3 | -8.36  |   |        |       |   |
| 9 Burroughs/BEC                       | 1 | -26.24 |   |        |       |   |
| 10 Celanese/Hercules Inc.             | 3 | -21.75 |   |        |       |   |
| 11 Cincinnati Milacron/Mottet         | 3 | -26.56 |   |        |       |   |
| 12 Combustion Eng/Billetto            | 3 | -15.22 |   |        |       |   |
| 13 Cooper Industries/Crane            | 3 | 9.53   |   |        |       |   |
| 14 Cooper Labs/ICI Pharmaceuticals    | 9 | 20.50  |   |        |       |   |
| 15 Corning Glass/Morton               | 3 | -2.26  |   |        |       |   |
| 16 Cummins Engine/Morris Chalmers     | 3 | 39.67  |   |        |       |   |
| 17 Datapoint/Hang Labs                | 3 | -9.61  |   |        |       |   |
| 18 Diamond Shamrock/Ethyl Corp        | 3 | -35.16 |   |        |       |   |
| 19 Eastman Food/Johnson & Johnson     | 3 | -8.79  |   |        |       |   |
| 20 Eaton/Truhaul                      | 3 | 48.72  |   |        |       |   |
| 21 Ferro/Sun Chemical                 | 3 | 16.40  |   |        |       |   |
| 22 General Mills/Carnation            | 3 | -2.56  |   |        |       |   |
| 23 General Motors/Ford                | 2 | 8.40   |   |        |       |   |
| 24 Hershey Foods/Horrel               | 1 | -36.23 |   |        |       |   |
| 25 Honeywell/Tricon                   | 3 | 6.09   |   |        |       |   |
| 26 Illinois Tool Works/Stewart Warner | 3 | -7.76  |   |        |       |   |
| 27 Koppers/Kaiser Aluminum            | 3 | 13.93  |   |        |       |   |
| 28 Knoxville/U.S. Gypsum              | 3 | -21.06 |   |        |       |   |
| 29 Merck/Nippon                       | 3 | -5.09  |   |        |       |   |
| 30 Minnesota Mining/3M                | 3 | -39.37 |   |        |       |   |
| 31 MCR/Deere                          | 2 | -12.59 |   |        |       |   |
| 32 M. Industries/Schlumberger         | 2 | -8.00  |   |        |       |   |
| 33 Nashua/Avery Intl.                 | 3 | -42.41 |   |        |       |   |
| 34 Outboard Marine/Briggs & Stratton  | 3 | 7.97   |   |        |       |   |
| 35 Owens Corning/Libby Owens Ford     | 3 | 26.22  |   |        |       |   |
| 36 Phillips Petroleum/Cities Service  | 9 | 18.20  |   |        |       |   |
| 37 Quaker Oats/Intl. Multifoods       | 3 | -13.83 |   |        |       |   |
| 38 Reinold/Tidwell                    | 3 | -48.57 |   |        |       |   |
| 39 Sanders Associates/Tetecor         | 9 | 53.72  |   |        |       |   |
| 40 Sealed Air/PMC Ind. Inc.           | 3 | -6.57  |   |        |       |   |
| 41 Shell/Standard Oil (Indiana)       | 2 | 6.40   |   |        |       |   |
| 42 Texaco/Esxon                       | 3 | 10.40  |   |        |       |   |
| 43 Texas Instruments/Raytheon         | 3 | -8.90  |   |        |       |   |
| 44 Textron/Aeco                       | 3 | 5.69   |   |        |       |   |
| 45 United Technologies/Boeing         | 3 | -67.00 |   |        |       |   |
| 46 Warner Lambert/Colgate Palmolive   | 3 | 18.61  |   |        |       |   |
| 47 Westinghouse/GEA                   | 3 | -11.07 |   |        |       |   |

The Wilcoxon Test:

According to Siegel (1956), the null hypothesis is rejected if the observed  $T$  is equal to or less than the critical  $T$  (Table 6 in Siegel, 1956). In this compilation, the observed  $T$  was 6 whereas the critical  $T$  at  $N = 4$  and a one-tailed alpha = 0.05 was 0. In addition, using the methodology in Gibbons (1971),  $T = 6$  would permit rejection at alpha = 0.4075. However, since alpha = 0.05 is acceptable,  $H_0$  is not rejected.

Notes:

A = Changes to bonus plan in the year of adoption of performance plan:  
1 = Bonus plan made more lucrative  
2 = Bonus plan made less lucrative  
3 = No amendment to bonus plan  
9 = No information available

B = Difference in growth of ratio of R&D to Sales between adopting and non-adopting companies (column 19 of Table 6.3). A negative amount would signify that a non-adopting company had a larger growth in ratio of R&D to Sales as compared to its matched adopting company and vice-versa.

C = Companies sorted on the basis of code 2 in column B.

D = Difference in growth of the ratio of R&D to Sales for selected pairs sorted in ascending order.

E = Absolute values for the amounts in column B.

F = Ranking of absolute values in column E in ascending order.

T = Sum of the ranks of negative amounts in column B.

B = Number of matched pairs.

Table 6.2

THE WILCOXON TEST ON THE RATIO OF R&D EXPENDITURES TO SALES  
(Adjustment of Sales in the year of adoption)

| Companies<br>(adopting/non-adopting)  | A | B      | C | D      | E     | F     | The Wilcoxon Test:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------|---|--------|---|--------|-------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 A. E. Staley/Kellogg                | 3 | -19.16 | 2 | -12.59 | 12.59 | 4     | According to Siegel (1956), the null hypothesis is rejected if the observed T is equal to or less than the critical T (Table 6 in Siegel, 1956). In this competition, the observed T was 6 whereas the critical T at $N = 4$ and a one-tailed alpha = 0.05 was 6. In addition, using the methodology in Gibbons (1971), $T = 6$ would permit rejection of alpha = 0.0075. However, since alpha = 0.05 is acceptable, the is not rejected.                                                                                                                                                                                                                                          |
| 2 Allied Corp/Mellinart               | 3 | -10.46 | 2 | -8.00  | 8.00  | 2     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 3 Armstrong Rubber/Cooper Tire        | 3 | 26.36  | 2 | 6.46   | 6.46  | 1     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 4 Ashland Oil/SINOIL                  | 3 | 12.06  | 2 | 8.46   | 8.46  | 3     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 5 Baxter Traveler/Schering Plough     | 3 | -3.17  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 6 Black & Becker/Baker Intl. Corp     | 9 | 12.16  |   |        |       | T = 6 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 7 Bristol Myers/Sloan Products        | 9 | -4.93  |   |        |       | N = 4 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 8 Brunswick/Emhart                    | 3 | -8.36  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 9 Burroughs/BEC                       | 1 | -26.26 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 10 Celanese/Mercedes Inc.             | 3 | -21.73 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 11 Cincinnati Milacron/Metals         | 3 | -20.54 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 12 Combustion Eng/Billetto            | 3 | -15.22 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 13 Cooper Industries/Craze            | 3 | 9.33   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 14 Cooper Labs/ICI Pharmaceuticals    | 9 | 20.56  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 15 Corning Glass/Warner               | 3 | -2.26  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 16 Cummins Engine/Milco Chalmers      | 3 | 37.47  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 17 Dalapoint/Mang Labs                | 3 | -9.61  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 18 Diamond Shamrock/Ethyl Corp        | 3 | -33.16 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 19 Eastman Kodak/Johnson & Johnson    | 3 | -8.29  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 20 Eaton/Freuhauf                     | 3 | 48.92  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 21 Ferro/Sun Chemical                 | 3 | 16.48  |   |        |       |       | Index:<br>6 = Changes to bonus plan in the year of adoption of performance plan;<br>1 = Bonus plan adds merit incentive<br>2 = Bonus plan adds less incentive<br>3 = No consistent to bonus plan<br>9 = No information available                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 22 General Mills/Corralton            | 3 | -2.36  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 23 General Motors/Ford                | 2 | 8.48   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 24 Hershey Foods/Morrel               | 1 | -36.23 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 25 Honeywell/Litton                   | 3 | 6.89   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 26 Illinois Tool Works/Essex Martner  | 3 | -7.76  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 27 Koppers/Haiser Aluminum            | 3 | 13.93  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 28 Knoxville/U.S. Sylvania            | 3 | -24.86 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 29 Herc/Upjohn                        | 3 | -5.89  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 30 Minnesota Mining/3M                | 3 | -39.37 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 31 MCI/Deere                          | 2 | -12.59 |   |        |       |       | B = Differences in growth of ratio of R&D to Sales between adopting and non-adopting companies (column 19 of Table 6.3). A negative amount would signify that a non-adopting company had a larger growth in ratio of R&D to Sales as compared to its matched adopting company and vice-versa.<br>C = Competitive sorted on the basis of code 2 in column B.<br>D = Differences in growth of the ratio of R&D to Sales for selected pairs sorted in ascending order.<br>E = Absolute values for the amounts in column B.<br>F = Ranking of absolute values in column E in ascending order.<br>T = Sum of the ranks of negative amounts in column B.<br>N = Number of matched pairs. |
| 32 MC Industries/Schlumberger         | 2 | -8.00  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 33 Mathco/Avco Intl.                  | 3 | -42.61 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 34 Outboard Marine/Briggs & Stratton  | 3 | 7.97   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 35 Ovens Corning/Libby Owens Ford     | 3 | 26.22  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 36 Phillips Petroleum/Citires Service | 9 | 18.28  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 37 Quaker Oats/Intl. Multifoods       | 3 | -13.83 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 38 Renard/Fisher                      | 3 | -48.57 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 39 Sanders Associates/Tracor          | 9 | 53.72  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 40 Sealed Air/USC Ind. Inc.           | 3 | -4.57  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 41 Shell/Standard Oil (Indiana)       | 2 | 6.46   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 42 Texaco/Exxon                       | 3 | 18.46  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 43 Texas Instruments/Raytheon         | 3 | -8.99  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44 Testron/Arco                       | 3 | 5.69   |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45 United Technologies/Boeing         | 3 | -67.00 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 46 Warner Lambert/Congate Palmlive    | 3 | 18.41  |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 47 Westinghouse/RCA                   | 3 | -11.07 |   |        |       |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

Table B.2

THE WILCOXON TEST ON THE RATIO OF R&D EXPENDITURES TO SALES  
(Adjustment of Ranks in the year of adoption)

| Companies<br>(Adopting/non-adopting)  | The Wilcoxon Test: |        |   |        |   |
|---------------------------------------|--------------------|--------|---|--------|---|
|                                       | A                  | B      | C | D      | E |
| 1 A. E. Slaye/Kellogg                 | 3                  | -19.16 | 2 | -12.59 | 4 |
| 2 Allied Corp/Mallinwor               | 3                  | -10.40 | 2 | -8.00  | 2 |
| 3 Westlons Rubber/Cooper Tire         | 3                  | 20.30  | 2 | 4.40   | 1 |
| 4 Ashland Oil/Shell                   | 3                  | 12.06  | 2 | 0.00   | 3 |
| 5 Baxter Irvenol/Schering Plough      | 3                  | -5.17  |   |        |   |
| 6 Black & Decker/Baker Intl. Corp     | 9                  | 12.16  |   |        |   |
| 7 Bristol Myers/Avon Products         | 9                  | -4.93  |   |        |   |
| 8 Brunner/Fabert                      | 3                  | -8.36  |   |        |   |
| 9 Burroughs/BEC                       | 1                  | -26.20 |   |        |   |
| 10 Celanese/Mercates Inc.             | 3                  | -21.73 |   |        |   |
| 11 Cincinnati Milacron/Mastek         | 3                  | -20.54 |   |        |   |
| 12 Combustion Eng/Billlette           | 3                  | -15.22 |   |        |   |
| 13 Cooper Industries/Crane            | 3                  | 9.53   |   |        |   |
| 14 Cooper Labs/IDN Pharmaceuticals    | 9                  | 20.30  |   |        |   |
| 15 Corning Glass/Norton               | 3                  | -2.20  |   |        |   |
| 16 Cummins Engine/Allis Chalmers      | 3                  | 39.47  |   |        |   |
| 17 Batapout/Hang Labs                 | 3                  | -9.01  |   |        |   |
| 18 Diamond Shamrock/Ethyl Corp        | 3                  | -35.16 |   |        |   |
| 19 Easton Foods/Johnson & Johnson     | 3                  | -8.29  |   |        |   |
| 20 Eaton/Fruhauf                      | 3                  | 48.92  |   |        |   |
| 21 Ferro/Sun Chemical                 | 3                  | 16.40  |   |        |   |
| 22 General Mills/Carnation            | 3                  | -2.36  |   |        |   |
| 23 General Motors/Ford                | 2                  | 8.40   |   |        |   |
| 24 Hershey Foods/Horrel               | 1                  | -30.23 |   |        |   |
| 25 Honeywell/Union                    | 3                  | 6.09   |   |        |   |
| 26 Illinois Tool Works/Stewart Warner | 3                  | -7.76  |   |        |   |
| 27 Koppers/Kaiser Aluminum            | 3                  | 13.93  |   |        |   |
| 28 Knoxville/U.S. Gypsum              | 3                  | -24.06 |   |        |   |
| 29 Mercit/Upjohn                      | 3                  | -5.09  |   |        |   |
| 30 Minnesota Mining/3M                | 3                  | -39.37 |   |        |   |
| 31 MCR/Duerr                          | 2                  | -12.59 |   |        |   |
| 32 M. Industries/Schlumberger         | 2                  | -8.00  |   |        |   |
| 33 Nashua/Avery Intl.                 | 3                  | -42.41 |   |        |   |
| 34 Outboard Marine/Briggs & Stratton  | 3                  | 7.97   |   |        |   |
| 35 Oens Corning/Libby Owens Ford      | 3                  | 26.22  |   |        |   |
| 36 Phillips Petroleum/Citrus Service  | 9                  | 18.20  |   |        |   |
| 37 Quaker Oats/Intl. Multifoods       | 3                  | -13.83 |   |        |   |
| 38 Renard/Tamco                       | 3                  | -48.57 |   |        |   |
| 39 Sanders Associates/Tracor          | 9                  | 53.72  |   |        |   |
| 40 Sealed Air/PMC Ind. Inc.           | 3                  | -6.57  |   |        |   |
| 41 Shell/Standard Oil (Indiana)       | 2                  | 6.40   |   |        |   |
| 42 Texaco/Esso                        | 3                  | 10.40  |   |        |   |
| 43 Texas Instruments/Raytheon         | 3                  | -8.90  |   |        |   |
| 44 Textron/Aico                       | 3                  | 5.49   |   |        |   |
| 45 United Technologies/Boeing         | 3                  | -69.00 |   |        |   |
| 46 Warner Lambert/Colgate Palmolive   | 3                  | 10.41  |   |        |   |
| 47 Westinghouse/GEA                   | 3                  | -11.07 |   |        |   |

The Wilcoxon Test:

According to Siegel (1956), the null hypothesis is rejected if the observed  $T$  is equal to or less than the critical  $T$  (Table B in Siegel, 1956). In this compilation, the observed  $T$  was 6 whereas the critical  $T$  at  $N = 4$  and a one-tailed alpha = 0.05 was 0. In addition, using the methodology in Gibbons (1971),  $T = 6$  would permit rejection at alpha = 0.075. However, since alpha = 0.05 is acceptable, the is not rejected.

Index:

A = Changes to bonus plan in the year of adoption of performance plan;  
1 = Bonus plan code more lucrative  
2 = Bonus plan code less lucrative  
3 = No assessment to bonus plan  
9 = No information available

B = Difference in growth of ratio of R&D to Sales between adopting and non-adopting companies (column 19 of Table A.3). A negative amount would signify that a non-adopting company had a larger growth in ratio of R&D to Sales as compared to its matched adopting company and vice-versa.

C = Companies sorted on the basis of code 2 in column B.

D = Differences in growth of the ratio of R&D to Sales for selected pairs sorted in ascending order.

E = Absolute values for the amounts in column B.

F = Ranking of absolute values in column E in ascending order.

T = Sum of the ranks of negative amounts in column B.

N = Number of matched pairs.

questionnaires were sent primarily to get direct confirmation from companies if they had adjusted their bonus and stock option plans simultaneously with the adoption of performance plans. Another reason for sending questionnaires was to back-up information received from Frederic W. Cook & Co., Inc. and extracted from proxy statements. Questionnaires were sent to 71 of the 81 companies identified by Frederic W. Cook & Co., Inc. (Appendix A). Ten companies were dropped because they were either not quoted on any exchange, or were not industrial companies, or had adopted performance plans in 1983 and 1984 etc.. Out of 71 questionnaires sent, 25 usable responses were received, of which seven were ignored since they were from companies excluded from the sample for reasons outlined in Appendix B. In most cases the returned questionnaires confirmed the data from Frederic W. Cook & Co., Inc. and the proxy statements.

The returned questionnaires were used to determine if the company had adjusted it's bonus plan in the year of adoption. In cases where no response was available regarding adjustment of bonus, the proxy statements were used. Where proxy statements announced the adoption of performance and other plans but failed to mention any adjustment in their bonus plans, it was assumed that no material adjustments had been made to the bonus plans. This assumption was predicated on the requirement of

Item 402 to Regulation S-K to the Securities Acts which require disclosure in proxy statements of all material amendments to existing compensation schemes.

The Wilcoxon test was performed on the four adopting companies that adjusted their bonus plans downward for R&D (Table 8.1) and ratio of R&D to Sales (Table 8.2). The computed test statistic resulted in the observed significance level of  $\alpha = 0.4375$  for R&D (Table 8.1) and  $\alpha = 0.6875$  for ratio of R&D to Sales (Table 8.2) as compared to a desired  $\alpha = 0.05$ .

