SHARE OWNERSHIP STRUCTURE AND SHARE PRICE PERFORMANCE ON THE JSE SECURITIES EXCHANGE

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ABSTRACT

Corporate finance literature abounds with research on the effect of share ownership structure on company performance. The bulk of this literature is in the context of developed countries and very little research covers the South African market. Some of the literature suggests that company performance can be improved by a substantial increase in institutional ownership, premised on the belief that such ownership is associated with better corporate governance. This notion is refuted by some researchers, arguing that ownership structure is rather an endogenous result of decisions that reflect the influence of shareholders and of trading on the market of stocks.

Using the event study methodology, this research examines the effect of significant increases in institutional ownership - using pension funds as a proxy for such ownership - on the share price performance of selected companies on the JSE Securities Exchange (JSE).

The outcome of this research suggests that a significant increase in institutional ownership on the JSE is associated with poor share price performance, which does not support existing literature.

DECLARATION

I hereby declare that this research is my own work. It is submitted in partial fulfillment of the requirements for the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. This research has not been submitted before for any degree or examination at any other university.

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Yoran Mogaladi

25 April 2008

DEDICATION

This work is dedicated to my wife, Annatjie, and two daughters, Kopano and Khumo, not only for their support and motivation, but also for enduring the pain of spending a short time with me over the tenure of my studies. I am much indebted to these precious angels.

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1 INTRODUCTION

1.1 Purpose of study

The purpose of this study is to investigate the effect of substantial increases in institutional ownership on the share price performance of companies listed on the JSE Securities Exchange (JSE).

Institutional shareholders tend to exert influence on company performance as they have the resources to monitor and evaluate management decisions, thus ensuring that these decisions are aligned with shareholder interests.

1.2 Context of study

Many empirical studies have been conducted to identify factors that affect company performance. These factors include events such as strike actions, CEO resignations, takeovers, mergers and acquisitions and ownership structure.

The relation between ownership structure and companies' performance has been studied extensively in developed markets like the United States, but very little research has been conducted in the South African market. Most researchers in this field believe that ownership structure influences performance. In particular, there is a belief that ownership structures that are characterised by a substantial institutional shareholding are associated with improved performance (McCornell and Servaes, 1990; Hansen and Hill, 1991).

It is important that a similar study is conducted to determine whether and how ownership structure in the South African market influences firms' performance. This study will therefore fill gaps in this area of research in South Africa and emerging markets in general.

1.3 Problem statement

Investors are desirous to acquire a fair level of expertise in what influences movements in share prices in order to make appropriate investment decisions. One factor that has been empirically found to influence firms' performance is their share ownership structure.

This research seeks to investigate the relation between changes in ownership structure and performance by examining how the share price of selected firms on the JSE responds to a substantial increase in pension fund holding, which is used as a proxy for institutional ownership in the research.

Institutional investors are amongst the major investors in South Africa, with vast financial resources to monitor the management of their investments to ensure that the management of company assets is aligned with their interests.

1.4 Significance of study

Although a lot of research has been conducted on the relationship between share ownership structure and firms' performance, the bulk of the research is based on analyses of developed markets, with very little research covering the South African market. This study thus seeks to fill gaps in the current understanding of the relation between ownership structure and firms' performance in the South African market.

Share price movements are useful in guiding existing and potential investors regarding their return prospects in a particular firm. By understanding what influences these movements, investors are better able to make informed decisions. This is an example of the practical aspects of this study.

As ownership structure is believed to influence the share price performance, South African and foreign investors may be interested to establish whether the literature claims about this relation are true in South Africa. It thus becomes clear that this research is important to investors.

1.5 Delimitations and limitations

This section provides information on what is included and excluded in this research, as well as limitations in the methodology's application.

1.5.1 Delimitations

This research is limited to companies that were listed on the JSE between 2002 and 2006, are in the Top 80 (by market capitalization) and have experienced at least a 10% increase in pension fund ownership in any given month between 2002 and 2006. Firms with some missing data in the time period of interest are excluded from further analyses.

The choice of 10% as a threshold stems from the belief that this level of change in ownership by pension funds is considered significant.

The focus on the Top 80 firms means that the findings of this research may not necessarily hold true for the whole of the JSE. Only if this research used the entire JSE as the population and sampling was done randomly irrespective of market value ranking would it be justified to make inferences on the JSE from the research findings. As it stands, the results for the selected sample of companies should be interpreted for the Top 80 firms.

1.5.2 Limitations

In event studies it is difficult to ascribe a share price movement exclusively to a particular event. The possibility that good news may be accompanied by bad news cannot be precluded. This makes it difficult to attribute the resultant share price response exclusively to the particular news. The share price reaction to a given event will have to be so significant that it overshadows the effect of spurious events.

Ownership changes can be gradual so that the market is oblivious to them, which potentially limits the robustness of the methodology.

A decision on the length of the event window is at the researcher's discretion as there is no unique method of choosing it. Thus to the extent that market reaction to ownership announcement is not spanned by the window, the methodology will be limited.

1.6 Definition of terms

A number of terms may be used interchangeably in this report.

Ownership and shareholding both refer to the percentage of share ownership in a particular firm.

In this research institutional ownership refers to ownership by pension funds (i.e. pension fund holding is used as a proxy for institutional ownership).

The words share price and stock price are also synonymous, as are firm and company.

The Central Limit Theorem is a statistical term that can be understood to mean that the approximation of the distribution of a measurement improves as the number of measurements (sample size) improves. In relation to this research 'sample size' refers to the number of companies that are analysed.

1.7 Assumptions

Because of the potential effect of this research on investor decision making, it is important to specify the underlying assumptions, which must be taken into consideration in interpreting the research results. This section provides the assumptions.

1.7.1 JSE Efficiency Assumption

Stock markets can be classified as either inefficient or efficient, depending on whether the share prices reflect the true (intrinsic) value of the companies or not.

In inefficient stock markets, share prices do not reflect the intrinsic value of the firm. This can be a problem when shifts in market prices are related to such inefficiencies, implying therefore that shares may be undervalued or overvalued. Active investors are relying on the belief that stock markets are inefficient, so that technical analysis can offer out-performance. Clearly, inefficient markets are not desirable in situations where the share prices do not capture the effects of events that could potentially change the future outlook of the company.

Studies on market efficiency have led to the formulation of the Efficient Market Hypothesis (EMH), which assumes that the stock market is efficient so that stocks already reflect all available information. The EMH evolved from the work of Fama (1965), who argued that in an active market securities will be appropriately priced and reflect all available information. According to Fama (1965), if a market is efficient, no information or analysis can be expected to result in out-performance of an appropriate benchmark.

There are three different forms of the EMH. These are the “weak” form, “semi-strong” form and “strong” form (Fama, 1965; Bodie, Kane and Marcus, 2005).

The weak form asserts that stock prices already reflect all information that can be obtained by examining market trading data such as the history of past prices. According to the weak form, if market trading data sent reliable indication of future performance, then all investors would have mastered these indications, with the implication that the indicators lose their value.

The semi-strong form holds that all publicly available information relating to the prospects of a firm including all company financial and operations data must be already captured in the share price. Thus if investors have access to this information it would be expected to be reflected in the share prices.

The strong form states that the share price reflects all available information including information that is available to company insiders.

According to Ball (1996), the efficient market hypothesis has the following limitations:

- Empirical data does not fit theory.
- It fails to incorporate information acquisition and processing costs.
- It assumes that investors are objective.

This research assumes that the JSE satisfies the semi-strong form of the EMH. The strong form is not assumed as the possibility of insider information access cannot be precluded on the JSE. Because the level of efficiency increases as the market transitions from the weak form to the strong form efficiency, the assumption that the

JSE satisfies the semi-strong form efficiency implies that the JSE is already efficient in the weak form.

1.7.2 Share Ownership

This research also assumes that the share ownership data is reliable with regards to the relative proportions of shares held by each investor as received from McGregor BFA.

Although ownership structural changes may occur on a daily basis, they are assumed to be reported publicly on a monthly basis.

2 LITERATURE REVIEW

2.1 Introduction

This section provides a literature review to collate information on existing research on the relation between share ownership structure and firms' performance. This review will contribute to addressing the research problem. The remainder of this section formulates a hypothesis based on the literature.

2.2 Background Discussion

Literature teems with research on the subject of ownership structure and the performance of firms. Firms listed on the stock exchanges of different countries have different ownership structures with different levels of ownership by each type of investor. Numerous studies have been performed to evaluate how the ownership composition of firms influences their performance. Ownership structure is believed to have implications for management alignment with shareholder interests.

2.3 Effect of Ownership Structure on Firm Performance

This section explores literature on the agency theory and the effect of ownership structure on the performance of firms in various countries.

2.3.1 The Agency Problem and Ownership Structure

Shareholders are not necessarily directly involved in the day-to-day running of the companies they own. Typically, they employ a management team to oversee the operations of the company, but management does not always act in the best interest of these shareholders. That is, managers do not always seek to maximize

shareholder value. This tendency by management is termed the agency problem (Fama and Jensen, 1983).

Corporate governance research examines the mechanisms investors use to control companies so as to minimize the agency problem (Minguez-Vere and Martin-Ugendo, 2007).

Minguez-Vere and Martin-Ugendo (2007) assert that contextual differences in countries can influence the alignment of managers' interests with those of investors. For example, they hint on the fact that the Spanish context is radically different from the circumstances in the United States, where investors are little involved in running publicly-owned companies and are concerned mainly with the value and risk of their portfolios, as opposed to what is the norm in most European countries like Spain, where ownership structures are highly concentrated and thus major shareholders presumably have more incentive to oversee managers.

Qi, Wu and Zang (2000) argue that when ownership is diffused, shareholders are not motivated to monitor management decisions closely because the ensuing benefit is too small to cover the monitoring costs.

Randoy and Goel (2003) hold that employing the agency theory in the relationship between ownership structure and firm performance leads to the prescription that firms should seek ownership structures that enable corporate management to realize the full potential of corporate assets.

Furthermore, Jensen and Meckling (1976) suggest that agency costs decrease as the owner's interest increases. They argue that investors may perceive that the owner-largest holder behaves in such a way to maximize firm value when the owner's holding is large, in which case convergence of interest occurs between the owner and outside investors.

According to Beagle (2006), advocates of the agency theory place value on control to address challenges of self-centeredness and the resultant poor governance.

2.3.2 Ownership Structure and Firms' Performance

The work of Shleifer and Vishny (1986) shows that some degree of institutional ownership concentration enhances firm performance since large institutional share holders, better able to reap a significant portion of the gains from improvement in firm performance or a takeover, have some incentives and resources to monitor management decisions.

This is view is supported by McCornell and Servaes (1990), who found that Tobin's Q (which is a proxy for performance, a higher value denoting better performance) increased with the ownership by institutional investors, based on a sample of more than 1000 firms.

Studies by Holderness and Sheenan (1988) find that, for a sample of 114 New York Stock Exchange and American Stock Exchange firms controlled by a majority shareholder, both Tobin's Q and accounting profits were significantly lower for firms with individual majority owners than for firms with corporate majority owners.

Jung and Kwon (2002) examined the relationship between corporate ownership structure and firm performance, focusing on the Korean ownership structure, which is characterised by the dominance of one primary owner, who also participates in firm management. In this type of ownership, the owner-largest holder effectively controls the whole company by holding a significant proportion of shares of the company. They found that firm performance increases as the holdings of the owner increase. They also found that significant holdings of institutional investors were associated with positive performance.

The findings of Jung and Kwon (2002) are supported by the work of Randoy and Goel (2003), which is based on 68 small and medium-sized enterprises (SMEs) publicly traded in Norway. Their studies suggest that family leadership (CEO or Chair) moderates the relationship between ownership structure and firm performance, thus implying reduced agency costs. They found that non-family (non-founder) firms benefited from a low level of board and inside ownership, a high level of institutional ownership, and a high level of foreign ownership because they face a context where agency costs are high.

Hoopes and Miller (2006) modeled ownership concentration, owner preferences, and competitive advantage. They argue that ownership structure and owner preferences

can yield resources and capabilities that increase firm profit. In particular, their research supports the existing literature that purports that high ownership concentration can lead to increased company performance. This argument is supported by the findings of the study by Claessens and Djankov (1999), to the effect that an increase in ownership concentration leads to higher profitability and labour productivity.

On the other hand, Miller and Le Breton-Miller (2004) suggest that concentrated ownership may lead to owners tending towards nepotism or favouritism. It can be argued that to the extent that this tendency compromises a company's operational and management efficiency, this may translate into poor company performance.

Hansen and Hill (1991) contend that institutional ownership in non-founder firms allows for greater outside corporate governance monitoring. Randoy and Goel (2003) argue that in a non-founder firm, a high level of board and inside ownership gives rise to conditions fertile to management entrenchment and self-fulfilling behaviour, which may lead to reduced outside owner's ability to monitor and control the behaviour of the firm's leadership, which in turn may lead to reduced firm value as a result of high agency costs resulting from a lack of transparency. This view is supported by Morck, Shleifer and Vishny (1988), who argue that management entrenchment can occur when insider holdings are high, leading to information-asymmetry problems between the insiders (owner-manager) and outside investors. Jung and Kwon (2002) hold that this is more likely to be the case under poor governance system, in which monitoring would be more difficult as the owner's holdings increase.

Maury (2006) studied the effect of family ownership on firm performance using empirical evidence from Western European corporations. The results of his studies showed that family control lowers the agency problem between owners and managers but gives rise to conflicts between the family and minority shareholders when shareholder protection is low and control is high. The findings are supported by the study by Fama and Jensen (1983), who found that family control can reduce the classical agency problem between owners and managers.

The study by Short and Keasy (1999) conducted in Great Britain found that the effect of ownership structure on firm performance depended on the level of ownership. Using return on shareholders' equity and a market measure similar to Tobin's Q, the

study showed that the relation between managerial ownership and firm performance is positive at ownership level ranging from 0% to 16% (0% -13% using a market measure), negative between 16% and 42% and positive again beyond 42%.

It is claimed that private ownership together with its concentration improves corporate performance. There are two kinds of studies that provide empirical evidence for this. The first study by D'Souza and Megginson (1999) compares the financial and operating performance of firms before and after privatisation in 28 industrialised countries that were privatised through public share offerings during the period from 1990 to 1996. They found significant increases in profitability, output, operating efficiency, and dividend payments after privatisation, thus suggesting that privatisation yields significant performance improvements. The second study compared the performance of state firms with either private or privatised firms operating under reasonably similar conditions (Boardman and Vining, 1989). Additional evidence has been obtained from the work of Frydman, Gray, Hessel and Rapaczynski (1997) as well as that of Dharwadkar and Brandes (2000), who performed studies of the post-communist and transition economies which, due to the existence of both state and privatised firms, have been favourable for testing the claim that privatisation leads to improved performance. On comparing state-owned enterprises (SOEs), mixed enterprises and private corporations among the 500 largest non-US industrial firms, Boardman and Vining (1989) found that mixed enterprises and SOEs performed substantially worse than similar private enterprises. Frydman, Gray, Hessel and Raoaczynski (1999) compared the performance of privatised and state firms in transition economies of Central Europe, while controlling for various forms of selection bias. Their argument is that privatisation has different effects depending on the types of owners to whom it gives control. They find, in particular, that privatisation to outsider owners has significant performance effects. Estrin and Rosevear (1999) studied the effect of specific ownership forms on performance among firms in Ukraine. Their findings are contrary to the claim that private ownership (considered alone) is associated with improved performance.

Smith, Cin, and Vodopivec (1997) studied the relation between employee or foreign ownership and firm performance. They found that there is a 4% and 1.4% increase in value-added for a percentage point increase in foreign ownership and employee ownership, respectively.

The work of Demsetz (1983) shows a contrary view to the findings that variations in ownership structure have a relation with variations in firm performance. Demsetz (1983) holds that ownership structure should be thought of as an endogenous result of decisions that reflect the influence of shareholders and of trading on the market of stocks. He argues that when owners of a privately held company decide to sell shares, and when owners of a listed company agree to a new distribution, they are effectively making a decision to change the ownership structure of their firms. Thus the trading of shares reflects the desire of owners to change their ownership levels in a firm. The resulting ownership structure therefore ought to be influenced by the profit-maximising interests of shareholders so that there should be no systematic relation between changes in ownership structure and changes in firms' performance.