Hence the null hypotheses are not rejected. This research concludes that there was no significant difference in growth of R&D and ratio of R&D to Sales between adopting companies that adjusted their bonus plans downwards and the matched non-adopting companies. Therefore, it is unlikely that failure to reject the null hypothesis was caused by the inclusion of adopting companies that did not adjust their bonus plans downward subject to two qualifications. First, the failure to reject could have been a result of the sample not adjusting their bonus plans sufficiently downward to compete with the newly introduced performance plans. Second, the small sample size (4 matched-pairs) could have affected the results.

## 8.2 Completion of the performance cycle

It is argued that companies that have not completed at least one performance cycle might not exhibit long-term behavior. This is predicated on the assumption that a radical change in orientation (i.e., a shift from short-term to long-term) would need time to materialize. Hence the failure to find a significantly larger R&D growth for adopting companies might have been caused by the inclusion of adopting companies that had not completed even one performance cycle. As a result, only adopting companies that completed at least one performance cycle were selected from the sample and tested to see if the results were any different from those obtained in chapter 7.

The hypotheses for this test on R&D (ratio of R&D to Sales) are as follows:

- Ho: The growth in R&D (ratio of R&D to Sales) for the adopting companies that have completed at least one performance cycle will not be significantly different than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies.
- Ha: The growth in R&D (ratio of R&D to Sales) for the adopting companies that have completed at least one performance cycle will be significantly larger than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies.

Tables 8.3 and 8.4 show that five adopting companies had not completed at least one performance cycle and hence the remaining 42 were considered for this test.

Table B.3

THE WILCOXON TEST ON R&D EXPENDITURES  
(Completion of performance cycle)

| Companies<br>(Adopting/non-adopting)   | A | B       | C | D       | E      | F  |
|----------------------------------------|---|---------|---|---------|--------|----|
| 1 A. E. Staley/Polysag                 | 2 | -22.34  | 1 | -205.14 | 245.14 | 42 |
| 2 Allied Corp/Halliburton              | 1 | 31.77   | 1 | -143.49 | 143.49 | 39 |
| 3 Armstrong Rubber/Cooper Tire         | 1 | 19.04   | 1 | -63.30  | 63.30  | 27 |
| 4 Ashland Oil/BDHI                     | 1 | -42.05  | 1 | -42.05  | 42.05  | 36 |
| 5 Baker Travenol/Schering Plough       | 1 | 22.37   | 1 | -70.45  | 70.45  | 35 |
| 6 Black & Veatch/Bechtel Indl. Corp    | 1 | -74.20  | 1 | -74.20  | 74.20  | 34 |
| 7 Bristol Myers/Siem Products          | 1 | -33.09  | 1 | -42.15  | 42.15  | 33 |
| 8 Brunswick/Echert                     | 1 | -42.15  | 1 | -54.70  | 54.70  | 31 |
| 9 Burrage/NEC                          | 2 | -42.43  | 1 | -51.19  | 51.19  | 30 |
| 10 Calumet/Hercules Inc.               | 1 | -34.44  | 1 | -43.99  | 43.99  | 27 |
| 11 Cincinnati Milacron/Metabolt        | 1 | -14.10  | 1 | -42.37  | 42.37  | 26 |
| 12 Combustion Eng/Millette             | 1 | -7.74   | 1 | -33.09  | 33.09  | 24 |
| 13 Cooper Industries/Crane             | 1 | 133.76  | 1 | -31.75  | 31.75  | 21 |
| 14 Cooper Labs/ICI Pharmaceuticals     | 1 | 132.96  | 1 | -34.44  | 34.44  | 20 |
| 15 Corning Glass/Warner                | 1 | -51.19  | 1 | -28.20  | 28.20  | 18 |
| 16 Cummins Engine/Morris Chalmers      | 2 | 32.44   | 1 | -74.05  | 74.05  | 16 |
| 17 Datapoint/Hung Labs                 | 1 | -245.14 | 1 | -16.10  | 16.10  | 14 |
| 18 Diamond Shamrock/Ethyl Corp         | 1 | 5.05    | 1 | -16.10  | 16.10  | 14 |
| 19 Easton Kodak/Johnson & Johnson      | 1 | -74.05  | 1 | -12.93  | 12.93  | 9  |
| 20 Eaton/Frankford                     | 1 | 37.39   | 1 | -7.74   | 7.74   | 5  |
| 21 Ferro/Van Chemical                  | 1 | -28.35  | 1 | 1.20    | 1.20   | 1  |
| 22 General Mills/Carleton              | 1 | 8.20    | 1 | 5.05    | 5.05   | 2  |
| 23 General Motors/Ford                 | 1 | 14.05   | 1 | 5.79    | 5.79   | 3  |
| 24 Hershey Foods/Morrell               | 1 | 10.20   | 1 | 5.05    | 5.05   | 4  |
| 25 Honeywell/Kittling                  | 1 | 61.06   | 1 | 6.20    | 6.20   | 6  |
| 26 Illinois Tool Works/Ramont Warner   | 1 | 24.90   | 1 | 14.20   | 14.20  | 7  |
| 27 Ingersoll/Raiser Aluminum           | 1 | 16.24   | 1 | 11.52   | 11.52  | 8  |
| 28 Ingersoll/R.S. Oppen                | 1 | -31.75  | 1 | 16.05   | 16.05  | 10 |
| 29 Ingersoll/John                      | 1 | 1.20    | 1 | 16.20   | 16.20  | 12 |
| 30 Ingersoll/Rising/IBM                | 1 | -42.37  | 1 | 19.04   | 19.04  | 13 |
| 31 ICI/Bechtel                         | 1 | 20.73   | 1 | 22.37   | 22.37  | 15 |
| 32 ICI/Industries/Chalmers             | 1 | -74.45  | 1 | 24.90   | 24.90  | 17 |
| 33 Ingersoll/Bechtel                   | 1 | -45.30  | 1 | 28.73   | 28.73  | 19 |
| 34 Ingersoll/Bechtel/Briggs & Stratton | 2 | 19.47   | 1 | 31.77   | 31.77  | 22 |
| 35 Owens Corning/Libby Glass Ford      | 1 | 40.95   | 1 | 33.01   | 33.01  | 23 |
| 36 Phillips Petroleum/Citro Service    | 1 | 33.01   | 1 | 37.39   | 37.39  | 25 |
| 37 Rubber Bolls/Int. Millifoods        | 1 | 3.95    | 1 | 44.90   | 44.90  | 28 |
| 38 Rubber/Union                        | 1 | -43.99  | 1 | 46.90   | 46.90  | 29 |
| 39 Sanders Associates/Tracor           | 1 | 200.06  | 1 | 61.06   | 61.06  | 32 |
| 40 Sealed Air/USC Ind. Inc.            | 1 | -15.16  | 1 | 132.76  | 132.76 | 30 |
| 41 Shell/Standard Oil (Indiana)        | 1 | 3.79    | 1 | 132.96  | 132.96 | 40 |
| 42 Teac/Erson                          | 2 | 14.90   | 1 | 200.06  | 200.06 | 41 |
| 43 Texas Instruments/Raytheon          | 1 | 46.90   |   |         |        |    |
| 44 Tetra/Avco                          | 1 | -54.70  |   |         |        |    |
| 45 United Technologies/Boeing          | 1 | -103.49 |   |         |        |    |
| 46 Warner Lambert/Calgate Palmolive    | 1 | 11.52   |   |         |        |    |
| 47 Westinghouse/NEC                    | 1 | -12.93  |   |         |        |    |

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon Test is computed as follows:

$$z = \frac{T - \text{Mean}}{\text{S.D. Dev.}} = \frac{T - 1/4(N)(N+1)}{((1/24)(N)(N+1)(2N+1))^{1/2}}$$

$$z = \frac{300 - 631.39}{79.90} = 0.71$$

$z = 0.71$  would permit rejection of  $H_0$  at  $\alpha = 0.741$  (1.000 - 0.259). However,  $\alpha = 0.05$  is acceptable and hence  $H_0$  is not rejected.

Notes:

A = No. of at least one performance cycle completed?

1 = Yes

2 = No

9 = No information available

B = Differences in growth of R&D between adopting and non-adopting companies (column 19 of Table B.4). A negative amount would signify that a non-adopting company had a larger R&D growth than its matched adopting company and vice-versa.

C = Composite sorted on the basis of code 1 in column B.

D = Differences in R&D growth for selected pairs sorted in ascending order.

E = Absolute values for the amounts in column B.

F = Absolute values in column E ranked in ascending order.

T = Sum of the ranks of negative amounts in column B.

H = Number of matched pairs.

Table 8.3  
THE MILCOHM TEST ON R&D EXPENDITURES  
(Completion of performance cycle)

| Companies<br>(Adopting/non-adopting) | A | B       | C | D       | E      | F  |
|--------------------------------------|---|---------|---|---------|--------|----|
| 1 A. E. Staley/Colleg                | 2 | -22.34  | 1 | -205.14 | 245.14 | 42 |
| 2 Allied Corp/Mallinor               | 1 | 31.77   | 1 | -143.49 | 143.49 | 39 |
| 3 Armstrong Rubber/Cooper Tire       | 1 | 19.04   | 1 | -45.39  | 45.39  | 27 |
| 4 Ashland Oil/IDH18                  | 1 | -42.05  | 1 | -42.05  | 42.05  | 36 |
| 5 Baiter Traveler/Schering Plough    | 1 | 22.37   | 1 | -79.45  | 79.45  | 39 |
| 6 Black & Veatch/Baker Int'l. Corp   | 1 | -74.29  | 1 | -74.29  | 74.29  | 34 |
| 7 Bristol Myers/Siem Products        | 1 | -33.89  | 1 | -43.15  | 43.15  | 33 |
| 8 Brunswick/Edhart                   | 1 | -42.15  | 1 | -46.76  | 46.76  | 31 |
| 9 Hercules/BEC                       | 2 | -93.43  | 1 | -51.19  | 51.19  | 30 |
| 10 Calumet/Hercules Inc.             | 1 | -36.44  | 1 | -43.99  | 43.99  | 27 |
| 11 Cincinnati Milacron/Bechtel       | 1 | -16.10  | 1 | -42.37  | 42.37  | 26 |
| 12 Combustion Eng/Billette           | 1 | -7.74   | 1 | -33.89  | 33.89  | 24 |
| 13 Cooper Industries/Dane            | 1 | 125.76  | 1 | -31.75  | 31.75  | 21 |
| 14 Cooper Labs/ICI Pharmaceuticals   | 1 | 132.76  | 1 | -36.44  | 36.44  | 20 |
| 15 Corning Glass/Warner              | 1 | -51.19  | 1 | -28.25  | 28.25  | 18 |
| 16 Cummins Engine/Mills Chalmers     | 2 | 52.44   | 1 | -24.05  | 24.05  | 16 |
| 17 Delapoint/Hung Labs               | 1 | -245.14 | 1 | -19.16  | 19.16  | 14 |
| 18 Diamond Shamrock/Ethyl Corp       | 1 | 5.05    | 1 | -16.10  | 16.10  | 11 |
| 19 Easton Endal/Johansen & Johnson   | 1 | -24.05  | 1 | -12.93  | 12.93  | 9  |
| 20 Eaton/Frankel                     | 1 | 37.39   | 1 | -7.74   | 7.74   | 5  |
| 21 Ferro/Ven Chemical                | 1 | -28.25  | 1 | 1.20    | 1.20   | 1  |
| 22 General Mills/Corstium            | 1 | 6.29    | 1 | 3.05    | 3.05   | 2  |
| 23 General Motors/Ford               | 1 | 14.05   | 1 | 5.79    | 5.79   | 3  |
| 24 Hershey Foods/Morrell             | 1 | 16.29   | 1 | 5.95    | 5.95   | 6  |
| 25 Honeywell/Litton                  | 1 | 41.04   | 1 | 8.20    | 8.20   | 6  |
| 26 Illinois Tool Works/Blaug Warner  | 1 | 24.90   | 1 | 10.20   | 10.20  | 7  |
| 27 Jupperts/Raiser Aluminite         | 1 | 16.24   | 1 | 11.32   | 11.32  | 8  |
| 28 Kerrville/N.S. Bynum              | 1 | -31.75  | 1 | 14.06   | 14.06  | 10 |
| 29 Merck/Upjohn                      | 1 | 1.20    | 1 | 16.24   | 16.24  | 12 |
| 30 Minnesota Mining/3M               | 1 | -42.37  | 1 | 19.04   | 19.04  | 13 |
| 31 MCI/Boere                         | 1 | 28.73   | 1 | 22.37   | 22.37  | 15 |
| 32 M. Industries/Schlumberger        | 1 | -79.45  | 1 | 24.90   | 24.90  | 17 |
| 33 Nashua/Every Int'l.               | 1 | -45.39  | 1 | 28.73   | 28.73  | 19 |
| 34 Oetliard Marine/Briggs & Stratton | 2 | 19.07   | 1 | 31.77   | 31.77  | 22 |
| 35 Owens Corning/Libby Glass Ford    | 1 | 46.93   | 1 | 33.81   | 33.81  | 23 |
| 36 Phillips Petroleum/Citico Service | 1 | 33.81   | 1 | 37.39   | 37.39  | 25 |
| 37 Reuter Data/Int'l. Multifoods     | 1 | 5.95    | 1 | 46.90   | 46.90  | 28 |
| 38 Rescor/Finch                      | 1 | -43.99  | 1 | 48.95   | 48.95  | 29 |
| 39 Sanders Associates/Tracer         | 1 | 246.06  | 1 | 41.04   | 41.04  | 32 |
| 40 Sealed Air/UNC Ind. Inc.          | 1 | -19.16  | 1 | 125.76  | 125.76 | 38 |
| 41 Shell/Standard Oil (Indiana)      | 1 | 5.79    | 1 | 132.96  | 132.96 | 40 |
| 42 Texaco/Esso                       | 2 | 16.90   | 1 | 209.45  | 209.45 | 41 |
| 43 Texas Instruments/Naytheon        | 1 | 46.90   |   |         |        |    |
| 44 Tetra/Arco                        | 1 | -50.79  |   |         |        |    |
| 45 United Technologies/Boeing        | 1 | -103.49 |   |         |        |    |
| 46 Warner Lambert/Calgate Pallmole   | 1 | 11.32   |   |         |        |    |
| 47 Westinghouse/GEA                  | 1 | -12.93  |   |         |        |    |

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon test is computed as follows:

$$T = \frac{1}{2} (N+1) \left( \frac{T - \frac{1}{2} (N+1)}{N} \right) \quad \text{or} \quad T = \frac{1}{2} (N+1) \left( \frac{T - \frac{1}{2} (N+1)}{N} \right) \quad \text{or} \quad T = \frac{1}{2} (N+1) \left( \frac{T - \frac{1}{2} (N+1)}{N} \right)$$

$$0.4 \text{ Dev.} \quad (1/240) (N+1) (20+1) \quad 1/2$$

$$= \frac{500 - 651.50}{79.90} = 0.71$$

$z = 0.71$  would permit rejection of  $H_0$  at  $\alpha = 0.7011$  (1.0000 - 0.2389). However,  $\alpha = 0.05$  is acceptable and hence  $H_0$  is not rejected.

Index:

0 = No at least one performance cycle completed?  
1 = Yes  
2 = No

9 = No information available

3 = Differences in growth of R&D between adopting and non-adopting companies (column 19 of Table 4.4). A negative count would signify that a non-adopting company had a larger R&D growth than its matched adopting company and vice-versa.

C = Companies sorted on the basis of code 1 in column 4.

D = Differences in R&D growth for selected pairs sorted in ascending order.

E = Absolute values for the counts in column 8.

F = Absolute values in column E ranked in ascending order.

T = Sum of the ranks of negative counts in column 8.

N = Number of matched pairs.



Table B.3

TEST ON THE ABILITY OF R&D EXPENDITURES TO SALES  
Completion of performance cycle

| Companies<br>(Adopting/non-adopting) | A | B      | C  | D      | E     | F  |
|--------------------------------------|---|--------|----|--------|-------|----|
| 1 A. C. Bickel/Kellogg               | 2 | -15.16 | -1 | -45.40 | 64.99 | 42 |
| 2 Allied Corp/Mallinckrodt           | 1 | -18.40 | 1  | -46.37 | 41    |    |
| 3 Armstrong Rubber/Goodyear Tire     | 1 | 29.38  | 1  | -42.41 | 62.41 | 39 |
| 4 B. F. Goodrich/Goodyear Tire       | 1 | 29.38  | 1  | -42.41 | 62.41 | 39 |
| 5 Shell International/Shell Plough   | 1 | -5.17  | 1  | -35.14 | 35.14 | 34 |
| 6 Black & Veatch/Black Int'l. Corp   | 1 | 12.14  | 1  | -36.23 | 36.23 | 33 |
| 7 Bristol-Myers/Johnson Products     | 1 | -4.93  | 1  | -24.86 | 24.86 | 34 |
| 8 Bausch & Lomb                      | 1 | -1.71  | 1  | -21.72 | 21.72 | 32 |
| 9 Bausch & Lomb                      | 2 | -26.34 | 1  | -21.72 | 21.72 | 32 |
| 10 Colson/Merck & Co.                | 1 | -21.73 | 1  | -15.22 | 15.22 | 25 |
| 11 Clinco/Alco/Norwich               | 1 | -26.34 | 1  | -12.83 | 12.83 | 23 |
| 12 Combustion Engineering            | 1 | -15.22 | 1  | -12.89 | 12.89 | 22 |
| 13 Cooper Industries/Grane           | 1 | 15.22  | 1  | -12.89 | 12.89 | 22 |
| 14 Cooper Industries/Grane           | 1 | 15.22  | 1  | -12.89 | 12.89 | 22 |
| 15 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 16 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 17 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 18 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 19 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 20 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 21 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 22 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 23 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 24 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 25 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 26 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 27 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 28 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 29 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 30 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 31 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 32 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 33 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 34 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 35 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 36 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 37 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 38 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 39 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 40 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 41 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 42 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 43 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 44 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 45 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 46 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |
| 47 Corning Glass/Corning             | 1 | -26.34 | 1  | -16.46 | 16.46 | 30 |

T = 320  
B = 42

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon test is computed as follows:

$$T = \frac{R_1 + R_2}{2} - \frac{1}{2}n(n+1)$$

$$R_1 = \sum_{i=1}^n R_i$$

$$R_2 = \sum_{i=1}^n R_i$$

$$R_3 = \sum_{i=1}^n R_i$$

$$R_4 = \sum_{i=1}^n R_i$$

$$R_5 = \sum_{i=1}^n R_i$$

$$R_6 = \sum_{i=1}^n R_i$$

$$R_7 = \sum_{i=1}^n R_i$$

$$R_8 = \sum_{i=1}^n R_i$$

$$R_9 = \sum_{i=1}^n R_i$$

$$R_{10} = \sum_{i=1}^n R_i$$

$$R_{11} = \sum_{i=1}^n R_i$$

$$R_{12} = \sum_{i=1}^n R_i$$

$$R_{13} = \sum_{i=1}^n R_i$$

$$R_{14} = \sum_{i=1}^n R_i$$

$$R_{15} = \sum_{i=1}^n R_i$$

$$R_{16} = \sum_{i=1}^n R_i$$

$$R_{17} = \sum_{i=1}^n R_i$$

$$R_{18} = \sum_{i=1}^n R_i$$

$$R_{19} = \sum_{i=1}^n R_i$$

$$R_{20} = \sum_{i=1}^n R_i$$

$$R_{21} = \sum_{i=1}^n R_i$$

$$R_{22} = \sum_{i=1}^n R_i$$

The determination as to whether the first performance cycle was completed was based on information from Appendix C.