Further evidence of the endogeneity of ownership structure suggested by Demsetz (1983) is gleaned from the work of Demsetz and Lehn (1985), who found no evidence of a relation between profit rate and ownership concentration. Furthermore, Demsetz and Villalonga (2001) suggest that ownership structure should not only be modeled as an endogenous variable, but also "as an amalgam of shareholdings owned by persons with different interests" (pp211). After examining a sample of 233 firms Demsetz and Villalonga (2001) found evidence in support of the belief that ownership structure is endogenous, but not the belief that it affects firm performance.

Not much literature has been published to determine the effect of share ownership structure on share price performance when a country is facing a financial crisis. Lemmon and Lins (2003) conducted a study to examine whether differences in ownership structure at the firm level can explain differences in firm performance during the East Asian financial crisis that began in July 1997. The argument of Lemmon and Lins (2003) is that a crisis leads to a significant reduction in the available return on investment opportunities of firms in the affected countries. They found that during the crisis cumulative stock returns of firms in which managers had high levels of control rights, but have separated their control and cash flow ownership, were 10-20% lower than those of other firms, which suggested that ownership structure plays an important role in determining the incentives of insiders to expropriate minority shareholders.

2.4 Conclusion of Literature Review

In summary, the literature suggests that ownership structure affects firm performance.

Some of the literature suggests that improved firm performance can be realised where institutional investors have a significant holding. In this school of thought it is argued that the institutional shareholders have more incentive to monitor the management of the company and as a result agency costs are reduced. It also appears from the literature that an increase in ownership concentration and private ownership are associated with better performance.

The claims to the effect that there is a relation between ownership structure and firm performance are refuted by a few researchers who think that there no systematic relation between these variables.

2.5 Formulation of Hypothesis

The review and conclusion above lead to the inference that ownership structure may affect company performance on the JSE. This research subscribes to the school of thought that purports that increased institutional ownership leads to improved performance.

A number of JSE-listed companies have a significant proportion of institutional ownership. These owners, by virtue of their level of sophistication, resources and the significant equity claims that they have with the companies, can influence the alignment of management with their interest through active monitoring of management decisions. This may well suppress the inclination to self-entrenchment by management, resulting in reduced agency costs so that management act in such a way as to prioritise shareholder value (Hansen and Hill,1991). On this basis the following hypothesis is tested in this research:

2.5.1 Null Hypothesis (H_0)

A substantial increase in institutional ownership has no impact on the share price performance of JSE-listed companies. This can be restated as: Abnormal returns

arising from the announcement of substantial increases in institutional shareholding are equal to zero.

2.5.2 Alternate Hypothesis (H_1)

A substantial increase in institutional ownership has a positive impact on the share price performance of JSE-listed companies. This can be restated as: Abnormal returns arising from the announcement of substantial increases in institutional shareholding are significantly greater than zero.

3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a discussion of the event study research methodology, the sampling procedure and data analysis using the Number Crunching Statistical Software (NCSS).

3.2 Event Study Methodology

In efficient markets share price changes must reflect new information or event. It is on this basis that the event study methodology was developed, as powerful research technique for quantifying the effect of an event on the value of a firm (Fama, Jensen, Fisher and Roll, 1969). Since then the method became a subject of further research in finance literature. The method basically involves the measurement of abnormal changes in share prices before and after an event and determining whether these returns are significantly different from zero. Only when the event in question is likely to have a financial impact, is unanticipated by the market, and provides new information to the market are event studies useful (McWilliams and Siegel, 1997).

The steps involved in carrying out events studies have been refined over time. According to McWilliams and Siegel (1997), there are five general steps involved in event studies. These are summarised below.

Identification of the event

Identifying an event represents an important step in event studies. Only unanticipated events, that have a financial impact and provide new information to the market, are amenable to event studies (McWilliams and Siegel, 1997).

Identification of the event date and window period

The event window is a time window that spans the period before and after the event announcement date. The possibility of a delayed response of the market to the event and possible information leakage prior to the announcement date justify the symmetry of the event window and the length of time on either side of the event. Fama et al (1969) argue that the defined event date may be uncertain, implying therefore that the researcher should also consider possible abnormal returns which might appear before and after defined event date. The establishment of the event date and the choice of the associated window period is a difficult task since the timing of information leakage is not straightforward, while the exact time of market reaction is not known. Longer window periods dilute the power of a test statistic (McWilliams and Siegel, 1997), while too short periods may not map out the event-market interaction appropriately. Only when the market gradually responds to an event are longer windows appropriate. According to McWilliams and Siegel (1997), in the case where information leakages are expected, a window that includes the planning period before the event might be justified. The degree of accuracy in identifying the event date significantly influences results of statistical analysis (Brown and Warner, 1985). Dyckman, Philbrock and Stephan (1984) posit that the sample size can somewhat mitigate the event date uncertainty in that a large size increases the odds of detecting abnormal performance. It is important to note that share price movements may be a function of a variety of events. Therefore, in choosing the event window, it is necessary to control for spurious events lest they negatively affect the quantification of the effect of the event of interest.

Estimation of expected and abnormal returns

The event study methodology requires the computation of returns that would be obtained had the event not occurred. These returns are called abnormal returns, which are the difference between the realised returns observed from the market and the expected returns. Since the expected return is unobserved, the researcher has to estimate it from one of the asset pricing models. One such model is the market model described in the next subsection (Bodie, Kane and Marcus, 2005).

Benchmark Selection

The sensitivity of the share price of individual firms to macroeconomic events may vary from one firm to another. Any model used in the estimation of expected returns should take into account a component of the total returns attributable to these sensitivities. Models that are typically used in the computation of expected returns fall into three categories, namely single factor, market-adjusted and multifactor models. These models are discussed below.

Single Factor Models

Single factor models use a single factor to represent all the macroeconomic variables used to calculate a market return. This is based on the assumption that each stock has the same relative sensitivity to each risk factor forming part of the overall systematic risk. The single factor market model shown in Equation 1 is commonly employed as a benchmark in event studies.

(1) $$AR_i = R_{i,t} - R_{f,t} - (\alpha_{i,t} + \beta_{i,t}(R_{m,t} - R_{f,t}))$$

where $R_{i,t}$ is the holding period return of stock i at time t.

$R_{f,t}$ is the risk free rate, represented by 90-day Treasury Bills.

$R_{m,t}$ is the return of the market index at time t.

$\beta_{i,t}$ is systematic risk of stock i at time t.

$\alpha_{i,t}$ is the average rate of return stock i would realize in a period with a zero market risk.

Equation 1 is written in terms of excess returns over the risk free rate rather than in terms of total returns because the level of stock market return represents the state of the macro-economy to the extent that it exceeds or falls short of the rate of return on risk-free Treasury Bills.

Market-Adjusted Models

The simplified variant of single factor models is the market-adjusted model, which assumes that individual stocks have a sensitivity of unity with market returns (β =1) and that α = 0 (MacKinlay, 1997). This is represented by Equation 2.

(2) $$R_{i,t} = R_{m,t} + \varepsilon_{i,t}$$

Multifactor Models

In multifactor models the idea is to improve the explanatory power of single factor models by explicitly using the various constituents of the macroeconomic risk factor. The accuracy of multifactor models depends on the type of model used in identifying the risk factors. One such model is that developed by Fama and French (1996), called the Fama and French three-*factor model*, shown in Equation 3.

(3) $$R_{i,t} = \alpha_i + \beta_{iM} R_{Mt} + \beta_{iSMB} SMB_t + \beta_{iHML} HML_t + e_{i,t}$$

where *SMB* = Small Minus Big (i.e. return of a portfolio of small stocks in excess of the return of a portfolio of large stocks)

HML = High Minus Low (i.e. the return of a portfolio of stocks with a high book-to-market ratio in excess of the return of a portfolio of stocks with a low book-to-market value.

$e_{i,t}$ is the residual which captures the abnormal return

The SMB and HML market factors are used in light of observations that firm size and book-to-market ratio have an influence on the average stock returns. In this model the market index does play a role and is considered to take account of the systematic risk.