The Wilcoxon test was performed on the differences in growth of R&D and the ratio of R&D to Sales between the adopting and non-adopting companies. Tables 8.3 and 8.4 show that the sum of the ranks of negative growth in R&D and ratio of R&D to Sales differences (i.e., where the non-adopting companies' growth in R&D and ratio of R&D to Sales exceeds that of the adopting companies) exceeds the mean of the ranks. The computed test statistic resulted in the observed significance levels of  $\alpha = 0.7611$  for R&D growth (Table 8.3) and  $\alpha = 0.8365$  for growth in ratio of R&D to Sales (Table 8.4) as compared to a desired  $\alpha = 0.05$ . Actually, these observed levels of significance are greater than those obtained from a consideration of the entire sample. (Tables 7.1 and 7.3).

Therefore, the null hypotheses are not rejected and this research concludes that there was no significant difference in the growth in R&D and ratio of R&D to Sales between adopting companies that had completed at least one performance cycle and the matched non-adopting companies. Hence, it is unlikely that inclusion of five adopting companies that had not completed at least one performance cycle, was responsible for the failure to reject the null.

### 8.3 Five year post-adoption period

Chapter 8.2 discussed the possibility that the growth in R&D and ratio of R&D to Sales for the portfolio of adopting companies was not significantly different from that of the portfolio of non-adopting companies because some of the adopting companies had not completed even one performance cycle. Extending that argument, it is argued that the three year post-adoption period used in the computations in chapter 7, might not be long enough for the effects of the performance plan to materialize. Hence, failure to find a significantly larger growth in R&D and ratio of R&D to Sales for adopting companies might have been caused by considering too short a post-adoption period.

Therefore, the post-adoption period was extended from three to five years expecting that five years was a long enough period for the effects of performance plans to materialize in the form of greater R&D growth. Adopting companies which had five years post-adoption R&D data available were selected from the sample. Tables 8.5 and 8.6 show that only 21 out of the 47 pairs of companies in the original sample were selected for this test. The remaining 26 pairs were excluded either because five year post-adoption R&D data was not available (16), or five year post-adoption R&D data was inconsistent (7) or non-adopting companies had adopted performance plans in the five year





post-adoption period (3). Finally, this sample of 21 pairs was tested to see if the results were any different from those obtained in chapter 7.

The hypotheses for this test on R&D (ratio of R&D to Sales) are as follows:

Ho: The growth in R&D (ratio of R&D to Sales) for the adopting companies for the post-adoption period of five years as compared to the pre-adoption period of three years, will not be significantly different than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies over the same periods.

Ha: The growth in R&D (ratio of R&D to Sales) for the adopting companies for the post-adoption period of five years as compared to the pre-adoption period of three years, will be significantly larger than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies over the same periods.

The Wilcoxon test was performed on the differences in growth of R&D and the ratio of R&D to Sales between the adopting and non-adopting companies. Tables 8.7 and 8.8 show that the sum of the ranks of negative growth in R&D and ratio of R&D to Sales differences (i.e., where the non-adopting companies' growth in R&D and ratio of R&D to Sales exceeds that of the adopting companies) exceeds the mean of the ranks.

The computed test statistic resulted in the observed significance levels of  $\alpha = 0.9207$  for R&D growth (Table 8.7) and  $\alpha = 0.9913$  for growth in ratio of R&D to Sales (Table 8.8) as compared to a desired  $\alpha$



Table 8.0  
THE WILCOXON TEST ON THE RATIO OF R&D EXPENDITURES TO SALES  
(5 year post-adoption periods)

| Companies<br>(Adopting/non-adopting) | A      | B      | C     | D     | E     | F     | G     | H     | I     | J     | K     | L     | M     | N     | O     | P     | Q     | R     | S     | T     | U     | V     | W     | X     | Y     | Z     |
|--------------------------------------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 A. E. Haley/Kellogg                | -31.34 | -31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 | 31.34 |
| 2 Ashland Oil/PSM                    | -32.40 | -32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 | 32.40 |
| 3 Black & Decker/Dorrell, Cary       | 0.35   | 0.35   | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  | 0.35  |
| 4 Bristol Myers/Free Products        | -15.69 | -15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 |
| 5 Brunswick/Cabot                    | -3.46  | -3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  | 3.46  |
| 6 Colson/Marcello, Inc.              | -32.21 | -32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 | 32.21 |
| 7 Cincinnati Milacron/Metrol         | 1.02   | 1.02   | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  | 1.02  |
| 8 Combustion Eng/Billings            | -17.10 | -17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 | 17.10 |
| 9 Corning Glass/Warner               | -22.43 | -22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 | 22.43 |
| 10 Corning Glass/Allis Chalmers      | 20.43  | 20.43  | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 | 20.43 |
| 11 Dalapoint/Hung Labs               | -15.77 | -15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 | 15.77 |
| 12 General Mills/Corning             | -19.16 | -19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 | 19.16 |
| 13 Hershey Foods/Normal              | -28.16 | -28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 | 28.16 |
| 14 Honeywell/Littell                 | 14.41  | 14.41  | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 | 14.41 |
| 15 Illinois Tool Works/Blairstown    | -17.57 | -17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 | 17.57 |
| 16 M. Industries/Schlumberger        | -10.92 | -10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 | 10.92 |
| 17 Baker Bros/Int'l. Multifoods      | -13.10 | -13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 | 13.10 |
| 18 Sanders Associates/Tracor         | 65.99  | 65.99  | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 | 65.99 |
| 19 Sealed Air/ABC Ind. Inc.          | -17.21 | -17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 | 17.21 |
| 20 Texas Instruments/Raytheon        | -3.01  | -3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  | 3.01  |
| 21 United Technologies/Rohing        | -40.07 | -40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 | 40.07 |

The Wilcoxon Test:

Siegel (1956) states that the z test provides an excellent approximation for the Wilcoxon test for samples smaller than 25. Therefore, the Wilcoxon test is computed as follows:

$$z = \frac{T - \text{Mean}}{\text{S.D.}} = \frac{T - 1/40(40+1)}{\text{S.D.}} = \frac{T - 10.25}{\text{S.D.}}$$

S.D. =  $\sqrt{\frac{1/24(40+1)(20+1)}{1/2}}$

=  $\sqrt{\frac{104}{24}} = 2.08$

$z = 2.30$  would permit rejection of  $H_0$  at  $\alpha = 0.01$  (1.645 - 0.007). However,  $\alpha = 0.05$  is acceptable and hence  $H_0$  is not rejected.

Notes:

A = Difference in growth in the ratio of R&D to Sales between adopting and non-adopting companies (column 17 of Table 8.0). A negative amount would signify a larger growth in the ratio of R&D to Sales for a non-adopting company as compared to its matched adopting company and vice-versa.

B = Column A sorted in ascending order.

C = Absolute values for the amounts in column B.

D = Absolute values in column C ranked in ascending order.

E = Sum of the ranks of negative amounts in column B.

F = Number of matched pairs.

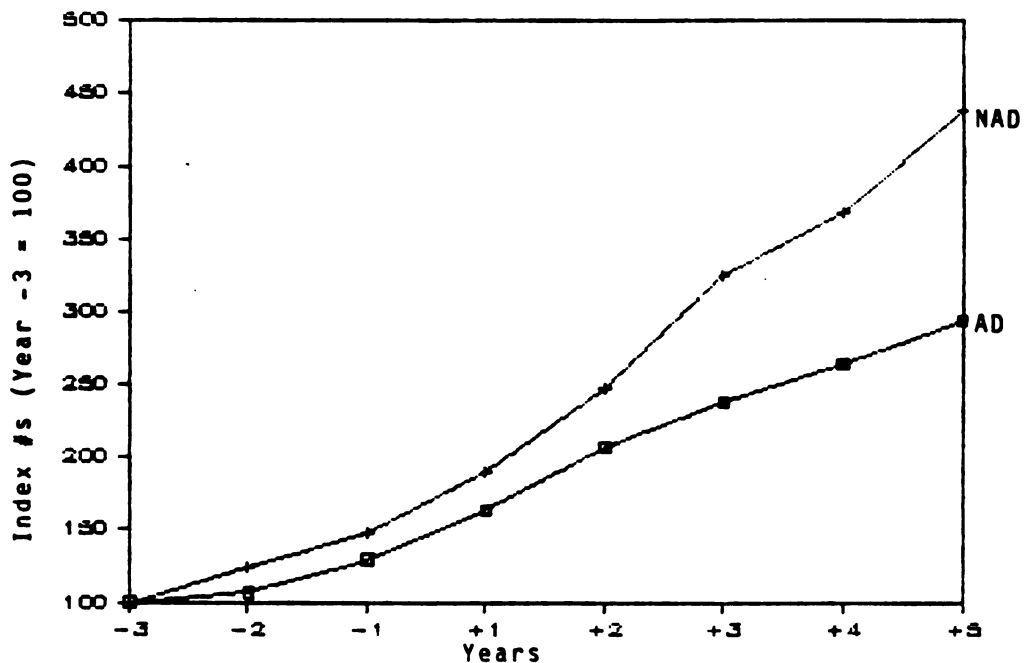


= 0.05. These observed significance levels are much greater than those obtained from a consideration of the entire sample (Tables 7.1 and 7.3). Actually, the computed test statistic would have been significant at  $\alpha = 0.0793$  (R&D growth) and  $\alpha = 0.0087$  (ratio of R&D to Sales) if an alternate hypothesis could have been constructed in the opposite direction. Therefore, the growth in R&D and ratio of R&D to Sales for non-adopting companies, with a five year post-adoption period, is significantly greater than that for adopting companies.

These results are also confirmed in Figures 8.1 and 8.2 which are based on the information contained in Tables 8.9 and 8.10. Tables 8.9 and 8.10 are trend statements based on R&D and ratio of R&D to Sales data contained in Tables 8.5 and 8.6 with year -3 (i.e., the third year preceding the year of adoption) as the base year and subsequent years expressed as a percentage of the base year. Figures 8.1 and 8.2 show that the differences between expenditures for R&D and the ratio of R&D to Sales for adopting and non-adopting companies widened in the fourth and fifth years after adoption as compared to the first three years after adoption. This might indicate that using a five year post-adoption period instead of a three year post-adoption period allowed the non-adopting companies to further the disparity in spending levels for R&D between themselves and the adopting companies.

Figure 8.1

**Trend Graph for R&D Expenditures for  
Five Year Post-Adoption Period  
(Yearly Portfolio Averages)**

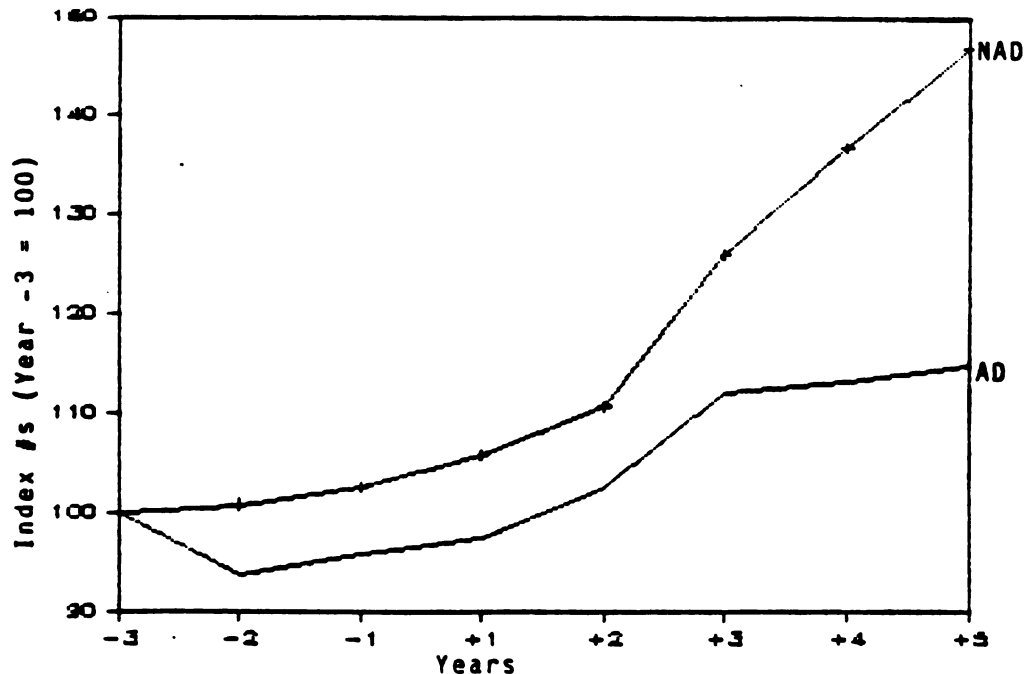


AD = Index #s of yearly average R&D for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 4, 5, 6, 7 and 8 of Table 8.9)

NAD = Index #s of yearly average R&D for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 9, 10, 11, 12, 13, 14, 15 and 16 of Table 8.9)

Figure 8.2

**Trend Graph for Ratio of R&D to Sales for  
Five Year Post-Adoption Period  
(Yearly Portfolio Averages)**



AD = Index #s of yearly average ratio of R&D to Sales for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 4, 5, 6, 7 and 8 of Table 8.10)

NAD = Index #s of yearly average ratio of R&D to Sales for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 9, 10, 11, 12, 13, 14, 15 and 16 of Table 8.10)

Table 8.9

TREND STATEMENT FOR R&D EXPENDITURES  
(Five year post-adoption period)