According to Kendall (1953), the main short-coming of multifactor models is that none of the risk factor proxies used in the model can be clearly identified as hedging a significant source of uncertainty. In addition, Black (1993) posit that the search for explanatory factors may eventually reveal patterns that are ascribed purely to chance.

In this research the single factor model shown in Equation 1 is used instead of the marked-adjusted model or the multifactor model. The reason for not using the multifactor model is the likelihood of errors resulting from estimating several risk factors, while the reason for not using the market-adjusted model is that its oversimplified nature, where individual stocks have a β-coefficient of unity, may limit the accuracy of the results of the research.

Estimation of Abnormal and Cumulative Abnormal Returns

For a set of companies, abnormal returns for a sample of companies are the market-capitalisation-weighted average abnormal returns of the constituent companies as shown in Equation 4 below.

(4) $$AR_t = \sum_{i=1}^{n} w_{i,t} AR_{i,t}$$

where $AR_{i,t}$ is the abnormal return of firm i at time t

n is the number of companies in the sample

$w_{i,t}$ is the market capitalisation weight of firm i at time t, given by Equation 5

(5) $$w_{i,t} = \frac{marketcap_{i,t}}{\sum_{i}^{n} marketcap_{i,t}}$$

The accumulated impact of a given event from time t_1 to t_n can be assessed using cumulative abnormal returns (CARs) as shown in Equation 6.

(6) $$CAR = \sum_{t_1}^{t_n} AR_t$$

The use of cumulative abnormal returns arises from two considerations. The one consideration is the problem of potential information leakage, in which information is released to a small group of investors before public announcement. In this case the stock prices may rise when the prospective news is good, thus making abnormal returns a poor indicator of the total impact of the information release. Another consideration is that the market may respond gradually to an announcement. Cumulative abnormal returns redress this problem by summing up all abnormal returns over the time period of interest, thus capturing the total firm-specific stock price movements for the whole period when the market might be responding to new information.

3.3 Statistical Tests

3.3.1 Introduction

The result of any quantitative research can be influenced by the type analytical test used. The next step once cumulative abnormal returns have been calculated is to use a statistical test to check whether they are significantly different from zero. Depending on the nature of the data being processed, parametric or non-parametric tests can be used. These tests are described below.

3.3.2 Parametric Tests

Parametric tests are premised on the assumption of normality of the distribution of CARs and independence of the CARs. These tests can handle both the case when the variances of the two populations being compared are equal (equal variance test) and when they are not equal (non-equal variance test).

Once it is ascertained that the cumulative abnormal returns are normally distributed and independent, and that the variances of the two data populations are not equal, the Aspin-Welch Unequal Variance t-test statistic is used to determine whether the mean CARs are significantly different from zero (Lyon, Barber and Tsai,1999).

Although according to Bowman (1983) parametric test assumptions may not be met in event studies as abnormal returns tend to exhibit cross-sectional dependence and

correlation, May (1971) has used parametric methods. Furthermore, the work of Brown and Warner (1985) suggests that there is no obvious relationship between the non-normality of daily returns and event study methodologies. Bowman (1983) cautions that abnormal returns exhibit a cross-sectional dependence and correlation, which might result in an upward bias in the test statistic used.

The t-test statistic is given by Equation 7.

$$t = \frac{\overline{CAR}}{\sigma(CAR)/\sqrt{n}} \quad (7)$$

where t = test statistic

$\overline{CAR}$ = mean cumulative abnormal returns

$\sigma(CAR)$ = Cross-sectional standard deviation of CAR

n = number CAR observations

Testing for normality

Whether the researcher uses parametric or non-parametric tests is dependent on the degree to which the underlying assumptions for either test are met. The two alternate measures of normality that are commonly used are kurtosis and skewness. Kurtosis is a measure of the heaviness of the tails of the distribution, while skewness measures the level of symmetry, where a lack of symmetry is indicative of non-normality. If the test for normality fails on skewness, it might be possible to use the square root or logarithmic transformation to normalise the data.

3.3.3 Non-parametric Tests

Unlike parametric tests, non-parametric tests are not premised on the assumption of normality. With non-parametric tests the sample need not satisfy the Central Limit Theorem and thus small sample sizes can be analysed.

There are many non-parametric tests. In fact, non-parametric equivalents exist for most parametric techniques. The most common of these (non-parametric tests) is the *Mann-Whitney U or Wilcoxon Rank-Sum* test statistic, which is used when the distributions for the two variables are identical (but not necessarily normal) in form and shape (that is, same variance) but differ in medians (Barber and Lyon, 1997). Another test is the *Kolmogorov-Smirnov test*, which is used to test for differences between two distributions. The latter test is sensitive to all kinds of differences between populations but not particularly sensitive to any specific type of difference. It is a good choice when there are ties in the data, in which case the Mann-Whitney U test may not be used.

The Mann-Whitney U test statistic is given by Equation 8.

(8) $$U_x = W_x - \frac{n_x(n_x + 1)}{2}$$

where W_x is the sum of the ranks for population x.

n is the number of CAR observations.

3.4 Population

The population for this study comprises the Top 80 market-capitalisation ranked companies listed on the JSE between 2002 and 2006.

3.5 Sample

Selected companies were those that had an increase of at least 10% in pension fund ownership in any month between 2002 and 2006. The choice of the 10% increase in pension fund ownership is justified by the fact that this level of change in ownership is considered significant for pension funds. Companies for which data were missing were not included in the sample.

In total there were 47 companies in the final sample. These are shown as APPENDIX 1.

APPENDIX 2 provides the expanded account of ownership changes by showing pension fund holdings for adjacent months in the period between 2002 and 2006.

Table 1 summarises the selection criteria for the sample.

Table 1: Sample Selection

Description	**Number of Companies**
Population	80
Minus those with pension fund shareholding movement less than 10% in any given month in the period 2002-2006 and those with missing data	-33
Final sample of firms	47

3.6 Data Collection

3.6.1 Data Source

The sources of data used in this research are as follows:

- JSE,
- Sharedata,
- McGregor BFA and
- National Treasury of South Africa.

The JSE and Sharedata were used primarily for historical All Share Index (ALSI) returns, alphas, betas, dividend yields, historical share prices as well as market capitalisation. McGregor BFA provided information on ownership structure and press releases, while the National Treasury of South Africa was used for information on Treasury-Bills (T-Bills).

3.6.2 Data Gathering

The process of gathering of data consisted mainly of requesting information from the respective sources by way of email and telephone communication, as well as website downloads. The information from McGregor BFA was collected from the company's offices while the rest of the information was emailed by the sources and/or downloaded from their websites.

In gathering the data, observations in which there was a co-occurrence of the ownership structural changes with notable events such as takeovers were omitted as these events could otherwise interfere with share price movements in the period of interest.

3.6.3 Data Reliability

The JSE, Sharedata and McGrecor BFA are reputable information sources and it is thus all data obtained from these sources is expected to be reliable.

The website of the National Treasury of South Africa lists historical T-Bills which are considered accurate to use in any research.

There is thus a fair level of confidence in the reliability of the raw data that was used in this research.

3.7 Data Analysis

The hypothesis formulated in Chapter 2 was tested using a combination of the event study methodology described in the previous section and the Number Crunching Statistical Software (NCSS).

Whereas the event study methodology was used for the computation of abnormal and cumulative abnormal returns, the NCSS was used for determining whether these returns were significantly different from zero.

This section explains how the data were analysed using these two techniques.

3.7.1 Computation of Abnormal Returns

Abnormal returns for each firm in the sample were computed using the single factor model shown in Equation (9).

(9) $$AR_i = R_{i,t} - R_{f,t} - (\alpha_t + \beta_t(R_{m,t} - R_{f,t}))$$

where $R_{i,t}$ is the holding period return of stock i at time t

$R_{f,t}$ is the risk free rate, represented by 90-day Treasury Bills.

$R_{m,t}$ is the return of the market index at time t.

$\beta_{i,t}$ is systematic risk of stock i.

$\alpha_{i,t}$ is the average rate of return stock i would realize in a period with a zero market risk.

The total holding period returns were calculated as shown in Equation 10.