| Companies<br>(Adopting/non-adopting)   | Adopting Companies |                |                |                |                | Non-adopting Companies |                |                |                |                 |                 |                 |                 |                 |                 |                 |
|----------------------------------------|--------------------|----------------|----------------|----------------|----------------|------------------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                                        | Year -3<br>(1)     | Year -2<br>(2) | Year -1<br>(3) | Year +1<br>(4) | Year +2<br>(5) | Year +3<br>(6)         | Year +4<br>(7) | Year +5<br>(8) | Year -3<br>(9) | Year -2<br>(10) | Year -1<br>(11) | Year +1<br>(12) | Year +2<br>(13) | Year +3<br>(14) | Year +4<br>(15) | Year +5<br>(16) |
| 1 A. E. Staley/Kellogg                 | 100.00             | 110.42         | 127.00         | 145.03         | 107.90         | 200.33                 | 202.00         | 203.75         | 100.00         | 115.50          | 140.05          | 131.17          | 107.61          | 344.16          | 602.00          | 416.29          |
| 2 Ashland Oil/SOHIO                    | 100.00             | 97.95          | 76.46          | 90.87          | 123.41         | 101.43                 | 179.90         | 142.45         | 100.00         | 111.52          | 143.33          | 201.90          | 233.33          | 512.30          | 676.19          | 630.10          |
| 3 Black & Veatch/Baker Intl. Corp      | 100.00             | 113.23         | 140.00         | 175.57         | 197.54         | 194.30                 | 106.25         | 100.61         | 100.00         | 153.39          | 193.46          | 254.56          | 339.49          | 650.02          | 633.53          | 339.95          |
| 4 Bristol Myers/Avon Products          | 100.00             | 109.42         | 127.31         | 144.05         | 197.30         | 190.06                 | 222.67         | 240.56         | 100.00         | 105.63          | 123.63          | 160.62          | 194.54          | 234.19          | 261.22          | 412.10          |
| 5 Brunswick/Emhart                     | 100.00             | 104.03         | 115.76         | 133.30         | 141.32         | 151.09                 | 110.44         | 120.70         | 100.00         | 109.06          | 144.06          | 429.57          | 529.57          | 552.06          | 644.29          | 500.00          |
| 6 Celanese/Hercules Inc.               | 100.00             | 107.79         | 119.40         | 122.00         | 135.06         | 132.47                 | 110.39         | 122.00         | 100.00         | 107.20          | 125.00          | 143.09          | 144.37          | 109.24          | 177.09          | 191.09          |
| 7 Cincinnati Milacron/Ortel            | 100.00             | 113.93         | 125.00         | 137.00         | 176.45         | 137.10                 | 273.91         | 231.03         | 100.00         | 123.00          | 146.15          | 200.00          | 207.69          | 231.20          | 264.10          | 294.07          |
| 8 Combustion Eng/Gillette              | 100.00             | 100.96         | 99.20          | 104.05         | 129.39         | 137.32                 | 162.51         | 149.72         | 100.00         | 110.34          | 120.71          | 132.90          | 146.10          | 141.37          | 160.13          | 170.12          |
| 9 Corning Glass/Corning                | 100.00             | 115.54         | 129.61         | 170.24         | 106.26         | 215.09                 | 200.00         | 211.16         | 100.00         | 93.65           | 129.22          | 101.19          | 259.97          | 267.90          | 327.19          | 340.41          |
| 10 Cummins Engine/Allis Chalmers       | 100.00             | 120.60         | 172.00         | 171.75         | 205.37         | 229.54                 | 257.30         | 294.31         | 100.00         | 115.25          | 113.71          | 93.37           | 125.60          | 150.72          | 107.92          | 105.17          |
| 11 Dalapoint/Hang Labs                 | 100.00             | 150.75         | 291.50         | 653.00         | 646.50         | 646.50                 | 1116.00        | 1101.75        | 100.00         | 153.76          | 206.57          | 306.30          | 040.56          | 150.72          | 2040.16         | 2750.22         |
| 12 General Mills/Coronation            | 100.00             | 102.01         | 124.75         | 140.99         | 151.00         | 179.93                 | 202.60         | 212.37         | 100.00         | 130.14          | 130.14          | 143.04          | 143.01          | 193.15          | 206.30          | 253.42          |
| 13 Herbery Foods/Horrel                | 100.00             | 105.47         | 133.03         | 130.01         | 177.41         | 232.00                 | 246.17         | 293.03         | 100.00         | 100.00          | 120.30          | 177.99          | 164.15          | 165.91          | 173.50          | 103.63          |
| 14 Honeywell/Litton                    | 100.00             | 103.16         | 125.17         | 153.02         | 192.77         | 242.73                 | 303.04         | 324.13         | 100.00         | 105.12          | 127.10          | 125.19          | 127.51          | 146.02          | 153.56          | 104.15          |
| 15 Illinois Tool Works/Bismarck Warner | 100.00             | 105.01         | 110.95         | 131.01         | 151.02         | 160.09                 | 131.19         | 174.95         | 100.00         | 100.95          | 113.70          | 113.70          | 116.93          | 110.44          | 101.93          | 110.14          |
| 16 IM Industries/Schlumberger          | 100.00             | 73.71          | 87.03          | 107.61         | 130.35         | 141.32                 | 170.42         | 203.69         | 100.00         | 110.93          | 126.91          | 167.63          | 243.20          | 340.43          | 604.90          | 604.50          |
| 17 Baker Oats/Intl. Multifoods         | 100.00             | 101.79         | 111.01         | 103.90         | 121.31         | 142.93                 | 150.04         | 139.77         | 100.00         | 104.50          | 103.92          | 113.63          | 124.10          | 104.50          | 117.63          | 103.79          |
| 18 Sanders Associates/Tracer           | 100.00             | 94.34          | 90.57          | 219.43         | 302.20         | 432.00                 | 471.51         | 633.96         | 100.00         | 130.59          | 173.94          | 209.35          | 200.57          | 217.00          | 257.51          | 325.70          |
| 19 Sealed Air/UNIC Ind. Inc.           | 100.00             | 100.00         | 125.12         | 142.10         | 150.77         | 191.94                 | 157.35         | 233.55         | 100.00         | 097.06          | 114.04          | 130.20          | 104.30          | 105.16          | 197.66          | 204.09          |
| 20 Texas Instruments/Raytheon          | 100.00             | 133.11         | 153.72         | 246.94         | 303.16         | 327.30                 | 416.67         | 500.43         | 100.00         | 117.83          | 143.76          | 107.67          | 223.26          | 249.34          | 319.33          | 344.00          |
| 21 United Technologies/Boeing          | 100.00             | 102.75         | 122.44         | 152.10         | 100.21         | 205.29                 | 232.01         | 270.04         | 100.00         | 116.02          | 144.55          | 274.97          | 401.03          | 441.94          | 561.70          | 224.61          |
| Means                                  | 100.00             | 106.42         | 129.50         | 163.43         | 206.30         | 237.20                 | 264.45         | 293.43         | 100.00         | 124.37          | 147.49          | 109.46          | 247.71          | 374.90          | 540.46          | 430.21          |

Table 0.10

**TREND STATEMENT FOR THE RATIO OF R&D EXPENDITURES TO SALES**  
**(Five year post-adoption period)**

| Companies<br>(Adopting/non-adopting)  | Adopting Companies |                |                |                |                | Non-adopting Companies |                 |                 |                 |                 |
|---------------------------------------|--------------------|----------------|----------------|----------------|----------------|------------------------|-----------------|-----------------|-----------------|-----------------|
|                                       | Year -3<br>(1)     | Year -2<br>(2) | Year -1<br>(3) | Year +1<br>(4) | Year +5<br>(5) | Year -3<br>(9)         | Year -2<br>(10) | Year -1<br>(11) | Year +1<br>(12) | Year +5<br>(16) |
| 1 A. E. Staley/Kellogg                | 100.00             | 102.33         | 100.00         | 97.67          | 104.65         | 104.51                 | 134.00          | 127.91          |                 |                 |
| 2 Bland & Baker/Miller Intl. Corp     | 100.00             | 97.29          | 53.57          | 60.71          | 60.71          | 75.00                  | 82.14           | 71.03           |                 |                 |
| 3 Black & Becker/Miller Intl. Corp    | 100.00             | 94.74          | 100.00         | 98.94          | 113.30         | 136.17                 | 129.79          | 104.00          |                 |                 |
| 4 Bristol-Myers/Mon Products          | 100.00             | 100.37         | 104.63         | 104.32         | 107.47         | 116.95                 | 110.39          | 128.05          |                 |                 |
| 5 Brunswich/Echert                    | 100.00             | 95.44          | 94.48          | 96.94          | 104.94         | 103.04                 | 89.35           | 90.00           |                 |                 |
| 6 Colson/Mercedes Inc.                | 100.00             | 95.78          | 87.95          | 94.61          | 83.43          | 100.30                 | 78.61           | 84.94           |                 |                 |
| 7 Cincinnati Milacron/Metek           | 100.00             | 96.22          | 89.00          | 83.83          | 95.80          | 114.09                 | 101.06          | 106.25          |                 |                 |
| 8 Combustion Eng/Elletts              | 100.00             | 94.71          | 83.53          | 80.59          | 80.59          | 74.71                  | 72.94           | 81.10           |                 |                 |
| 9 Corning Glass/Morton                | 100.00             | 105.70         | 100.00         | 118.44         | 114.44         | 128.09                 | 124.22          | 124.09          |                 |                 |
| 10 Cuisins Engine/Allis Chalmers      | 100.00             | 100.00         | 123.40         | 134.17         | 157.90         | 182.45                 | 202.13          | 196.37          |                 |                 |
| 11 Datapoint/Hong Labs                | 100.00             | 111.00         | 120.31         | 101.74         | 150.43         | 159.17                 | 129.35          | 120.00          |                 |                 |
| 12 General Mills/Coronation           | 100.00             | 91.26          | 97.09          | 102.91         | 90.29          | 90.06                  | 104.00          | 109.71          |                 |                 |
| 13 Hershey Foods/Hormel               | 100.00             | 100.00         | 111.11         | 100.00         | 86.11          | 94.44                  | 102.70          | 105.36          |                 |                 |
| 14 Honeywell/Jittion                  | 100.00             | 94.73          | 90.49          | 99.44          | 104.90         | 112.90                 | 129.94          | 124.16          |                 |                 |
| 15 Illinois Tool Works/Stewart Warner | 100.00             | 89.17          | 87.26          | 96.18          | 97.45          | 91.72                  | 77.87           | 84.62           |                 |                 |
| 16 M. Industries/Schlumberger         | 100.00             | 73.29          | 70.81          | 72.67          | 92.50          | 85.71                  | 92.55           | 110.01          |                 |                 |
| 17 Quaker Oats/Intl. MultiFoods       | 100.00             | 96.12          | 97.47          | 77.52          | 74.42          | 80.62                  | 78.29           | 70.00           |                 |                 |
| 18 Sanders Associates/Tracor          | 100.00             | 96.13          | 82.87          | 114.34         | 105.50         | 105.03                 | 119.34          | 124.31          |                 |                 |
| 19 Sealed Air/UNC Ind. Inc.           | 100.00             | 83.09          | 85.91          | 81.00          | 80.34          | 105.47                 | 73.15           | 91.20           |                 |                 |
| 20 Texas Instruments/Raytheon         | 100.00             | 107.00         | 99.77          | 106.19         | 119.30         | 123.46                 | 130.49          | 146.56          |                 |                 |
| 21 United Technologies/Boeing         | 100.00             | 95.40          | 100.00         | 86.09          | 77.23          | 77.52                  | 80.62           | 95.39           |                 |                 |
| Means                                 | 100.00             | 93.61          | 95.68          | 97.34          | 102.41         | 112.01                 | 113.25          | 114.94          |                 |                 |

One explanation for the widening of differences in growth of R&D and ratio of R&D to Sales could be self-selection, i.e., only companies that were not long-term oriented, and perhaps financially weak, were expected to adopt the performance plans. The performance plans may have been unable to maintain the executives' long-term orientation beyond the first three years. Another reason could be that executives may have compared the relatively low, or in some cases, no performance awards received after the completion of their first three year performance cycle with their bonuses and decided to concentrate on maximizing their own utility by focusing on the short-term.

Therefore, the null hypotheses are not rejected and this research concludes that there was no significant difference in the growth in R&D and ratio of R&D to Sales between adopting companies and non-adopting companies using pre and post adoption periods of three and five years respectively. Hence, it is most unlikely that failure to reject the null was caused by using a post-adoption period of three years instead of five years.

#### 8.4 The averaging process used

As discussed in chapter 5.2.2, R&D data for the three year pre and post adoption periods was averaged and the resulting pre and post adoption period averages were used in the tests. Elliott et al (1984) state that such an

averaging process could reduce noise in the measure caused by random fluctuations from year to year. On the other hand, they suggest that the averaging process could remove relevant variation if the fluctuations were not random.

The averaging process could have removed important non-random fluctuations thereby contributing to the failure to reject the null hypothesis which specified that there was no significant difference between the growth in R&D and ratio of R&D to Sales between the adopting and non-adopting companies. In order to statistically test if the averaging process could have led to a failure to reject the null, the R&D figures used in the original computation (Tables 6.4 and 6.5) were modified so as to consider pre and post adoption periods of one year each instead of three years each. This time the pre-adoption period consisted of year - 1 (i.e., the year prior to the year of adoption) whereas the post-adoption period was represented by year +1 (i.e., the first year of operation of the performance plan). Growth in R&D and ratio of R&D to Sales was defined as the percentage increase in a company's post-adoption period (i.e., year +1) as compared to its pre-adoption period (i.e., year -1) (Tables 8.11 and 8.12).

Table A.11  
 R&D EXPENDITURES  
 (1) year, pre and post-adoption periods)

| Company                            | Adopting Companies<br>(1) 12 (12-12-11) | Non-adopting Companies<br>(2) 12 (12-12-10) | Difference<br>(1)-(2) |
|------------------------------------|-----------------------------------------|---------------------------------------------|-----------------------|
| 1 A. E. Industries                 | 7.00                                    | 14.75                                       | -7.75                 |
| 2 A. E. Industries                 | 4.18                                    | 16.18                                       | -11.99                |
| 3 Armstrong Rubber Company         | 7.85                                    | 16.13                                       | -8.28                 |
| 4 Ashland Oil/Shell                | 8.65                                    | 11.36                                       | -2.71                 |
| 5 Baker Petroleum Refining Company | 10.10                                   | 21.39                                       | -11.29                |
| 6 Borden Chemical Products         | 22.78                                   | 18.79                                       | 3.99                  |
| 7 Bristol Petroleum Products       | 62.46                                   | 31.48                                       | 30.98                 |
| 8 Brunswick/Amstar                 | 28.90                                   | 26.57                                       | 2.33                  |
| 9 Crompton Corporation             | 12.00                                   | 20.78                                       | -8.78                 |
| 10 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 11 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 12 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 13 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 14 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 15 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 16 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 17 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 18 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 19 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 20 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 21 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 22 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 23 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 24 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 25 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 26 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 27 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 28 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 29 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 30 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 31 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 32 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 33 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 34 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 35 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 36 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 37 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 38 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 39 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 40 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 41 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 42 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 43 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 44 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 45 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 46 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 47 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 48 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 49 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 50 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 51 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 52 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 53 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 54 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 55 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 56 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 57 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 58 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 59 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 60 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 61 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 62 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 63 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 64 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 65 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 66 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 67 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 68 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 69 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 70 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 71 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 72 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 73 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 74 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 75 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 76 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 77 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 78 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 79 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 80 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 81 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 82 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 83 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 84 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 85 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 86 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 87 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 88 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 89 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 90 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 91 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 92 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 93 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 94 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 95 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 96 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 97 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 98 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 99 Crompton Corporation            | 12.00                                   | 20.78                                       | -8.78                 |
| 100 Crompton Corporation           | 12.00                                   | 20.78                                       | -8.78                 |

\* All expenditures reported  
 in millions of dollars



Table 8.12  
 LIST OF R&D EXPENDITURES IN DOLLARS  
 (1 year pre and post sampling periods)

| Company<br>(Sampling/Non-sampling) | Sampling Companies |                | Non-sampling Companies |                | Reference<br>(1974-76) |
|------------------------------------|--------------------|----------------|------------------------|----------------|------------------------|
|                                    | Year -1<br>(1)     | Year +1<br>(2) | Year -1<br>(3)         | Year +1<br>(4) |                        |
| 1 A. E. Bailey/Calog               | 6.42               | 6.42           | 6.42                   | 6.42           | 21.37                  |
| 2 Allied Capital/Chem              | 1.42               | 1.36           | 4.77                   | 6.96           | 7.72                   |
| 3 American Cyanamid/Chem           | 1.42               | 1.36           | 4.77                   | 6.96           | 7.72                   |
| 4 Amchem/Chem                      | 6.15               | 6.17           | 15.13                  | 6.79           | 26.23                  |
| 5 Brierley/Chem                    | 6.21               | 5.34           | 22.94                  | 6.63           | 7.23                   |
| 6 Brierley/Chem/Pharm              | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 7 Brierley/Chem/Pharm              | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 8 Brierley/Chem/Pharm              | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 9 Brierley/Chem/Pharm              | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 10 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 11 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 12 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 13 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 14 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 15 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 16 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 17 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 18 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 19 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 20 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 21 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 22 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 23 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 24 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 25 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 26 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 27 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 28 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 29 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 30 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 31 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 32 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 33 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 34 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 35 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 36 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 37 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 38 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 39 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 40 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 41 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 42 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 43 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 44 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 45 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 46 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |
| 47 Brierley/Chem/Pharm             | 1.40               | 1.36           | 4.76                   | 6.42           | 4.76                   |

The hypotheses for this test on R&D (ratio of R&D to Sales) are as follows:

- Ho: The growth in R&D (ratio of R&D to Sales) for the adopting companies for the post-adoption period of one year as compared to the pre-adoption period of one year, will not be significantly different than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies over the same periods.
- Ha: The growth in R&D (ratio of R&D to Sales) for the adopting companies for the post-adoption period of one year as compared to the pre-adoption period of one year, will be significantly larger than the growth in R&D (ratio of R&D to Sales) for the non-adopting companies over the same periods.

The Wilcoxon test was performed on the differences in growth of R&D and the ratio of R&D to Sales between the adopting and non-adopting companies. Tables 8.13 and 8.14 show that the sum of the ranks of negative growth in R&D and ratio of R&D to Sales differences (i.e., where the non-adopting companies' growth in R&D and ratio of R&D to Sales exceeds that of the adopting companies) exceeds the mean of the ranks.