(10) $$R_{i,t} = 100 \times \left[\left(\frac{P_2 - P_1}{P_1} \right) + Dy \right]$$

where P_2 and P_1 are share prices at time t_2 and t_1, respectively

Dy is the daily dividend yield, computed as shown in Equation 11

(11) $$Dy = \left(1 + \frac{Dy_{annum}}{100} \right)^{\left(\frac{1}{252} - 1 \right)}$$

where Dy_{annum} is the dividend yield per annum.

The market return $R_{m,t}$ was calculated using the ALSI as a market proxy, applying the same computation approach used in Equation 10.

3.7.2 Computation of Average Abnormal Returns

For the sample of firms used in this study, market-capitalisation-weighted average abnormal returns (Equation 12) were used.

(12) $$AR_t = \sum_{i=1}^{n} w_i AR_i$$

where $$w_i = \frac{marketcap_i}{\sum_{i}^{n} marketcap_i}$$

An important assumption in averaging these abnormal returns is that there is no overlap between the event windows of stocks in the sample, so that cumulative abnormal returns across securities are independent.

3.7.3 Computation of Cumulative Abnormal Returns (CAR)

Due to a potential leakage of information, cumulative abnormal returns were used which aggregate the abnormal returns over the period of interest. Leakage could occur when information regarding the ownership changes is released to a small group of investors before the official public release, resulting in the stock price increasing prior to the announcement date.

The CARs were calculated using Equation 13.

(13) $$CAR = \sum_{t_1}^{t_n} AR_t$$

The event window for this study consisted of 25 observations before the event date and 25 observations thereafter. This window is denoted as ‘T-25 to T+25’. The reason for not exceeding this event window was to avert possible interference of the effects of previous periods’ events.

3.7.4 Hypothesis Testing

The last step in analysing the data was to perform statistical tests to check whether the null hypothesis could be rejected or accepted (i.e. to check whether the

alternative hypothesis holds true or not). This involved performing normality and t-test statistic tests.

a. Normality Tests

All in all, the entire CAR observations over the event window totaled 50, clearly a sufficient size to satisfy the Central Limit Theorem. Because of uncertainty on the exact length of the event window, it was necessary to also compute the test statistic for CAR observations for segments of the event window, with 25 and 10 observations to the left of the event date and 25 and 10 to the right. This gave five sets of CAR observations including the full event window.

Tests for normality and variance equality were performed for all five CAR observation sets using the NCSS.

b. Test statistic

When it was observed that all five CAR observation sets satisfied the normality assumption, the next step was to use parametric tests (t-test) to test the hypothesis. Non-parametric tests were also run for comparison as well as to accommodate small-sized CAR observation sets.

Since only the case of using the entire event window (50 observations) and 25 observations on either side of the event date satisfied the Central Limit Theorem, the other two cases (10 observations on either side of the event date) were additionally subjected to the non-parametric *Kolmogorov-Smirnov test,* not only because this test can take smaller sample sizes but also because there were ranking ties in these observations.

The output of the parametric model provided the t-test statistic, the probability level (p-value), the power of the test at the specified significance level or alpha (α) and a decision on whether or not to reject the null hypothesis.

The p-value measures the probability that the test statistic will take the observed value assuming that the null hypothesis is true. The null hypothesis is rejected if the p-value is less than the stated significance level (alpha), otherwise it is accepted. The power of test measures the probability that one is able to reject the null hypothesis when it is false and thereby avoid a Type-II error which arises when there is insufficient evidence in the sample to reject the null hypothesis. This metric is sensitive to the sample size, magnitude of

variances, alpha level and the difference between the mean CARs and zero. A high power means a high probability of erroneously rejecting the null hypothesis (Albright, Wiston and Zappe, 2006).

3.8 Validity and Integrity

3.8.1 Validity

Validity is important in this research as it is an indication of whether the research measures what it is supposed to measure (Leedy and Ormrod, 2001). Specifically, it measures the credibility and accuracy of the research project.

It is important that the research design and data on share ownership structure and share price performance yield accurate conclusions on the effect of ownership structure on share price performance. This requirement represents the internal validity of the research.

In this report internal validity was enhanced by controlling variables that can have spurious effects on the share price performance. This was done by analysing press reports during the same period to identify any other event that may have occurred in the same period as the announcement of the shareholding change. If no information was publicly reported on such variables, then it would be assumed that the abnormal shift in the share price was reflective of the shareholding change event. Where concurrency was reported, the analysis was simplified by excluding that data point from the model.

The market capitalization differences of the firms were controlled using market-capitalisation-weighted average abnormal returns instead of equally-weighted averages.

3.8.2 Integrity

Although the original share price data was obtained from reliable sources like Sharedata and the JSE, it was important to check the integrity of this data to ensure that the research outcome is useful.

Integrity tests were conducted through a spot-check approach of downloading financial information from the respective firms' websites to compare the share price data reported in audited statements with that reported by Sharedata. The ALSI data obtained from the JSE website was verified by comparison with the Sharedata information. This comparison assumed that the JSE and Sharedata are independent service providers.

Company alphas and betas, which were obtained from the JSE, were verified by regressing of historical individual stock returns and the AlSI returns. This was achieved by using a year's daily return data for the year period preceding the event. This period is called the event estimation window. In this research a 252-day estimation window was used which formed the basis of the regression data of the individual stock returns and ALSI returns.

3.8.3 Conclusion

This chapter discussed the event study methodology and also described the method of sampling as well as how the analysis was carried out. The assumptions of the event study methodology and the statistical analysis technique used are important to bear in mind when interpreting the findings of this research.

4 PRESENTATION AND INTERPRETATION OF RESULTS

4.1 Introduction

The results of the analysis described in the previous chapter are presented and interpreted in this chapter. As will be recalled from Chapter 2, the hypothesis that was tested is as follows:

Null Hypothesis (H_0):

A substantial increase in institutional ownership has no impact on the share price performance of JSE-listed companies. This can be restated as: Abnormal returns arising from the announcement of substantial increases in institutional shareholding are equal to zero.

Alternate Hypothesis (H_1):

A substantial increase in institutional ownership has a positive impact on the share price performance of JSE-listed companies. This hypothesis can be restated as: Abnormal returns arising from the announcement of a substantial increase in institutional shareholding are significantly greater than zero.

4.2 Cumulative Abnormal Returns

The cumulative abnormal returns (CARs) over the event window are presented in Figure 1. It is noted that the CARs are all less than zero before and after the announcement date. It is also observed that the CARs approach zero close to the event date, while they become more negative away from the event date. This observation could be ascribed to the possibility that as one moves farther from the announcement date, effects of events of previous periods may creep into the event window of interest, thus distorting the results of the analysis. This is why the choice of the event window is not an easy task as indicated previously. On the other hand, as the announcement date draws closer, the effects of previous periods' events tend

to fade, implying therefore that CARs around this date are more reflective of the market's response to the announcement.

Although this observation is in disagreement with the alternate hypothesis that CARs are positive for substantial changes in institutional ownership, it was important to establish whether these returns are significantly different from zero from a statistical viewpoint.

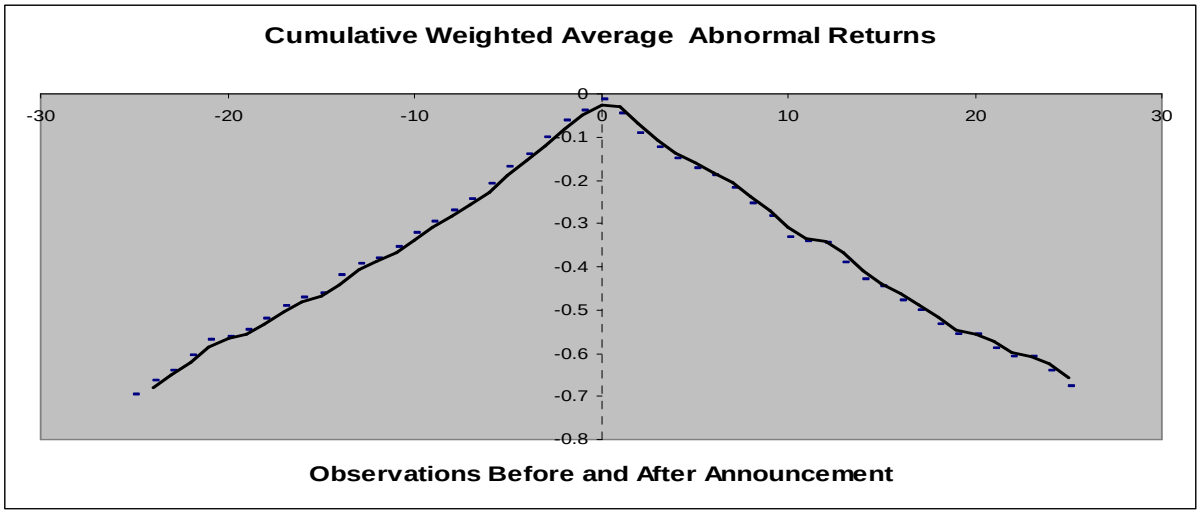

Figure 1: Cumulative Abnormal Returns

APPENDIX 3 shows the CARs and the corresponding average abnormal returns data for each observation period.

4.3 Normality and Variance Test Results and Interpretation

The results of the test for normality for the five CAR observation sets, namely CARs of the entire event window (50 observations), the period before announcement (25 and 10 observations) and the period after announcement (25 and 10 observations), are shown in Table 2. It should be mentioned that if the normality assumption was satisfied by the skewness test but not the kurtosis test, the overall result was taken to be acceptance of normality. From Table 2 it appears that all observation groups effectively satisfied the assumption of normality. The equal-variance test showed that the variances were unequal. This meant that it was justifiable to use parametric tests to measure the statistical significance of the deviations of these CARs from zero.

Non-parametric tests were used for comparison and where the sample size was small.

Table 2: Results for Normality and Equal Variance Assumption Tests

		Skewness	Kurtosis	Modified-Levene Equal-Variance Test
Entire Window (50 CAR Observations)	***Value***	0.569	-3.061	141.06
	Probability	0.570	0.00221	
	Decision	**Accept Normality**	**Reject Normality**	**Reject Equal Variances**
25 CAR Observations to the Left of Event Date	***Value***	0.479	-1.531	62.16
	Probability	0.632	0.126	
	Decision	**Accept Normality**	**Accept Normality**	**Reject Equal Variances**
25 CAR Observations to the right of Event Date	***Value***	0.384	-2.135	77.3
	Probability	0.701	0.0327	
	Decision	**Accept Normality**	**Reject Normality**	**Reject Equal Variances**
10 Observations to the Left of Event Date	***Value***	0.191	-1.194	31.60
	Probability	0.849	0.232	
	Decision	**Accept Normality**	**Accept Normality**	**Reject Equal Variances**
10 Observations to the Right of Event Date	***Value***	-0.117	-0.346	19.44
	Probability	0.907	0.729	
	Decision	**Accept Normality**	**Accept Normality**	**Reject Equal Variances**

4.4 T-Test Statistic Results and Interpretation

It is noted, for the observations spanning the entire event window, as well as for the 25 observations to the right of the event date, that the test for normality was passed only with respect to the skewness normality and not the kurtosis normality. This is no cause for concern as this report takes the skewness normality to be a sufficient indication of normality. It should be recalled that data distortions on the extreme ends of the event window are expected resulting from spurious effects from previous periods.

The parametric Aspin-Welch Unequal-Variance t-test statistic showed that the variances in all observation cases were unequal.

Due to the small sample size of two of the groups being tested (n=10 on either side of the event date), it was decided that even though the normality assumption was met, it was important to also subject these groups to non-parametric tests. The non-parametric Kolmogorov-Smirnov Test was used for these data sets instead of Mann-Whitney U or Wilcoxon Rank-Sum Test as there were ranking ties in the observations.

Table 3 summarises, for each CAR observation set, the test-statistic, p-value, the power of the test as well as a decision on whether the null hypothesis was rejected or not. The full model output for these tests is shown in APPENDICES 4-8. The Appendices also show histograms, normal probability distributions and Box plots for the CARs. These graphs show statistical distributions that form the basis of the accompanying summary statistics in the output.

Table 3: Test Statistics for Cumulative Abnormal Returns

CAR Group	Test-statistic		p-value	Power at α=5%	Decision at α =5%
T-25 to T+25	**Aspin-Welch**	-14.22	0	1.000	Reject Ho
	Kolmogorov	0.272	-	-	Reject Ho
T+1 to T+25	**Aspin-Welch**	-10.02	0	1.000	Reject Ho
	Kolmogorov	0.38	-	-	Reject Ho
T+1 to T+10	**Aspin-Welch**	-6.626	0.000048	1.000	Reject Ho
T-1 to T-10	**Aspin-Welch**	-5.902	0.000114	1.00	Reject Ho
	Kolmogorov	0.562	-	-	Reject Ho
T-1 to T-25	**Aspin-Welch**	-9.883	0	1.000	Reject Ho
	Kolmogorov	0.387	-	-	Reject Ho

The rest of this chapter discusses the results of each CAR observation set to interpret these in the context of the intent of this research.

4.4.1 Results and Interpretation for T-25 to T+25

As can be seen in Appendix 4, the mean difference between the cumulative abnormal returns and zero over the entire event window was -0.384, with the 95% lower confidence limit (LCL) of -0.437 and upper limit (UCL) of -0.330, showing that the 95% confidence interval of the mean difference does not contain zero.

The rest of the NCSS model output is about the statistical significance of this result as indicated by the p-value and the power of the test. The Aspin-Welch t-test reported a p-value of 0 at a 5% significance level. The null hypothesis that the

cumulative abnormal returns are zero was thus rejected. Interpreting this result in isolation with the power of the test can be deceptive as the latter measures the probability that one is able to reject the null hypothesis when it is false and thereby avoid a Type-II error which arises when there is insufficient evidence in the sample to reject the null hypothesis. The power for the Aspin-Welch test at both 1% and 5% significance level was 100%. This result suggests that there is a high probability of avoiding a Type-II error. The results of the Aspin-Welch test were confirmed by those from the non-parametric Kolmogorov-Smirnov Test.

These findings are in not in agreement with the school of thought that posits that significant increases in institutional ownership lead to improved company performance (e.g. McCornell and Servaes,1990; Hansen and Hill,1991). Nor are the findings in support of the contrary view of Demsetz (1983) and Demsetz and Lehn (1985), that ownership structure has no relation with firms' performance.

The cumulative abnormal returns in this research were consistently negative over the entire event window. This unexpected result can be traced to a number of possible factors. For example, the criterion of selecting only companies which had experienced at least 10% increase in pension fund holding in a given month might not be appropriate due to the possibility that, although this level of increase may be considered significant, the market might not 'see' this as a significant ownership change. It is thus possible that if sampling was based on a criterion of, say, a 100% change in pension fund ownership, the results would have been different.

As the above results are for the entire event window, the possibility of spurious effects in a longer window meant that it was important to carry out a segmented analysis of CARs on either side of the window. The rest of the discussion looks at the results for the different segments of the CAR observations.

4.4.2 Results and Interpretation T-1 to T-25

Both the parametric and non-parametric methods suggest that the null hypothesis is rejected for this set of observations. The p-value was 0, which was lower than both the 1% and 5% significance level, leading to the rejection of the null hypothesis. This was further supported by the fact that the 95% confidence interval did not contain the null hypothesis parameter, 0, (the mean difference between the CARs and zero was -

0.385 with the lower confidence limit at -0.463 and the upper confidence limit at -0.307, at 95% confidence level). The probability of avoiding a Type-II error at a 1% and 5% significance level was 100% for both significance levels.

4.4.3 Results and Interpretation T-1 to T-10

The Kolmogrov-Smirnov test, which was used here due not only to the small sample size but also to the presence of ties, showed that the null hypothesis could be rejected. The Aspin-Welch test was also used for comparison and the overall decision in this case was that the null hypothesis is rejected at a 5% significance level. The p-value was 0.000114, which was lower than both the 1% and 5% significance level, thus leading to the rejection of the null hypothesis. In addition, the 95% confidence interval did not contain zero (the mean difference between the CARs and zero was -0.185 with the LCL at -0.251 and the UCL at -0.119). The probability of avoiding a Type-II error at a 1% and 5% significance level was 99.9% and 98.4%, respectively.