The computed test statistic resulted in the observed significance levels of  $\alpha = 0.6103$  for R&D growth (Table 8.13) and  $\alpha = 0.6480$  for growth in ratio of R&D to Sales (Table 8.14) as compared to a desired  $\alpha = 0.05$ . Therefore, the null hypotheses are not rejected and this research concludes that there was no significant difference in the growth in R&D and ratio of R&D to Sales

Table 6.13

THE RECEIVING TEST ON RAIL EXPOSURES  
(1 year per year exposure period)

| Companies<br>(Adopting four sampling) | A      | B      | C     | D  |
|---------------------------------------|--------|--------|-------|----|
| 1 A. E. Day/Calilling                 | 26.15  | -45.93 | 45.93 | 43 |
| 2 Allied Drywall/Baron                | 12.47  | -25.95 | 25.95 | 41 |
| 3 American Drywall/Baron              | 12.47  | -25.95 | 25.95 | 41 |
| 4 Ashland Oil/Baron                   | 6.23   | -21.64 | 21.64 | 40 |
| 5 Baker Vacuum/Baron/Plough           | 29.20  | -27.99 | 27.99 | 39 |
| 6 Bickel/Baker/Burns Ind. Corp        | -27.92 | -27.92 | 27.92 | 38 |
| 7 Bickel/Baker/Burns Ind. Corp        | -27.92 | -27.92 | 27.92 | 38 |
| 8 Borden/Baron                        | -4.34  | -18.19 | 18.19 | 34 |
| 9 Borden/Baron                        | -16.43 | -13.77 | 13.77 | 30 |
| 10 Borden/Baron                       | -16.43 | -13.77 | 13.77 | 30 |
| 11 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 12 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 13 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 14 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 15 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 16 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 17 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 18 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 19 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 20 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 21 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 22 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 23 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 24 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 25 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 26 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 27 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 28 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 29 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 30 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 31 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 32 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 33 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 34 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 35 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 36 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 37 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 38 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 39 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 40 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 41 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 42 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 43 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 44 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 45 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 46 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |
| 47 Ciba/Baron                         | -23.46 | -14.86 | 14.86 | 27 |

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon test is computed as follows:

$$T = \sum_{i=1}^n R_i = \sum_{i=1}^n (R_i - 0.5(n+1))$$

$$T_{0.05, n} = [0.7081(n+1)(n+1)]^{1/2}$$

$$T_{0.01, n} = [0.854(n+1)(n+1)]^{1/2}$$

$$T_{0.001, n} = [1.024(n+1)(n+1)]^{1/2}$$

$$T_{0.0001, n} = [1.201(n+1)(n+1)]^{1/2}$$

$$T_{0.00001, n} = [1.378(n+1)(n+1)]^{1/2}$$

$$T_{0.000001, n} = [1.555(n+1)(n+1)]^{1/2}$$

$$T_{0.0000001, n} = [1.732(n+1)(n+1)]^{1/2}$$

$$T_{0.00000001, n} = [1.909(n+1)(n+1)]^{1/2}$$

$$T_{0.000000001, n} = [2.086(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000001, n} = [2.263(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000001, n} = [2.440(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000001, n} = [2.617(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000001, n} = [2.794(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000001, n} = [2.971(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000001, n} = [3.148(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000001, n} = [3.325(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000001, n} = [3.502(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000001, n} = [3.679(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000001, n} = [3.856(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000001, n} = [4.033(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000001, n} = [4.210(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000001, n} = [4.387(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000001, n} = [4.564(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000001, n} = [4.741(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000001, n} = [4.918(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000001, n} = [5.095(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000001, n} = [5.272(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000001, n} = [5.449(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000001, n} = [5.626(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000001, n} = [5.803(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000001, n} = [5.980(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000001, n} = [6.157(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000001, n} = [6.334(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000001, n} = [6.511(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000001, n} = [6.688(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000001, n} = [6.865(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000000001, n} = [7.042(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000000001, n} = [7.219(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000000001, n} = [7.396(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000000000001, n} = [7.573(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000000000001, n} = [7.750(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000000000001, n} = [7.927(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000000000000001, n} = [8.104(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000000000000001, n} = [8.281(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000000000000001, n} = [8.458(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000000000000000001, n} = [8.635(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000000000000000001, n} = [8.812(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000000000000000001, n} = [8.989(n+1)(n+1)]^{1/2}$$

$$T_{0.0000000000000000000000000000000000000000000000001, n} = [9.166(n+1)(n+1)]^{1/2}$$

$$T_{0.00000000000000000000000000000000000000000000000001, n} = [9.343(n+1)(n+1)]^{1/2}$$

$$T_{0.000000000000000000000000000000000000000000000000001, n} = [9.520(n+1)(n+1)]^{1/2}$$

Notes:

A = Difference in grade of rail between

sampling and non-sampling segments

B = Difference in grade of rail between

sampling and non-sampling segments

C = Difference in grade of rail between

sampling and non-sampling segments

D = Difference in grade of rail between

sampling and non-sampling segments

E = Difference in grade of rail between

sampling and non-sampling segments

F = Difference in grade of rail between

sampling and non-sampling segments

G = Difference in grade of rail between

sampling and non-sampling segments

H = Difference in grade of rail between

sampling and non-sampling segments

I = Difference in grade of rail between

sampling and non-sampling segments

J = Difference in grade of rail between

sampling and non-sampling segments

K = Difference in grade of rail between

sampling and non-sampling segments

L = Difference in grade of rail between

sampling and non-sampling segments

M = Difference in grade of rail between

sampling and non-sampling segments

N = Difference in grade of rail between

sampling and non-sampling segments

O = Difference in grade of rail between

sampling and non-sampling segments

P = Difference in grade of rail between

sampling and non-sampling segments

Q = Difference in grade of rail between

sampling and non-sampling segments

R = Difference in grade of rail between

sampling and non-sampling segments

S = Difference in grade of rail between

sampling and non-sampling segments

Table B-1

THE WILCOX TEST ON THE RESULTS OF 500 COMPARISONS TO SUEZ  
(1 year pre and post-shipment periods)

| Companies<br>(Shipping/Year-shipment) | A     | B      | C     | D  | The Wilcoxon Test                                                      |
|---------------------------------------|-------|--------|-------|----|------------------------------------------------------------------------|
| 1 A. C. Burdette/Ship                 | 21.87 | -46.18 | 64.18 | 46 | According to Siegel (1956), the Wilcoxon test is completed as follows: |
| 2 A. C. Burdette/Ship                 | 21.87 | -46.18 | 64.18 | 46 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 3 Westing House/Cooper Tire           | 22.16 | -41.78 | 61.78 | 41 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 4 United Oil/Shell                    | 26.23 | -37.78 | 57.78 | 42 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 5 American Petroleum Corp/Shell       | 26.23 | -37.78 | 57.78 | 42 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 6 American Petroleum Corp/Shell       | 26.23 | -37.78 | 57.78 | 42 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 7 British Petroleum Products          | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 8 Borealis/Shell                      | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 9 Borealis/Shell                      | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 10 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 11 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 12 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 13 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 14 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 15 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 16 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 17 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 18 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 19 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 20 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 21 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 22 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 23 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 24 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 25 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 26 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 27 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 28 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 29 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 30 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 31 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 32 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 33 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 34 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 35 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 36 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 37 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 38 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 39 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 40 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 41 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 42 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 43 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 44 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 45 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 46 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |
| 47 Borealis/Shell                     | -4.54 | -17.43 | 26.43 | 27 | $T = \text{Rank} \dots \dots \dots T = 11000(04-1)$                    |

Index:

- A = Differences in grade of the ratio of MB to Sales between shipping and non-shipping companies (column 7 of Table B-1). A negative value indicates that the shipping company is MB to Sales for a non-shipping company as compared to its matched shipping company and vice versa.
- B = Column A sorted in ascending order.
- C = Absolute values for the amounts in column A.
- D = Absolute values in column C ranked in ascending order.
- E = Sum of the ranks of negative amounts in column B.
- F = Number of matched pairs.

T = 100

between adopting companies and non-adopting companies using pre and post adoption periods of one year each. Hence, it is unlikely that the averaging process contributed to the failure to reject the null.

#### 8.5 R&D as an appropriate surrogate for long-term oriented behavior

Another explanation for the failure to reject the null hypothesis, which stated that there was no significant difference in the growth of R&D and ratio of R&D to Sales between adopting and non-adopting companies, could be that executives of adopting companies might not have considered R&D to be a crucial element in their companies' long-term survival. This could be due to a perception that R&D is either wasteful, overrated, unnecessary or because the risk-reward tradeoff was not attractive. R&D may not have been impacted by the introduction of performance plans even though the adopting companies may have become long-term oriented. These executives could pursue their long-term orientation by increasing expenditures on capital equipment, repairs and maintenance etc.. In addition, companies may, either inadvertently or otherwise, classify their R&D expenditures as capital expenditures in order to avoid writing them off in the year of incurrence as required by SFAS No. 2. This might make capital expenditures an even more important surrogate for management's long-term oriented behavior.

One expenditure that has already been considered as a surrogate for long-term oriented behavior is capital expenditures. Larcker (1983) used capital expenditures as such a surrogate and found that growth of capital expenditures for a portfolio of adopting companies was significantly greater than that for a portfolio of non-adopting companies. Hence the executives of these adopting companies could have reflected their long-term orientation, pursuant to adoption of performance plans, by increasing the growth of capital expenditures.

Therefore, it is possible that the null hypothesis, which proposed that there was no significant difference in the growth in R&D and ratio of R&D to Sales between adopting and non-adopting companies, was not rejected because executives did not consider R&D crucial to their companies' long-term survival. However, it must be noted that this alternate hypothesis contradicts research cited in chapter 4 which concludes that R&D has a lagged relationship with the companies' value.

The same 47 matched pairs that were used in the original R&D computations in chapter 7 were used for the tests on capital expenditures. Most of the 1975-82 capital expenditures data was extracted from the Valueline database and the remaining data was taken from the companies' 10K statements and annual reports. (Tables 8.15 and 8.16). It was expected that, following Larcker's (1983) results, the



Table A-18

## INDEX OF CAPITAL EXPENDITURES IN DOLLARS

| Companies<br>(Alphabetically) | Mining Companies |                |                |                |                | Non-mining Companies |                 |                 |                 |                 | Difference<br>(1980-1970) |
|-------------------------------|------------------|----------------|----------------|----------------|----------------|----------------------|-----------------|-----------------|-----------------|-----------------|---------------------------|
|                               | Year -3<br>(1)   | Year -2<br>(2) | Year -1<br>(3) | Year +0<br>(4) | Year +1<br>(5) | Year -3<br>(10)      | Year -2<br>(11) | Year -1<br>(12) | Year +0<br>(13) | Year +1<br>(14) |                           |
| 1 A. C. Bailey Corp.          | 3.26             | 3.41           | 3.11           | 5.48           | 13.32          | 26.27                | 12.93           | 152.87          | 4.75            | 5.51            | 137.25                    |
| 2 Allied Capital Corp.        | 17.50            | 16.44          | 14.25          | 5.51           | 8.26           | 9.23                 | 26.42           | 5.84            | 5.73            | 5.12            | 17.25                     |
| 3 American Cyanamid Corp.     | 1.00             | 1.00           | 1.00           | 1.00           | 1.00           | 1.00                 | 1.00            | 1.00            | 1.00            | 1.00            | 0.00                      |
| 4 Armstrong Rubber Corp.      | 1.00             | 1.00           | 1.00           | 1.00           | 1.00           | 1.00                 | 1.00            | 1.00            | 1.00            | 1.00            | 0.00                      |
| 5 Armstrong Rubber Corp.      | 1.00             | 1.00           | 1.00           | 1.00           | 1.00           | 1.00                 | 1.00            | 1.00            | 1.00            | 1.00            | 0.00                      |
| 6 Baker & Baker Inc.          | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 7 Baker & Baker Inc.          | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 8 Baker & Baker Inc.          | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 9 Baker & Baker Inc.          | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 10 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 11 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 12 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 13 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 14 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 15 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 16 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 17 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 18 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 19 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 20 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 21 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 22 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 23 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 24 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 25 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 26 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 27 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 28 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 29 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 30 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 31 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 32 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 33 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 34 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 35 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 36 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 37 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 38 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 39 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 40 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 41 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 42 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 43 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 44 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 45 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 46 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 47 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 48 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 49 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |
| 50 Baker & Baker Inc.         | 8.79             | 8.53           | 7.71           | 6.98           | 16.45          | 5.56                 | 5.43            | 26.36           | 5.82            | 7.08            | 17.28                     |

Base  
1970Base  
1970



growth (as defined in chapter 5.2.2 for R&D) in capital expenditures and the ratio of capital expenditures to sales for the portfolio of adopting companies would be significantly larger than that for the portfolio of non-adopting companies.

The hypotheses for this test on capital expenditures (ratio of capital expenditures to sales) are as follows:

**H<sub>0</sub>:** The growth in capital expenditures (ratio of capital expenditures to sales) for the portfolio of adopting companies will not be significantly different than the growth in capital expenditures (ratio of capital expenditures to sales) for the non-adopting companies.

**H<sub>a</sub>:** The growth in capital expenditures (ratio of capital expenditures to sales) for the portfolio of adopting companies will be significantly larger than the growth in capital expenditures (ratio of capital expenditures to sales) for the non-adopting companies.

The Wilcoxon test was performed on the differences in growth of capital expenditures and the ratio of capital expenditures to sales between the adopting and non-adopting companies. Tables 8.17 and 8.18 show that the sum of the ranks of negative growth in capital expenditures and ratio of capital expenditures to sales differences (i.e., where the non-adopting companies' growth in capital expenditures and ratio of capital expenditures to sales exceeds that of the adopting companies) exceeds the mean of the ranks.

Table 8.17  
THE WILCOX TEST ON CAPITAL EXPENDITURES

| Computers<br>(adding/subtracting) | A       | B       | C      | D   |
|-----------------------------------|---------|---------|--------|-----|
| 1 A. C. Rely/Reling               | 212.25  | -464.56 | 464.56 | 47  |
| 2 Capital Machine                 | 152.45  | -171.36 | 171.36 | 46  |
| 3 Rethel/Reling Computer          | -152.45 | -171.36 | 171.36 | 45  |
| 4 Reland B1/Reland                | -152.45 | -151.18 | 151.18 | 39  |
| 5 Motor Transm/Reling Pump        | 21.89   | -107.44 | 107.44 | 29  |
| 6 Reland B1/Reland                | 21.89   | -107.44 | 107.44 | 28  |
| 7 Rethel/Reling Products          | -171.36 | -91.31  | 91.31  | 24  |
| 8 Rethel/Reland                   | -79.63  | -61.62  | 61.62  | 23  |
| 9 Rethel/Reland                   | -61.62  | -79.63  | 79.63  | 22  |
| 10 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 21  |
| 11 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 20  |
| 12 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 19  |
| 13 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 18  |
| 14 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 17  |
| 15 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 16  |
| 16 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 15  |
| 17 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 14  |
| 18 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 13  |
| 19 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 12  |
| 20 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 11  |
| 21 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 10  |
| 22 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 9   |
| 23 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 8   |
| 24 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 7   |
| 25 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 6   |
| 26 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 5   |
| 27 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 4   |
| 28 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 3   |
| 29 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 2   |
| 30 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 1   |
| 31 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | 0   |
| 32 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -1  |
| 33 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -2  |
| 34 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -3  |
| 35 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -4  |
| 36 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -5  |
| 37 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -6  |
| 38 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -7  |
| 39 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -8  |
| 40 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -9  |
| 41 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -10 |
| 42 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -11 |
| 43 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -12 |
| 44 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -13 |
| 45 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -14 |
| 46 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -15 |
| 47 Rethel/Reland                  | -61.62  | -79.63  | 79.63  | -16 |

The Wilcoxon Test:

According to Siegel (1956), the Wilcoxon test is computed as follows:

$$T = \sum_{i=1}^n R_i = \sum_{i=1}^n (R_i - 0.5n) = \sum_{i=1}^n R_i - 0.5n(n+1)$$

where  $R_i$  = Rank of the  $i$ th observation in the combined sample of  $n$  observations.  
 $n$  = Number of observations in the combined sample.  
 $0.5n(n+1)$  = The sum of the first  $n$  natural numbers.

The Wilcoxon test statistic is computed as follows:

$$W = \frac{T - 0.5n(n+1)}{\sqrt{\frac{n(n+1)}{12}}}$$

where  $W$  = Wilcoxon test statistic.  
 $T$  = Sum of the ranks of the observations in the combined sample.  
 $n$  = Number of observations in the combined sample.  
 $0.5n(n+1)$  = The sum of the first  $n$  natural numbers.

The Wilcoxon test statistic is computed as follows:

$$W = \frac{T - 0.5n(n+1)}{\sqrt{\frac{n(n+1)}{12}}}$$

where  $W$  = Wilcoxon test statistic.  
 $T$  = Sum of the ranks of the observations in the combined sample.  
 $n$  = Number of observations in the combined sample.  
 $0.5n(n+1)$  = The sum of the first  $n$  natural numbers.