4.4.4 Results and Interpretation for T+1 to T+25

Both the Aspin-Welch and the Mann-Whitney U tests gave a p-value of 0, which is lower than both the 1% and 5% significance level, leading to the rejection of the null hypothesis. The 95% confidence interval did not contain the null hypothesis parameter, 0, (the mean CAR was -0.382 with the lower confidence limit at -0.461 and the upper confidence limit at -0.303, at 95% confidence level). The probability of avoiding a Type-II error at a 1% and 5% significance level was 100% for both significance levels.

4.4.5 Results and Interpretation for T+1 to T+10

The overall decision for this small sample was that the null hypothesis is rejected at 1% and 5% significance levels using both the Aspin-Welch and Mann-Whitney U tests. The p-value was 0.000228 with the Aspin-Welch method and 0.000079 with the Mann-Whitney U test. This p-value was lower than both the 1% and 5% significance level. In addition, the 95% confidence interval did not contain zero (the mean difference between CARs and zero is -0.186 with the LCL at -0.244 and the

UCL at -0.127). The probability of avoiding a Type-II error at a 1% and 5% significance level was 99.9% and 99.7%, respectively.

Even when using cumulative observations closer to the event date, the results consistently suggested that substantial increases in pension fund holding lead to negative abnormal returns. This is a particularly interesting finding as the existing literature posits either that increases in institutional shareholding lead to positive abnormal returns (McCornell and Servaes, 1990; Hansen and Hill, 1991) or that institutional shareholding has no relation with firms' performance (Demsetz, 1983; Demsetz and Lehn, 1985).

Worth remembering is that pension funds were used as a proxy for institutional investors. It is possible that if this research had used not just pension funds but all types of institutional investors the research findings could have been different.

No analyses have been performed to evaluate the sensitivity of the research outcome to a variation in the input parameters arising from different selection criteria (e.g. the use of, say, 50% increase in ownership as threshold) and ownership proxy. It is, however, unlikely that the findings under these conditions would be the same as the current findings.

5 CONCLUSION AND FUTURE WORK

5.1 Introduction

This last chapter derives conclusions based on the results of this research and provides recommendations for future work.

5.2 Conclusion

This research sought to investigate the effect of a significant increase in institutional ownership on the share price performance of selected JSE-listed companies. The primary intention of the research was to contribute to the existing literature on ownership structure and share price performance, with the understanding that little literature covers this area of research in South Africa.

The results of this research do not support the work of other researchers (e.g. Shleifer and Vishny, 1986; McCornell and Servaes, 1990, Demsetz, 1983 and Demsetz and Lehn, 1985) in that increased institutional ownership led to negative abnormal returns. This finding was not expected since it is hard to conceive that the increased holding of pension funds in a company could yield poor company performance. The findings could be attributed, at least in part, to the question as to what is the minimum percentage increase in pension fund ownership that is necessary to induce a market response.

The conclusion of this research is that increases in institutional ownership using pension funds as a proxy lead to poor firm performance.

5.3 Recommendations for future work

There is scope for future work on this topic, especially with regards to the refinement of the sampling procedure for the initial sample of firms. For example, from portfolio theory it is important to make a detailed analysis of the correlation and covariance

matrix of the population and then select a sample by avoiding extremes of correlations to offset potential biases. For further research it is recommended that the sampling consider those firms that have almost no correlation.

This research did not evaluate the degree of sensitivity of abnormal returns to increases in institutional ownership. It only tested whether these returns were significantly different from zero. In this regard, future research could explore a combination of the event study methodology and regression analysis, bearing in mind, however, that the inherent limitations of more than one modeling techniques may have adverse effects on the overall model accuracy. The latter can be mitigated by optimising the quality of such input parameters as the sample size and ensuring more stringent control of any confounding effects.

Establishing the minimum level of change in institutional ownership necessary to induce market reaction is important in assessing the relationship between such a change and firms' performance. In this regard it is recommended that higher percentage changes in ownership (say >50%) be used in selecting the sample of firms to study.

Finally, the possibility that pension funds are not a good proxy for institutional ownership warrants a similar study that is based on the use of all forms of institutional shareholders.

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APPENDIX 1: Sample of Analysed Companies and the Corresponding Pension Fund Ownership Movements

CODE	Company Name	Event Date	Pension Fund Holding (%)	% Increase From Previous Month
ABL	AFRICAN BANK INVESTMENTS LTD	30 Jun 2006	6.5225	23%
AEG	AVENG LTD	31 Aug 2006	8.5782	14%
AFE	AECI LTD	30 Apr 2002	9.6048	40%
AFX	AFRICAN OXYGEN LTD	28 Feb 2003	7.0636	12%
AGL	ANGLO AMERICAN PLC	30 Sep 2002	2.9908	32%
ALT	ALLIED TECHNOLOGIES LTD	28 Feb 2006	3.8189	10%
AMS	ANGLO AMERICAN PLATINUM CORPORATION LTD	30 Sep 2004	0.6444	14%
ANG	ANGLOGOLD ASHANTI LTD	31 Oct 2002	1.623	19%
APN	ASPEN PHARMACARE HOLDINGS LTD	30 Nov 2002	8.3384	21%
ARL	ASTRAL FOODS LTD	31 May 2004	8.0645	11%
ASA	ABSA GROUP LTD	31 Dec 2004	11.3439	17%
AVI	AVI LTD	31 Dec 2004	15.4333	11%
BIL	BHP BILLITON PLC	31 Oct 2003	2.5688	17%
CAT	CAXTON CTP PUBLISHERS AND PRINTERS	31 Dec 2004	9.6499	11%
FOS	FOSCHINI LTD	31 Dec 2004	14.7147	27%
FSR	FIRSTRAND LTD	30 Sep 2002	5.4351	20%
GFI	GOLD FIELDS LTD	31 Aug 2005	2.1931	18%
GND	GRINDROD LTD	29 Feb 2004	4.2416	530%
GRF	GROUP FIVE LTD	30 Jun 2002	14.1439	18%
GRT	GROWTHPOINT PROPERTIES LTD	31 Dec 2004	19.9753	126%
HAR	HARMONY GOLD MINING COMPANY LTD	31 Jul 2002	4.3558	23%
HVL	HIGHVELD STEEL & VANADIUM CORPORATION LTD	28 Feb 2003	3.0264	12%
HYP	HYPROP INVESTMENTS LTD	31 Jul 2006	6.5981	18%
IMP	IMPALA PLATINUM HOLDINGS LTD	30 Nov 2002	2.854	31%
LBT	LIBERTY INTERNATIONAL PLC	31 Jan 2003	2.8468	43%
MPC	MR PRICE GROUP LTD	31 Mar 2003	14.8759	14%
MSM	MASSMART HOLDINGS LTD	31 Jan 2004	11.6546	21%
MTN	MTN GROUP LTD	30 Jun 2003	7.3575	78%
MTX	METOREX LTD	30 Jun 2003	7.4533	97%
NHM	NORTHAM PLATINUM LTD	31 Dec 2004	17.4046	17%
NPN	NASPERS LTD N	31 Dec 2002	23.4755	29%
OML	OLD MUTUAL PLC	30 Sep 2002	3.5825	20%
PPC	PRETORIA PORTLAND CEMENT COMPANY LTD	31 Jan 2005	0.7271	13%
RCH	RICHEMONT SECURITIES AG	31 Dec 2004	3.4835	27%
RDF	REDEFINE INCOME FUND LTD	30 Nov 2006	7.9517	38%
REM	REMGRO LTD	31 Dec 2004	14.0019	18%
RLO	REUNERT LTD	31 Dec 2004	11.487	30%
RMH	RMB HOLDINGS LTD	31 Dec 2004	9.963	19%
SAB	SABMILLER PLC	31 Dec 2004	5.9824	25%
SAP	SAPPI LTD	31 Mar 2003	4.4427	12%
SHF	STEINHOFF INTERNATIONAL HOLDINGS LTD	31 Dec 2004	8.9958	18%
SLM	SANLAM LTD	31 Dec 2004	9.3858	26%
SNT	SANTAM LTD	31 May 2002	4.3703	25%
TRE	TRENCOR LTD	30 Jun 2006	5.2032	23%