Table 0.10  
THE WILCOXON TEST ON THE RATIO OF CAPITAL EXPENDITURES TO SALES

| Companies<br>(Adapting/non-adapting)   | A       | B       | C      | D | E  |
|----------------------------------------|---------|---------|--------|---|----|
| 1 A. E. Staley/Alltag                  | 137.39  | -104.21 | 140.21 |   | 47 |
| 2 Allied Corp/Milliken                 | -97.48  | -125.39 | 125.39 |   | 44 |
| 3 Armstrong Rubber/Cooper Tire         | -94.43  | -104.99 | 104.99 |   | 42 |
| 4 Ashland Oil/MSB                      | 17.76   | -61.45  | 96.43  |   | 41 |
| 5 Baiter Irons/Boeing Pileup           | -4.76   | -61.09  | 66.09  |   | 40 |
| 6 Black & Veatch/Boyer Ind. Corp       | 57.70   | -61.06  | 67.43  |   | 37 |
| 7 Bristol Myers/Sloan Products         | -66.69  | -64.90  | 64.90  |   | 36 |
| 8 Brunswick/Edhart                     | -13.43  | -67.40  | 57.40  |   | 35 |
| 9 Burrage/NEC                          | -30.47  | -62.11  | 52.11  |   | 33 |
| 10 Colson/Mercator Inc.                | -2.06   | -61.00  | 51.00  |   | 32 |
| 11 Cromptell Micro/Permet              | -2.71   | -61.00  | 61.00  |   | 30 |
| 12 Combustion Eng/Millite              | -65.46  | -54.96  | 54.96  |   | 29 |
| 13 Cooper Industries/Orme              | 76.29   | -54.96  | 54.96  |   | 28 |
| 14 Cooper Labs/ICI Pharmaceuticals     | 4.10    | -54.07  | 54.07  |   | 26 |
| 15 Corning Glass/Martin                | 6.70    | -57.29  | 57.29  |   | 25 |
| 16 Corning Glass/Morris                | 72.18   | -54.05  | 54.05  |   | 24 |
| 17 Delapack/Ring Lube                  | -104.90 | -52.93  | 52.93  |   | 23 |
| 18 Diamond Shamrock/Elbey Corp         | -18.46  | -51.43  | 51.43  |   | 22 |
| 19 Eastman Kodak/Johnson & Johnson     | 13.92   | -54.90  | 54.90  |   | 20 |
| 20 Ecolab/Procter                      | 3.32    | -53.33  | 53.33  |   | 19 |
| 21 Ferro/Pharm Chemical                | 7.50    | -53.00  | 53.00  |   | 18 |
| 22 General Mills/Canadian              | -4.40   | -47.73  | 67.73  |   | 12 |
| 23 General Motors/Ford                 | -41.40  | -7.30   | 7.30   |   | 9  |
| 24 Hershey Foods/Marcel                | 19.11   | -4.90   | 4.90   |   | 7  |
| 25 Honeywell/Allen                     | -82.11  | -4.40   | 4.40   |   | 5  |
| 26 Illinois Tool Works/Boomer's Barter | 16.19   | -4.02   | 4.02   |   | 4  |
| 27 Koppers/Fairchild                   | -4.02   | -3.86   | 3.86   |   | 3  |
| 28 Louisville/Ph. S. S. Sponen         | -7.10   | -2.71   | 2.71   |   | 1  |
| 29 Macmillan/John                      | -21.43  | 3.32    | 3.32   |   | 2  |
| 30 Macquarie Mining/IBM                | -15.32  | 6.70    | 6.70   |   | 6  |
| 31 MCI/Boeing                          | 41.79   | 6.40    | 6.40   |   | 8  |
| 32 M. Industries/Schlumberger          | 7.57    | 7.57    | 7.57   |   | 10 |
| 33 Owens/Irry Int.                     | -24.43  | 7.30    | 7.30   |   | 11 |
| 34 Peabody Energy/Briggs & Stratton    | 129.94  | 16.19   | 16.19  |   | 13 |
| 35 Queen Canning/Libby Foods/Ford      | 13.29   | 12.30   | 12.30  |   | 14 |
| 36 Phillips Petroleum/Citizens Service | -6.73   | 13.29   | 13.29  |   | 15 |
| 37 Baker Bata/Int'l. Bullfinch         | -24.46  | 13.92   | 13.92  |   | 17 |
| 38 Borden/Unilever                     | -125.39 | 17.70   | 17.70  |   | 19 |
| 39 Borden's Household/Procter          | 126.50  | 19.11   | 19.11  |   | 21 |
| 40 Borden's Paper/Int'l. Ind. Inc.     | -146.21 | 32.31   | 32.31  |   | 27 |
| 41 Shell/Standard Oil (Indiana)        | -22.73  | 41.79   | 41.79  |   | 31 |
| 42 Tesco/Faxon                         | 12.30   | 57.70   | 57.70  |   | 34 |
| 43 Texas Instruments/Raytheon          | -29.29  | 76.29   | 76.29  |   | 38 |
| 44 Tetra/Arco                          | -24.95  | 72.18   | 72.18  |   | 39 |
| 45 United Technologies/Boeing          | -49.43  | 126.50  | 126.50 |   | 43 |
| 46 Warner Lambert/Calgate Pediatric    | -51.46  | 127.36  | 127.36 |   | 45 |
| 47 Westinghouse/NEC                    | 33.31   | 129.94  | 129.94 |   | 46 |

The Wilcoxon Test:

According to Siegel (1954), the Wilcoxon test is computed as follows:

$$T = \frac{1}{2} (n+1) + \frac{1}{2} (n+1) (n+1) \left( \frac{1}{2} \right) \\ \text{S.E. Dev.} = \frac{1}{2} (n+1) (n+1) (n+1) \left( \frac{1}{2} \right)$$

$$Z = \frac{T - \text{S.E. Dev.}}{\text{S.E. Dev.}} = \frac{94.39}{1.32} = 71.43$$

$Z = 1.32$  would permit rejection of  $H_0$  at  $\alpha = 0.005$  (1,000 - 0.005). However,  $\alpha = 0.05$  is acceptable and hence  $H_0$  is not rejected.

Notes:

A = Difference in growth of ratio of capital expenditures to sales between adapting and non-adapting companies (column 19 of Table 0.10). A negative amount would signify a larger growth in ratio of capital expenditures to sales for a non-adapting company as compared to its matched adapting company and vice-versa.

B = Column A sorted in ascending order.

C = Absolute values for the amounts in column B.

D = Absolute values in column C ranked in ascending order.

E = One of the ranks of the negative amounts in column D.

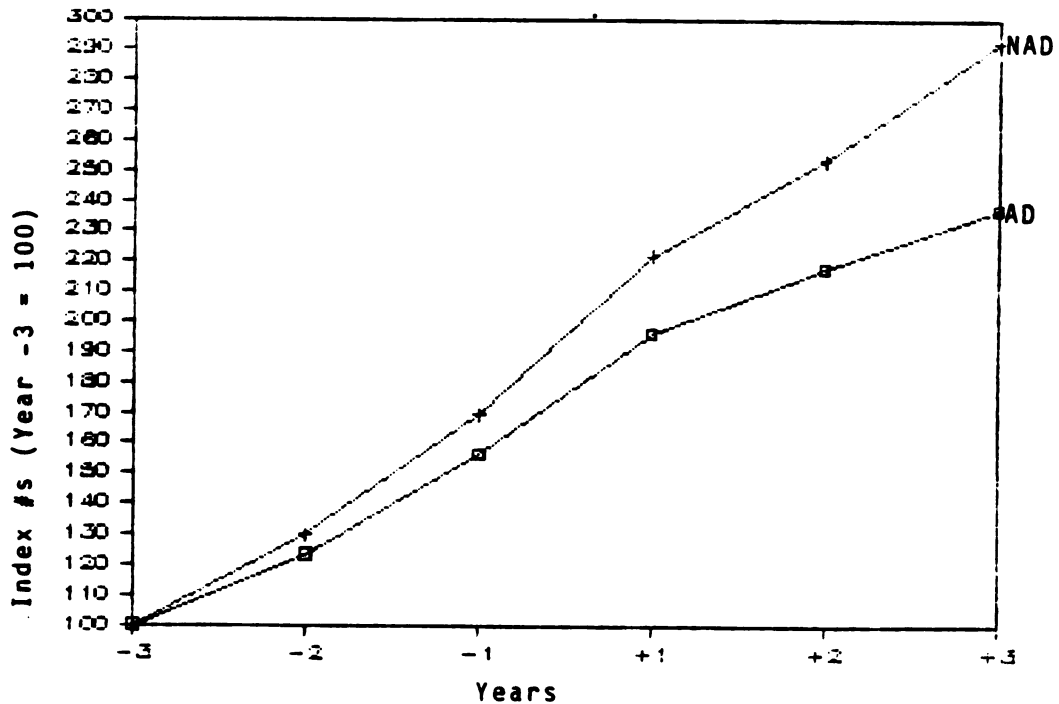
F = Number of matched pairs.

The computed test statistic resulted in the observed significance levels of  $\alpha = 0.8997$  for growth in capital expenditures (Table 8.17) and  $\alpha = 0.9066$  for growth in ratio of capital expenditures to sales (Table 8.18) as compared to a desired  $\alpha = 0.05$ . This is confirmed by Figures 8.3 and 8.4 which are based on the information contained in Tables 8.19 and 8.20. Tables 8.19 and 8.20 are trend statements based on capital expenditures and ratio of capital expenditures to sales data contained in Tables 8.15 and 8.16 with year -3 (i.e., the third year preceding the year of adoption) as the base year and subsequent years expressed as a percentage of the base year. Figures 8.3 and 8.4 show that the differences between capital expenditures and ratios of capital expenditures to sales for adopting and non-adopting companies widened in the post-adoption period.

Therefore, the null hypotheses are not rejected and this research concludes that there was no statistically significant difference in the growth in capital expenditures and ratio of capital expenditures to sales between adopting companies and non-adopting companies. These results indicate that the failure to reject the null was not because R&D was considered unimportant to the long-term survival of the company. The same tests conducted on the same sample of companies in the context of capital expenditures also resulted in a failure to reject the null.

Figure 8.3

**Trend Graph for Capital Expenditures  
(Yearly Portfolio Averages)**

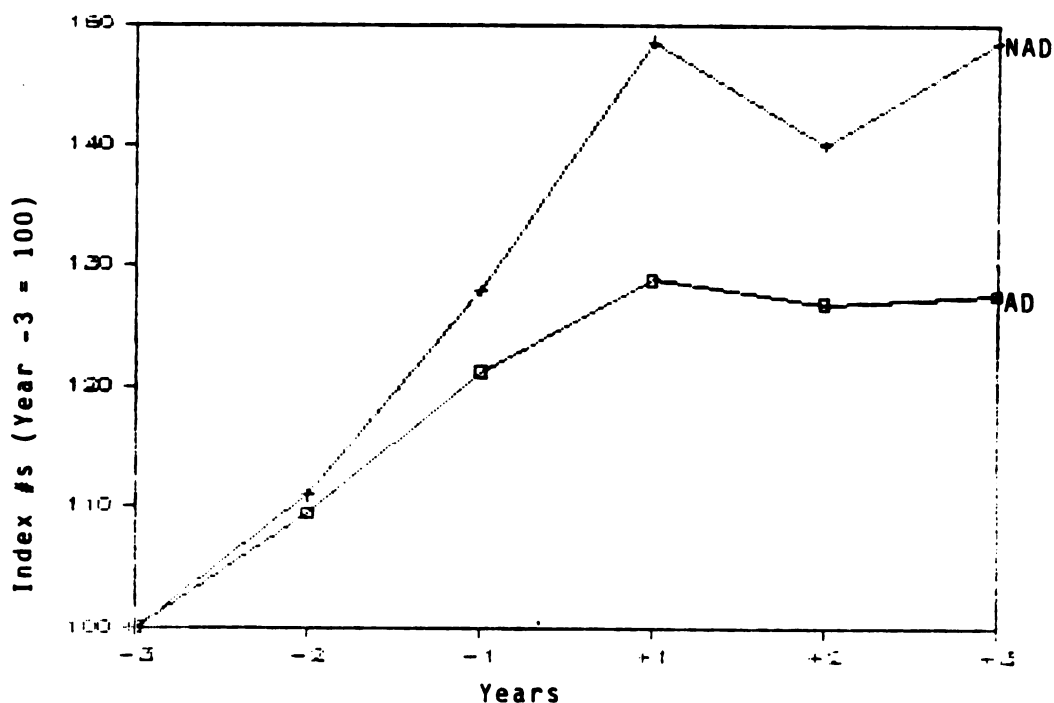


AD = Index #s of yearly average of capital expenditures for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 8.19)

NAD = Index #s of yearly average of capital expenditures for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 8.19)

Figure 8.4

**Trend Graph for Ratio of Capital  
Expenditures to Sales  
(Yearly Portfolio Averages)**



**AD** = Index #s of yearly average ratio of capital expenditures to sales for the portfolio of adopting companies with year -3 (i.e. the base year) = 100 (columns 1, 2, 3, 5, 6, and 7 of Table 8.20)

**NAD** = Index #s of yearly average ratio of capital expenditures to sales for the portfolio of non-adopting companies with year -3 (i.e. the base year) = 100 (columns 10, 11, 12, 14, 15 and 16 of Table 8.20)







This latter result conflicts with Larcker's (1983) study where he found that the capital expenditure growth for his sample of adopting companies was significantly larger than that for non-adopting companies. It is possible that factors such as differences in sample selected, sample size and accuracy in matching, etc. accounted for the conflict in results.

The results of the alternate hypotheses are summarized in Table 8.21. This chapter concludes by stating that the results obtained in this research are determined by the sample selected, the size of the sample, the effectiveness in matching of adopting with non-adopting companies etc.. These factors could have biased the results and hence additional research with different samples etc. is needed before these results can be generalized. The next chapter concludes this research by evaluating the implications of the results and suggesting future areas of research.

Table 8.21

Summary of results of Alternate Hypotheses

| # | Rationale                                                                                                                                                                                                                                                              | Results of the Tests                                                                                                                                                                                                | Conclusions                                                                                                                                                                                                                                                                                                                                                                     |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <p>Inclusion of companies that did not adjust their bonus plans downward could have contributed to a failure to reject the null.</p> <p>The Wilcoxon test was performed on four companies that adjusted their bonus plans downward.</p>                                | <p>The null hypothesis was not rejected at <math>\alpha=0.05</math>. The Wilcoxon tests were significant at <math>\alpha = 0.4375</math> (R&amp;D) and <math>\alpha=0.6875</math> (ratio of R&amp;D to Sales).</p>  | <p>Inclusion of companies that did not adjust their bonus plans downward, did not contribute to the failure to reject the null subject to two qualifications. First, failure to reject could have resulted from companies not adjusting their bonus plans sufficiently downward to make the bonus competitive with the performance plan. Second, the sample size was small.</p> |
| 2 | <p>Inclusion of companies that had not completed at least one performance cycle could have contributed to a failure to reject the null.</p> <p>The Wilcoxon test was performed on 42 companies that had completed at least one performance cycle.</p>                  | <p>The null hypotheses was not rejected at <math>\alpha=0.05</math>. The Wilcoxon tests were significant at <math>\alpha = 0.7611</math> (R&amp;D) and <math>\alpha = 0.8365</math> (ratio of R&amp;D to Sales)</p> | <p>Inclusion of companies that had not completed at least one performance cycle, did not contribute to the failure to reject the null.</p>                                                                                                                                                                                                                                      |
| 3 | <p>Using a three year post-adoption period instead of a five year post-adoption period could have contributed to a failure to reject the null.</p> <p>The Wilcoxon test was performed on 21 companies for whom five year post-adoption R&amp;D data was available.</p> | <p>The null hypotheses was not rejected at <math>\alpha=0.05</math>. The Wilcoxon tests were significant at <math>\alpha = 0.9207</math> (R&amp;D) and <math>\alpha = 0.9913</math> (ratio of R&amp;D to Sales)</p> | <p>Using a three year post-adoption period instead of a five year post-adoption period, did not contribute to a failure to reject the null. The results were significant for an alternate hypothesis in the opposite direction.</p>                                                                                                                                             |

Table 8.21 (Cont'd.)

| # | Rationale                                                                                                                                                                                                                                                                                                                                                                                                                                  | Results of the tests                                                                                                                                                                                                                             | Conclusions                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | <p>Using an averaging process instead of one year pre and post-adoption periods could have removed relevant non-random fluctuations, thereby contributing to a failure to reject the null.</p> <p>The Wilcoxon test was performed on all 47 matched-pairs with pre and post-adoption periods of one year each.</p>                                                                                                                         | <p>The null hypothesis was not rejected at <math>\alpha = 0.05</math>. The Wilcoxon tests were significant at <math>\alpha = 0.6103</math> (R&amp;D) and <math>\alpha = 0.6490</math> (ratio of R&amp;D to Sales).</p>                           | <p>Using an averaging process instead of one year pre and post-adoption periods, did not contribute to the failure to reject the null.</p>                                                                                                                                                                                                                                                                                                                                    |
| 5 | <p>Considering R&amp;D as a surrogate for long-term oriented behavior could have contributed to a failure to reject the null.</p> <p>The Wilcoxon test was performed on capital expenditures (which were assumed for this hypothesis, to be a better surrogate than R&amp;D for long-term oriented behavior). The experimental design used was identical to that used for R&amp;D and the test was performed for the 47 matched-pairs.</p> | <p>The null hypothesis was not rejected at <math>\alpha = 0.05</math>. The Wilcoxon tests were significant at <math>\alpha = 0.8997</math> (capital expenditures) and <math>\alpha = 0.9066</math> (ratio of capital expenditures to sales).</p> | <p>It is unlikely that using R&amp;D as a surrogate for long-term oriented behavior contributed to the failure to reject the null, since the tests on capital expenditures also resulted in a failure to reject the null.</p> <p>Conflict between these results and Larcher's (1983) results regarding capital expenditures as a surrogate for long-term oriented behavior, could have been caused by differences in sample used, sample, size, accuracy in matching etc.</p> |

## **CHAPTER 9**

### **CONCLUSION**

Performance plans are a recent addition to the variety of incentive compensation schemes that are presently used to compensate top corporate executives. Companies introducing these plans expect that executives will be motivated by the plans to remain with the company and work towards its long-term success. An extract of the proxy statement of Eastman Kodak (Table 9.1) reflects that company's expectation for the performance plan. In addition, these plans are expected to reduce the divergence of interests between executives and stockholders and motivate executives to maximize the value of the company by making their rewards contingent on long-term accounting numbers based performance.

Performance plans are widely used in large corporations; Rich and Larson (1984) report that 40% of Fortune 500 companies have already adopted performance plans. Rich and Larson (1984) also estimate that \$1.5 billion will be spent on these plans over the next ten years. Since companies are expected to make a huge

Table 9.1

**Extract from proxy statement: Eastman Kodak**

"The Company is proposing for shareholder approval an Incentive Stock Option Plan and a Long Term Performance Award Plan. The Board of Directors, following a review of the Company's compensation program, has approved each plan subject to approval by the shareholders.

The two Plans are designed to improve the performance of the Company and, by so doing, to serve the interests of its shareowners. Each is designed to encourage sound decision making and to motivate key employees, drawing from them maximum effort in the Company's best interest. By increasing the ownership of Kodak shares among those who play significant roles in the Company's success, implementation of the plans will clearly identify and emphasize the mutual interests of employees and shareholders. In addition, their adoption should have a positive effect on the Company's ability to attract and retain men and women with leadership potential."

Source: Eastman Kodak  
Proxy statement dated  
March 24, 1982, p. 19

commitment to these plans, it is necessary to determine if performance plans deliver what is expected of them.

Larcker (1983) evaluated performance plans and found that companies adopting performance plans experienced a significantly larger growth in capital expenditures than did the non-adopting companies. This research adopted R&D as the surrogate for long-term orientation and hypothesized that companies adopting performance plans would experience a significantly larger R&D growth than that experienced by non-adopting companies. However, this research concludes that companies adopting long-term performance plans did not experience a significantly larger growth in R&D expenditures and the ratio of R&D to Sales than the non-adopting companies. Actually, an important result of this research was that the adopting companies experienced a smaller, though not significant, growth in R&D expenditures and ratio of R&D to Sales as compared to the non-adopting companies.

It is also noteworthy that an additional test on growth of capital expenditures for the same sample of matched pairs found that the growth in capital expenditures and ratio of capital expenditures to sales for adopting companies was not significantly different from that of the non-adopting companies. These results also indicated that the growth in capital expenditures and the ratio of capital expenditures to sales for non-adopting companies was

larger, though not significantly, than that of the adopting companies.

This divergence of results between this research and Larcker's (1983) study could have been caused by methodological problems such as different samples, different sample sizes, imperfect matching etc.. Therefore, the effectiveness of performance plans in inducing long-term oriented actions is still an open question and additional research needs to be done to resolve this issue.

Chapter 8 evaluated and rejected all but one of the alternate hypotheses which could have explained the failure to reject the null. The one hypothesis that should be investigated further as a possible explanation for the failure to reject the null hypothesis concerned the possibility that bonus plans were much more generous than performance plans and could have affected the results by making performance plans unattractive in comparison. The tests performed in this research concerning the importance of bonus vs. performance plans were inadequate for two reasons. First, there were only four adopting companies that adjusted their bonus plans downward to make them competitive with performance plans. The small sample size could have affected the results. Second, it is possible that these four companies did not adjust their bonus plans sufficiently downward to make them competitive with performance plans. Since the test did not consider the

magnitude of downward adjustment, an insufficient downward adjustment could have affected the results.

On the other hand, a more plausible explanation could be that companies adopted performance plans for reasons other than to make their executives long-term oriented. Chapter 2 discussed recent studies by Benston (1985), Coughlan and Schmidt (1985) and Murphy (1985) which hypothesized that there is an alignment of interests between corporate executives and their stockholders. As a result, executives would attempt to maximize the long-term value of the company as measured by the stock market and must already be long-term oriented. Therefore, it is unlikely that the performance plans were adopted to make already long-term oriented executives even more long-term oriented.

If corporate executives are already long-term oriented, then why are performance plans introduced and what objective are they meant to achieve? One reason why a company might adopt a performance plan could be to offer an attractive and diverse compensation package to top executives. It may wish to lure these executives away from other companies as suggested in the quote from Eastman Kodak (Table 9.1). In addition, the company could be sending a signal to the labor market that it is dynamic and willing to offer a diverse compensation package to the right executive.



Second, a company might wish to send a positive signal to the stock market to counter the perception that it is staid and conservative. The adoption of a new incentive compensation scheme which purportedly induces long-term behavior could influence the stock market's judgment of its future. Recent studies by Brickley, Bhagat and Lease (1985) and Tehranian and Waagelein (1985) provide evidence that there was positive stock price performance around the time companies adopted long-term and short-term incentive plans.

Third, there has been negative publicity about the lack of correlation between executive compensation and company performance, where executive compensation has been represented by salary and bonus (Redling, 1981; Loomis, 1982). Therefore, companies may prefer to diversify their compensation package with stock options, SARs and performance plans so that they could keep the salary and bonus amounts steady and avoid adverse publicity.

Fourth, executives need to be compensated for the risk of turnover resulting from takeovers, mergers etc.. Performance plans are one of many plans used for this purpose.

Finally, Benston (1985) and Murphy (1985) found that annual changes (both positive and negative) in the value of executives' stockholdings were three to five times their total annual cash compensation. This could lead to

risk-avoiding behavior by executives since their human capital (i.e., the discounted present value of future compensation) and non-human capital (i.e. the company's stock) are tied in with the same company (Kaplan, 1982). Since performance plans are either paid in cash or can be easily converted into cash, an executive could diversify his risk with his performance award.

The examination of incentive compensation schemes and their association with managerial behavior leaves open several potential research questions. First, further evidence as to the reasons why companies adopt long-term performance plans would be useful in view of the results obtained in this research.

Second, the magnitude of rewards under performance plans and bonus plans need to be compared to resolve the question regarding the uncompetitiveness of performance plans. A ratio of average payments under performance plans to yearly bonus payments could be computed for each adopting company. Companies could be segmented according to whether they have high or low ratios, a high ratio indicating that rewards under performance plans are competitive with rewards under bonus plans. Therefore, companies with high ratios could be expected to be more receptive to the long-term orientation espoused by

performance plans and significantly increase their R&D growth.

Third, Frederic W. Cook & Co., Inc., (1981) report that a few companies have dropped their performance plans. The reasons why these companies dropped their performance plans would be interesting. An interesting methodology would be to compare R&D of companies before and after dropping the performance plan. A model could also be constructed to predict, based on certain company characteristics, the kind of companies that could be expected to drop or adopt performance plans.

Fourth, inspite of considerable controversy surrounding the effectiveness of bonus plans, they are still prevalent. One reason could be that bonus plans are a necessary ingredient to an optimal scheme of executive compensation. Another reason could be that the Boards of Directors are ineffective and are in fact controlled by corporate management who in turn determine what their compensation schemes should be. Further research on these and other reasons for the widespread use of bonus plans would be useful.

Fifth, Smith and Watts (1982) suggest that executives rewarded by a bonus plan have incentives to turn down positive NPV projects with long payback periods since cash outflows are incurred in the near term but cash inflows could result after the executive retires or resigns

from the company. However, there is no evidence to suggest that executives do in fact behave in that manner. The lack of such evidence has prompted Kaplan (1984) to recommend that management accountants should determine if the suggested theories about management behavior have any empirical support.

Finally, Smith and Watts (1982) suggest that, by deferring payment of the bonus earned by an executive until after his retirement, an executive might be persuaded to stay with the company until his retirement. These "golden handcuffs" as Kaplan (1982) calls them, are expected to expand the executive's time horizon. Towers, Perrin, Forster and Crosby (1980) found that 64% of 100 largest industrial companies with bonus plans empowered their bonus committees to defer payment. It would be useful to determine the extent to which bonus committees have exercised the power to defer payment and whether these "golden handcuffs" been effective in stemming the turnover of executives.

## A P P E N D I X   A

## APPENDIX A

DETAILS ABOUT COMPANIES ADOPTING PERFORMANCE  
PLANS IN 1978-82 : FURNISHED BY FREDERIC  
W. COOK & CO., INC.

| COMPANY                | F I<br>B B<br>T C<br>U B<br>B B PLAN<br>E E TYPE | YEAR<br>ADOPTED | START<br>OF<br>FIRST<br>CYCLE | OTHER PLANS<br>IN PLACE<br>WHEN LTP<br>CYCLE<br>LAUNCHED | PERFORMANCE CRITERIA |         |         |                                  | COMMENTS                                          |
|------------------------|--------------------------------------------------|-----------------|-------------------------------|----------------------------------------------------------|----------------------|---------|---------|----------------------------------|---------------------------------------------------|
|                        |                                                  |                 |                               |                                                          | ROI                  | EPS     | ADP     | ADP                              |                                                   |
|                        |                                                  |                 |                               |                                                          | 1978-82              | 1978-82 | 1978-82 | 1978-82                          |                                                   |
| APF                    | 47                                               | PU              | 1980                          | 1980                                                     | 3                    | 103     | 103     | EPS GROWTH AND R&D               | PLS IN TRENCH                                     |
| ALLIED                 | 48                                               | PU              | 1980                          | 1980                                                     | 3                    | 103     | 103     | N/A                              |                                                   |
| AMERICAN CN            | 24                                               | PU/5            | 1982                          | 1982                                                     | 4                    | 103     | 103     | EPS GROWTH AND R&D               |                                                   |
| AMSTERS RUMER          | 20                                               | PU              | 1981                          | 1982                                                     | 3                    | 103     | 103     | EPS GROWTH AND R&D               |                                                   |
| ARLAND OIL             | 23                                               | PU              | 1978                          | 1979                                                     | 4                    | 103     | 103     | EPS GROWTH AND R&D               | STOCK PURCHASE                                    |
| BATTEL THERMO          | 42                                               | PU              | 1982                          | 1982                                                     | 4                    | 103     | 103     | EPS GROWTH                       |                                                   |
| BEATRICE FOODS         | 20                                               | PU              | 1982                          | 1982                                                     | N/A                  | 103     | 103     | N/A                              |                                                   |
| BLACK & BEDDER         | 45                                               | PU              | 1980                          | 1980                                                     | 3                    | 103     | 103     | EPS GROWTH                       | REPLACED PLAN IN 1984 WITH RELATIVE BASED PU PLAN |
| BALSTOL-HEGGS          | 42                                               | PU              | 1978                          | 1978                                                     | 5                    | 103     | 103     | RELATIVE EPS GROWTH              | PLS IN TRENCH                                     |
| BRUSHBOX               | 45                                               | PU              | 1978                          | 1978                                                     | 5                    | 103     | 103     | BOOK VALUE GROWTH                |                                                   |
| BUNGELOS               | 44                                               | PU              | 1982                          | 1982                                                     | 4                    | 103     | 103     | N/A                              |                                                   |
| CELANESE               | 20                                               | PU              | 1980                          | 1980                                                     | 3                    | 103     | 103     | RELATIVE R&D                     |                                                   |
| CENTRAL SYNA           | 20                                               | PU              | NA                            | 103                                                      | N/A                  | 103     | 103     | N/A                              |                                                   |
| CERTAIN-TEED           | 22                                               | PU              | 1980                          | 1980                                                     | 4                    | 103     | 103     | R&D                              | IN 1984 ADOPTED NEW PU WITH 3-YR CYCLE            |
| CHAMPION INTERNATIONAL | 25                                               | PU              | 1978                          | 1978                                                     | 4                    | 103     | 103     | RELATIVE EPS GROWTH              |                                                   |
| CINCINNATI MILKCO      | 45                                               | PU              | 1979                          | 1979                                                     | 5                    | 103     | 103     | N/A                              | INITIAL GROWTH FOR 3 & 4 AND 5 YEAR NEW 'NA PLAN  |
| CLAYTON                | 23                                               | PU              | 1980                          | 1980                                                     | 5                    | 103     | 103     | N/A                              |                                                   |
| COCA-COLA              | 49                                               | PU              | 1982                          | 1982                                                     | 3                    | 103     | 103     | R&D AND EPS GROWTH               |                                                   |
| COMBUSTION ENGINEERING | 45                                               | PU              | 1978                          | 1978                                                     | N/A                  | 103     | 103     | N/A                              | INITIAL GROWTH FOR 3 AND 5 YEAR                   |
| COROL LIMITED FOODS    | 20                                               | PU              | 1979                          | 1979                                                     | 4                    | 103     | 103     | EPS GROWTH (RELATIVE & ABSOLUTE) |                                                   |
| COOPER INDUSTRIES      | 25                                               | PU              | 1978                          | 1978                                                     | 4                    | 103     | 103     | EPS GROWTH                       |                                                   |
| COOPER LABORATORIES    | 42                                               | PU              | 1978                          | 1978                                                     | 5                    | 103     | 103     | ROLES AND NET INCOME GROWTH      |                                                   |

| F I | COMPANY                 | C C TYPE | PLAN | YEAR | AMP | CYCLE | 1974 | AMP                           | HP                                    | PERFORMANCE CRITERIA |          | COMMENTS |    |          |       |       |
|-----|-------------------------|----------|------|------|-----|-------|------|-------------------------------|---------------------------------------|----------------------|----------|----------|----|----------|-------|-------|
|     |                         |          |      |      |     |       |      |                               |                                       | START                | IN PLACE |          |    |          |       |       |
|     |                         |          |      |      |     |       |      |                               |                                       |                      |          |          | OF | WASH LIP |       |       |
|     |                         |          |      |      |     |       |      |                               |                                       |                      |          |          |    |          | FIRST | CYCLE |
|     |                         |          |      |      |     |       |      |                               |                                       |                      |          |          |    |          |       |       |
| U B | U B                     | U B      | U B  | U B  | U B | U B   | U B  | U B                           | U B                                   | U B                  | U B      |          |    |          |       |       |
| 28  | CORNING GLASS MONOS     | PH       | 1970 | 1979 | 5   | 103   | 103  | REL. OF FACTORS INCLUDING REE |                                       |                      |          |          |    |          |       |       |
| 40  | CUMMINS ENGINE          | PH       | 1980 | 1980 | 5   | 103   | 103  | RELATIVE REE                  |                                       |                      |          |          |    |          |       |       |
| 44  | DAVIDSON                | PH       | 1970 | 1979 | 3   | 103   | 103  | SPR GRAMPH AND BNC            | ONLY ONE GRANT HNE                    |                      |          |          |    |          |       |       |
| 29  | DANFORS BROWDER         | PH       | 1980 | 1980 | 4   | 103   | 103  | HP                            | PH IN TONER                           |                      |          |          |    |          |       |       |
| 27  | DAV JONES               | PH       | 1979 | 1979 | 4   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 26  | DAYTON HEWLE            | PH       | 1982 | 1982 | 5   | 103   | 103  | HP                            | INITIAL GRANTS FOR 3 AND 5 YRS        |                      |          |          |    |          |       |       |
| 26  | DAYTON                  | PH       | 1984 | 1984 | 4   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 42  | ELI LILLY               | PH       | 1979 | 1979 | 1   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 26  | FEDERAL PAPER MONOS     | PH       | 1980 | 1980 | 3   | 103   | 103  | REE                           |                                       |                      |          |          |    |          |       |       |
| 26  | FELCO                   | PH       | 1982 | 1982 | 5   | 103   | 103  | HP                            | INITIAL GRANTS FOR 3 AND 5 YRS        |                      |          |          |    |          |       |       |
| 20  | FIRESTONE TIRE & RUBBER | PH       | 1980 | 1980 | 4   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 26  | GENERAL ELECTRIC        | PH       | 1970 | 1970 | 5   | 103   | 103  | SPR GRAMPH                    | PH IN TONER                           |                      |          |          |    |          |       |       |
| 26  | GENERAL HILLS           | PH       | 1979 | 1980 | 3   | 103   | 103  | SPR GRAMPH AND REE            | PH IN TONER                           |                      |          |          |    |          |       |       |
| 40  | GENERAL MOTORS          | PH       | 1982 | 1982 | 5   | 103   | 103  | GRAMPH                        | INITIAL GRANT FOR 3 YRS               |                      |          |          |    |          |       |       |
| 26  | GEORGETY FORD           | PH       | 1970 | 1970 | 3   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 44  | HOENIGELL               | PH       | 1970 | 1970 | 4   | 103   | 103  | SPR GRAMPH                    |                                       |                      |          |          |    |          |       |       |
| 20  | IC INDUSTRIES           | PH       | 1982 | 1982 | 3   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 24  | ILLINOIS TOOL MONOS     | PH       | 1980 | 1980 | 5   | 103   | 103  | SPR GRAMPH                    | PH IN TONER                           |                      |          |          |    |          |       |       |
| 26  | KOPPEL                  | PH       | 1979 | 1979 | 3   | 103   | 103  | SPR GRAMPH                    | 103 FREESTANDING SNA, PH 103 DIVISION |                      |          |          |    |          |       |       |
| 23  | LEVY STRAUS             | PH       | 1980 | 1980 | 4   | 103   | 103  | HP                            | PH IN TONER                           |                      |          |          |    |          |       |       |
| 28  | MANVILLE                | PH       | 1970 | 1970 | 4   | 103   | 103  | SPR GRAMPH                    | INITIAL GRANTS FOR 2 AND 4 YRS        |                      |          |          |    |          |       |       |
| 26  | MC-CORMACK              | PH       | 1980 | 1980 | 4   | 103   | 103  | HP                            |                                       |                      |          |          |    |          |       |       |
| 42  | MECK                    | PH       | 1982 | 1982 | 5   | 103   | 103  | HP                            | INITIAL GRANTS FOR 3 AND 5 YRS        |                      |          |          |    |          |       |       |

| COMPANY<br>(1 indicates plan dropped) | F I<br>R R<br>T C<br>U B<br>U B<br>E E | PLAN<br>YEAR<br>TYPE | YEAR<br>1967<br>1968 | CYCLE<br>1967<br>1968 | CYCLE<br>1967<br>1968 | PERFORMANCE<br>CRITERIA | COMMENTS |
|---------------------------------------|----------------------------------------|----------------------|----------------------|-----------------------|-----------------------|-------------------------|----------|
|                                       |                                        |                      |                      |                       |                       |                         |          |
|                                       |                                        |                      |                      |                       |                       |                         |          |
|                                       |                                        |                      |                      |                       |                       |                         |          |
| HEERLEN                               | 27                                     | PU                   | 1960                 | 1960                  | 1960                  | 1960                    | 1960     |
| HILLMAN ROSS                          | 45                                     | PU                   | 1962                 | 1962                  | 1962                  | 1962                    | 1962     |
| HIMMELBAUM HUNTING & HFS              | 20                                     | PU                   | 1961                 | 1961                  | 1961                  | 1961                    | 1961     |
| HORTON THOMAS                         | 20                                     | PU                   | 1962                 | 1962                  | 1962                  | 1962                    | 1962     |
| HOTIUSOLA                             | 35                                     | PU                   | 1961                 | 1961                  | 1961                  | 1961                    | 1961     |
| ICR                                   | 44                                     | PU                   | 1962                 | 1962                  | 1962                  | 1962                    | 1962     |
| IL                                    | 20                                     | PU                   | 1970                 | 1970                  | 1970                  | 1970                    | 1970     |
| IMBROLO                               | 44                                     | PU                   | 1960                 | 1960                  | 1960                  | 1960                    | 1960     |
| NATIONAL INTERGROUP                   | 23                                     | PU                   | 1979                 | 1979                  | 1979                  | 1979                    | 1979     |
| NEW YORK TIMES                        | 27                                     | PU                   | 1960                 | 1960                  | 1960                  | 1960                    | 1960     |
| ODIS-CORNING FURNELAS                 | 20                                     | PU                   | 1960                 | 1960                  | 1960                  | 1960                    | 1960     |
| OUTGROUP MACHINE                      | 45                                     | PU                   | 1962                 | 1962                  | 1962                  | 1962                    | 1962     |
| POCER                                 | 40                                     | PU                   | 1961                 | 1961                  | 1961                  | 1961                    | 1961     |
| PHILLIPS PETROLEUM                    | 23                                     | PU                   | 1970                 | 1970                  | 1970                  | 1970                    | 1970     |
| QUAKER OILS                           | 20                                     | PU                   | 1979                 | 1979                  | 1979                  | 1979                    | 1979     |
| REDAID                                | 45                                     | PU                   | 1961                 | 1961                  | 1961                  | 1961                    | 1961     |
| REYNOLDS (L.I.)                       | 21                                     | PU                   | 1979                 | 1979                  | 1979                  | 1979                    | 1979     |
| SARGENT ASSOCIATES                    | 25                                     | PU                   | 1960                 | 1960                  | 1960                  | 1960                    | 1960     |
| SEITZ PAPER                           | 25                                     | PU                   | 1962                 | 1962                  | 1962                  | 1962                    | 1962     |
| SEALED PAPER                          | 40                                     | PU                   | 1970                 | 1970                  | 1970                  | 1970                    | 1970     |
| SHELL                                 | 23                                     | PU                   | 1979                 | 1979                  | 1979                  | 1979                    | 1979     |
| SINGER                                | 25                                     | PU                   | 1961                 | 1961                  | 1961                  | 1961                    | 1961     |





**A P P E N D I X   B**

## APPENDIX B

LIST OF COMPANIES OMITTED FROM THE SAMPLE  
AND REASONS FOR THE OMISSION

| Company Name            | Comments                                                       |
|-------------------------|----------------------------------------------------------------|
| 1. AMF                  | Inconsistent figures<br>due to restatement                     |
| 2. Allied               |                                                                |
| 3. American Can         | No match available                                             |
| 4. Armstrong Rubber     |                                                                |
| 5. Ashland Oil          |                                                                |
| 6. Baxter Travenol      |                                                                |
| 7. Beatrice Foods       | No R&D available                                               |
| 8. Black and Decker     |                                                                |
| 9. Bristol-Myers        |                                                                |
| 10. Brunswick           |                                                                |
| 11. Burroughs           |                                                                |
| 12. Celanese            |                                                                |
| 13. Central Soya        | First year of operation<br>not available                       |
| 14. Certain-Teed        | Already had a plan<br>started in 1976 and<br>which was renewed |
| 15. Champion Intl.      | No R&D data available                                          |
| 16. Cincinnati Milacron |                                                                |

|     |                    |                                                                |
|-----|--------------------|----------------------------------------------------------------|
| 17. | Chevron            | Not disclosed in<br>Valueline                                  |
| 18. | Coca-cola          | No R&D data available                                          |
| 19. | Combustion Eng.    |                                                                |
| 20. | Consolidated Foods | Incomplete R&D data                                            |
| 21. | Cooper Industries  |                                                                |
| 22. | Cooper Labs        |                                                                |
| 23. | Corning Glass      |                                                                |
| 24. | Cummins Engine     |                                                                |
| 25. | Datapoint          |                                                                |
| 26. | Diamond Shamrock   |                                                                |
| 27. | Dow Jones          | No R&D data available                                          |
| 28. | Eastman Kodak      |                                                                |
| 29. | Eaton              |                                                                |
| 30. | Eli Lilly          | Already had a plan<br>started in 1975 and<br>which was renewed |
| 31. | Federal Paper      | No R&D data available                                          |
| 32. | Ferro              |                                                                |
| 33. | Firestone Tire     | Plan for CEO only;<br>based on contract                        |
| 34. | General Electric   | No match available                                             |
| 35. | General Mills      |                                                                |
| 36. | General Motors     |                                                                |
| 37. | Hershey Foods      |                                                                |
| 38. | Honeywell          |                                                                |
| 39. | IC Industries      | Incomplete R&D data                                            |
| 40. | Illinois Tool      |                                                                |

|     |                    |                                            |
|-----|--------------------|--------------------------------------------|
| 41. | Koppers            |                                            |
| 42. | Levi-Strauss       | No R&D data available                      |
| 43. | Manville           |                                            |
| 44. | McGraw-Edison      | First year of operation<br>not available   |
| 45. | Merck              |                                            |
| 46. | Meredith           | No R&D data available                      |
| 47. | Midland Ross       | Inconsistent figures<br>due to restatement |
| 48. | Minnesota Mining   |                                            |
| 49. | Morton Thiokol     | First year of operation<br>is 1984         |
| 50. | Motorola           | First year of operation<br>not available   |
| 51. | NCR                |                                            |
| 52. | NL Industries      |                                            |
| 53. | Nashua             |                                            |
| 54. | Natl. Intergroup   | No R&D data available                      |
| 55. | New York Times     | No R&D data available                      |
| 56. | Owens-Corning      |                                            |
| 57. | Outboard Marine    |                                            |
| 58. | Paccar             | No R&D data available                      |
| 59. | Phillips Petroleum |                                            |
| 60. | Quaker Oats        |                                            |
| 61. | Rexnord            |                                            |
| 62. | R. J. Reynolds     | No R&D data available                      |
| 63. | Sanders Assoc.     |                                            |
| 64. | Scott Paper        | First year of operation<br>is 1983         |

|     |                   |                                            |
|-----|-------------------|--------------------------------------------|
| 65. | Sealed Power      |                                            |
| 66. | Shell             |                                            |
| 67. | Singer            | Inconsistent figures<br>due to restatement |
| 68. | A. O. Smith       | Proxy unclear about<br>performance plan    |
| 69. | A. E. Staley      |                                            |
| 70. | J. P. Stevens     | Inconsistent figures<br>due to restatement |
| 71. | Swift Independent | Not disclosed in<br>Valueline              |
| 72. | Sybron            | Inconsistent figures<br>due to restatement |
| 73. | Tenneco           | First year of operation<br>not available   |
| 74. | Texaco            |                                            |
| 75. | Texas Instruments |                                            |
| 76. | Textron           |                                            |
| 77. | Time              | No R&D data available                      |
| 78. | United Tech.      |                                            |
| 79. | Warner Lambert    |                                            |
| 80. | Washington Post   | No R&D data available                      |
| 81. | Westinghouse      |                                            |

## Notes

|    |                                                                                   |           |    |
|----|-----------------------------------------------------------------------------------|-----------|----|
| 1. | Total # of companies considered<br>for the experiment                             |           | 81 |
| 2. | Total # of companies selected<br>for the experiment                               |           | 47 |
| 3. | Total # of companies rejected<br>for the experiment for the<br>following reasons: |           |    |
| a. | First year of operation<br>not available                                          | 4         |    |
| b. | R&D data not available<br>or incomplete                                           | 15        |    |
| c. | Inconsistent figures<br>due to restatement                                        | 5         |    |
| d. | Miscellaneous                                                                     | <u>10</u> | 34 |

## **A P P E N D I X   C**



Appendix C  
ADDITIONAL INFORMATION ABOUT ADOPTING COMPANIES

| Companies<br>(Adopting/non-adopting)  | Year of<br>Adoption | Year 1 of<br>operation | A | B | C | D | E | F | G | H | I | J   | K |
|---------------------------------------|---------------------|------------------------|---|---|---|---|---|---|---|---|---|-----|---|
| 1 A. E. Staley/Kellogg                | 1979-80             | 1979-80                | 3 | 3 | 9 | 2 | 5 | 2 | 9 | 2 | 1 | 999 | 9 |
| 2 Allied Corp/Halliburton             | 1980                | 1980                   | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 999 | 9 |
| 3 Armstrong Rubber/Cooper Tire        | 1981-82             | 1981-82                | 3 | 3 | 9 | 9 | 3 | 1 | 9 | 1 | 1 | 120 | 9 |
| 4 Ashland Oil/BOHIO                   | 1978-79             | 1978-79                | 1 | 3 | 4 | 9 | 4 | 1 | 1 | 1 | 1 | 120 | 2 |
| 5 Baxter Travenol/Schering Plough     | 1982                | 1982                   | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 120 | 2 |
| 6 Black & Decker/Baker Intl. Corp     | 1979-80             | 1979-80                | 3 | 9 | 9 | 9 | 3 | 1 | 1 | 1 | 1 | 100 | 9 |
| 7 Bristol Myers/Avon Products         | 1978                | 1978                   | 3 | 3 | 9 | 9 | 5 | 1 | 9 | 2 | 1 | 500 | 1 |
| 8 Brunswick/Echert                    | 1978                | 1978                   | 3 | 3 | 9 | 9 | 5 | 1 | 9 | 2 | 1 | 100 | 2 |
| 9 Burroughs/DEC                       | 1982                | 1982                   | 3 | 1 | 3 | 1 | 4 | 2 | 1 | 1 | 1 | 120 | 2 |
| 10 Celanese/Hercules Inc.             | 1980                | 1980                   | 3 | 3 | 9 | 1 | 3 | 1 | 1 | 1 | 1 | 130 | 2 |
| 11 Cincinnati Milacron/Ashtek         | 1979                | 1979                   | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 100 | 1 |
| 12 Combustion Eng/Sillette            | 1978                | 1978                   | 3 | 3 | 3 | 9 | 3 | 1 | 1 | 1 | 1 | 999 | 9 |
| 13 Cooper Industries/Crane            | 1978                | 1978                   | 3 | 3 | 3 | 2 | 4 | 1 | 1 | 2 | 1 | 100 | 1 |
| 14 Cooper Labs/ICN Pharmaceuticals    | 1977-78             | 1977-78                | 3 | 3 | 9 | 9 | 9 | 2 | 1 | 1 | 2 | 460 | 9 |
| 15 Corning Glass/Norton               | 1979                | 1979                   | 3 | 3 | 3 | 2 | 4 | 1 | 1 | 2 | 2 | 200 | 1 |
| 16 Cummins Engine/Allis Chalmers      | 1980                | 1980                   | 3 | 3 | 9 | 9 | 5 | 2 | 1 | 1 | 1 | 300 | 1 |
| 17 Datapoint/Mang Labs                | 1978-79             | 1978-79                | 3 | 3 | 9 | 9 | 3 | 1 | 1 | 1 | 1 | 120 | 1 |
| 18 Diamond Shamrock/Ethyl Corp        | 1980                | 1980                   | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 120 | 2 |
| 19 Eastman Kodak/Johnson & Johnson    | 1982                | 1982                   | 3 | 3 | 3 | 4 | 1 | 3 | 1 | 1 | 1 | 100 | 9 |
| 20 Eaton/Fruehauf                     | 1981                | 1981                   | 3 | 3 | 3 | 1 | 4 | 1 | 1 | 1 | 1 | 200 | 1 |
| 21 Ferro/Bun Chemical                 | 1982                | 1982                   | 3 | 3 | 3 | 2 | 3 | 1 | 9 | 2 | 1 | 400 | 2 |
| 22 General Mills/Carnation            | 1979-80             | 1979-80                | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 100 | 1 |
| 23 General Motors/Ford                | 1982                | 1982                   | 3 | 1 | 4 | 2 | 3 | 1 | 1 | 2 | 1 | 120 | 2 |
| 24 Hershey Foods/Hormel               | 1978                | 1978                   | 1 | 3 | 3 | 9 | 4 | 1 | 1 | 2 | 1 | 100 | 1 |
| 25 Honeywell/Litton                   | 1978                | 1978                   | 3 | 3 | 3 | 9 | 4 | 1 | 1 | 2 | 1 | 100 | 1 |
| 26 Illinois Tool Works/Stewart Warner | 1980                | 1980                   | 3 | 3 | 3 | 2 | 5 | 1 | 2 | 1 | 1 | 200 | 2 |
| 27 Koppers/Kaiser Aluminum            | 1979                | 1979                   | 3 | 3 | 9 | 9 | 3 | 1 | 1 | 2 | 1 | 100 | 2 |
| 28 Manville/U.S. Gypsum               | 1978                | 1978                   | 3 | 3 | 9 | 9 | 3 | 1 | 1 | 1 | 1 | 120 | 9 |
| 29 Merck/Upjohn                       | 1982                | 1982                   | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 124 | 1 |
| 30 Minnesota Mining/TM                | 1981                | 1981                   | 3 | 3 | 3 | 2 | 3 | 1 | 9 | 1 | 1 | 200 | 2 |
| 31 NCR/Deere                          | 1982                | 1982                   | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 100 | 1 |
| 32 NL Industries/Schlumberger         | 1978                | 1978                   | 3 | 2 | 3 | 2 | 4 | 1 | 1 | 1 | 1 | 170 | 1 |
| 33 Nashua/Avery Intl.                 | 1980                | 1981                   | 3 | 3 | 9 | 9 | 3 | 1 | 1 | 2 | 2 | 100 | 2 |
| 34 Outboard Marine/Briggs & Stratton  | 1981-82             | 1981-82                | 3 | 3 | 3 | 1 | 4 | 2 | 2 | 1 | 1 | 125 | 1 |
| 35 Owens Corning/Libby Owens Ford     | 1980                | 1980                   | 3 | 3 | 9 | 2 | 4 | 1 | 1 | 2 | 1 | 120 | 2 |
| 36 Phillips Petroleum/Cities Service  | 1978                | 1978                   | 1 | 9 | 9 | 9 | 5 | 1 | 1 | 3 | 1 | 120 | 1 |
| 37 Quaker Oats/Intl. Multifoods       | 1978-79             | 1978-79                | 3 | 3 | 9 | 9 | 3 | 1 | 9 | 1 | 1 | 999 | 9 |
| 38 Rexnord/Tiemen                     | 1981-82             | 1981-82                | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 3 | 1 | 100 | 2 |
| 39 Sanders Associates/Tracor          | 1979-80             | 1979-80                | 3 | 9 | 9 | 9 | 4 | 1 | 1 | 1 | 1 | 100 | 1 |
| 40 Sealed Air/LMC Ind. Inc.           | 1978                | 1978                   | 1 | 3 | 4 | 2 | 4 | 1 | 1 | 1 | 1 | 100 | 1 |
| 41 Shell/Standard Oil (Indiana)       | 1979                | 1979                   | 3 | 2 | 9 | 2 | 4 | 1 | 1 | 1 | 1 | 100 | 9 |
| 42 Texaco/Exxon                       | 1981                | 1981                   | 3 | 3 | 9 | 2 | 5 | 2 | 2 | 2 | 1 | 100 | 9 |
| 43 Texas Instruments/Raytheon         | 1979                | 1980                   | 3 | 3 | 4 | 2 | 3 | 1 | 1 | 1 | 2 | 100 | 1 |
| 44 Textron/Avco                       | 1982                | 1982                   | 1 | 3 | 4 | 2 | 3 | 1 | 1 | 1 | 1 | 140 | 1 |
| 45 United Technologies/Boeing         | 1979                | 1979                   | 3 | 3 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 100 | 1 |
| 46 Warner Lambert/Collgate Palmo      | 1982                | 1982                   | 3 | 3 | 3 | 2 | 3 | 1 | 9 | 1 | 1 | 400 | 1 |
| 47 Westinghouse/RCA                   | 1979                | 1979                   | 3 | 3 | 2 | 2 | 4 | 1 | 1 | 2 | 1 | 120 | 1 |

## APPENDIX C (continued)

## INDEX

- A. Which of the following plans were already in existence at the time the performance plan was adopted?
1. Bonus plan
  2. Stock price related plans such as stock options, SARs etc.
  3. Both of the above
  4. None of the above
  9. Information not available
- B. Was the bonus plan amended simultaneously with the adoption of the performance plan?
1. Bonus plan was made more lucrative than before
  2. Bonus plan was made less lucrative than before
  3. No amendment in the bonus plan
  4. Not applicable since no bonus plan was in effect when the performance plan was adopted
  9. Information not available
- C. Were stock price related plans amended simultaneously with the adoption of the performance plan?
1. Stock plans were made more lucrative than before
  2. Stock plans were made less lucrative than before
  3. No amendment in the stock price related plans
  4. Not applicable since no stock price related plan was in effect when the performance plan was adopted
  9. Information not available

- D. Were one or more stock price related plans introduced simultaneously with the performance plan?
1. Yes
  2. No
  9. Information not available
- E. What was the length of the first award cycle under the terms of the performance plan?
1. 1 year
  2. 2 years
  3. 3 years
  4. 4 years
  5. 5 years
  6. 6 years
  7. Not yet determined by the company
  9. Information not available.
- F. Has atleast one performance cycle been completed?
1. Yes
  2. No
  9. Information not available
- G. Do the award cycles overlap? (An overlap would be indicated when for example one cycle is 1975-79 and another is 1977-81)
1. Yes
  2. No
  9. Information not available
- H. Were performance plans introduced in the form of units or shares?
1. Units
  2. Shares
  3. Both units and shares
  9. Information not available
- I. How soon after the approval of the stockholders or the Board of Directors as the case may be, were the plans put into effect?
1. In the same financial year as the year of approval
  2. In the financial year following the year of approval
  3. Plans not yet put into effect
  9. Information not available

J.\* Which of the following performance measures were adopted to evaluate performance under the performance plan?

- 100. Earnings per share (EPS) or EPS growth
- 200. Return on Assets/Investment
- 300. Return on Equity
- 400. Earnings or earnings growth
- 500. Book value or book value growth
- 600. Sales
- 998. Not yet determined by the company
- 999. Information not available

K. Has any payment been made or funds set aside for future payment under the terms of the performance plan?

- 1. Yes
- 2. No
- 9. Information not available

\* For example, a company that adopts EPS, Return on Assets and Sales as performance measures is coded 126.

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