TRU	TRUWORTHS INTERNATIONAL LTD	31 Jul 2002	20.0428	197%
WBO	WILSON BAYLY HOLMES-OVCON LTD	31 May 2006	4.586	50%
WHL	WOOLWORTHS HOLDINGS LTD	31 Jul 2002	26.0656	86%

APPENDIX 2: Pension Fund Ownership Changes (Month-to-Month) for 75 Firms

% Ownership Movement = [(%previousmonth/%currentmonth)-1]x100; the rest of the Data is raw data obtained from McGrecorBFA

ShareCode	Company	Owner	Date	Ownership (%)	Movement in Ownership from previous Month
ASA	ABSA GROUP LTD	Pens/Prov	30 Nov 2004	9.71	
ASA	ABSA GROUP LTD	Pens/Prov	31 Dec 2004	11.34	17%
AFE	AECI LTD	Pens/Prov	31 Mar 2002	6.86	
AFE	AECI LTD	Pens/Prov	30 Apr 2002	9.60	40%
ABL	AFRICAN BANK INVESTMENTS LTD	Pens/Prov	31 May 2006	5.32	
ABL	AFRICAN BANK INVESTMENTS LTD	Pens/Prov	30 Jun 2006	6.52	23%
ABL	AFRICAN BANK INVESTMENTS LTD	Pens/Prov	31 Jul 2006	6.67	
ABL	AFRICAN BANK INVESTMENTS LTD	Pens/Prov	31 Aug 2006	7.83	17%
AFX	AFRICAN OXYGEN LTD	Pens/Prov	31 Jan 2003	6.33	
AFX	AFRICAN OXYGEN LTD	Pens/Prov	28 Feb 2003	7.06	12%
ARI	AFRICAN RAINBOW MINERALS LTD	Pens/Prov	28 Feb 2003	17.70	
ARI	AFRICAN RAINBOW MINERALS LTD	Pens/Prov	31 Mar 2003	19.77	12%
FPT	ALLAN GRAY PROPERTY TRUST	Pens/Prov	31 Jul 2004	13.93	
FPT	ALLAN GRAY PROPERTY TRUST	Pens/Prov	31 Aug 2004	19.56	40%
ALT	ALLIED TECHNOLOGIES LTD	Pens/Prov	31 Jan 2006	3.46	

ALT	ALLIED TECHNOLOGIES LTD	Pens/Prov	28 Feb 2006	3.82	10%
AMS	ANGLO AMERICAN PLATINUM CORPORATION LTD	Pens/Prov	31 Aug 2004	0.57	
AMS	ANGLO AMERICAN PLATINUM CORPORATION LTD	Pens/Prov	30 Sep 2004	0.64	14%
AGL	ANGLO AMERICAN PLC	Pens/Prov	31 Aug 2002	2.27	
AGL	ANGLO AMERICAN PLC	Pens/Prov	30 Sep 2002	2.99	32%
ANG	ANGLOGOLD ASHANTI LTD	Pens/Prov	30 Sep 2002	1.37	
ANG	ANGLOGOLD ASHANTI LTD	Pens/Prov	31 Oct 2002	1.62	19%
APN	ASPEN PHARMACARE HOLDINGS LTD	Pens/Prov	31 Oct 2002	6.92	
APN	ASPEN PHARMACARE HOLDINGS LTD	Pens/Prov	30 Nov 2002	8.34	21%
ASR	ASSORE LTD	Pens/Prov	31 Jan 2003	1.36	
ASR	ASSORE LTD	Pens/Prov	28 Feb 2003	2.41	77%
ARL	ASTRAL FOODS LTD	Pens/Prov	30 Apr 2004	7.26	
ARL	ASTRAL FOODS LTD	Pens/Prov	31 May 2004	8.06	11%
AEG	AVENG LTD	Pens/Prov	31 Jul 2006	7.54	
AEG	AVENG LTD	Pens/Prov	31 Aug 2006	8.58	14%
AVI	AVI LTD	Pens/Prov	30 Nov 2004	13.85	
AVI	AVI LTD	Pens/Prov	31 Dec 2004	15.43	11%
BAW	BARLOWORLD LTD	Pens/Prov	28 Feb 2003	9.51	
BAW	BARLOWORLD LTD	Pens/Prov	31 Mar 2003	10.43	10%

BIL	BHP BILLITON PLC	Pens/Prov	30 Sep 2003	2.19	
BIL	BHP BILLITON PLC	Pens/Prov	31 Oct 2003	2.57	17%
BVT	BIDVEST GROUP LTD (THE)	Pens/Prov	30 Nov 2004	10.73	
BVT	BIDVEST GROUP LTD (THE)	Pens/Prov	31 Dec 2004	12.73	19%
CAT	CAXTON CTP PUBLISHERS AND PRINTERS	Pens/Prov	30 Nov 2004	8.73	
CAT	CAXTON CTP PUBLISHERS AND PRINTERS	Pens/Prov	31 Dec 2004	9.65	11%
DTC	DATATEC LTD	Pens/Prov	31 Aug 2002	5.39	
DTC	DATATEC LTD	Pens/Prov	30 Sep 2002	5.99	11%
DDT	DIMENSION DATA HOLDINGS PLC	Pens/Prov	30 Sep 2005	5.10	
DDT	DIMENSION DATA HOLDINGS PLC	Pens/Prov	31 Oct 2005	5.95	17%
DSY	DISCOVERY HOLDINGS LTD	Pens/Prov	30 Jun 2002	2.00	
DSY	DISCOVERY HOLDINGS LTD	Pens/Prov	31 Jul 2002	2.60	30%
DST	DISTELL GROUP LTD	Pens/Prov	30 Jun 2002	0.79	
DST	DISTELL GROUP LTD	Pens/Prov	31 Jul 2002	1.72	118%
DST	DISTELL GROUP LTD	Pens/Prov	30 Nov 2004	1.15	
DST	DISTELL GROUP LTD	Pens/Prov	31 Dec 2004	1.49	30%
ELD	ELAND PLATINUM HOLDINGS LTD	Pens/Prov	30 Jun 2006	5.17	
ELD	ELAND PLATINUM HOLDINGS LTD	Pens/Prov	31 Jul 2006	5.85	13%
ELH	ELLERINE HOLDINGS LTD	Pens/Prov	29 Feb 2004	15.46	
ELH	ELLERINE HOLDINGS LTD	Pens/Prov	31 Mar 2004	17.07	10%

EMI	EMIRA PROPERTY FUND	Pens/Prov	31 Dec 2005	5.33	
EMI	EMIRA PROPERTY FUND	Pens/Prov	31 Jan 2006	7.71	45%
FSR	FIRSTRAND LTD	Pens/Prov	31 Aug 2002	4.54	
FSR	FIRSTRAND LTD	Pens/Prov	30 Sep 2002	5.44	20%
FOS	FOSCHINI LTD	Pens/Prov	30 Nov 2004	11.55	
FOS	FOSCHINI LTD	Pens/Prov	31 Dec 2004	14.71	27%
GFI	GOLD FIELDS LTD	Pens/Prov	31 Jul 2005	1.86	
GFI	GOLD FIELDS LTD	Pens/Prov	31 Aug 2005	2.19	18%
GDF	GOLD REEF CASINO RESORTS LTD	Pens/Prov	31 Aug 2005	0.38	
GDF	GOLD REEF CASINO RESORTS LTD	Pens/Prov	30 Sep 2005	0.53	41%
GND	GRINDROD LTD	Pens/Prov	31 Jan 2004	0.67	
GND	GRINDROD LTD	Pens/Prov	29 Feb 2004	4.24	530%
GRF	GROUP FIVE LTD	Pens/Prov	30 Apr 2002	12.02	
GRF	GROUP FIVE LTD	Pens/Prov	30 Jun 2002	14.14	18%
GRT	GROWTHPOINT PROPERTIES LTD	Pens/Prov	30 Nov 2004	8.85	
GRT	GROWTHPOINT PROPERTIES LTD	Pens/Prov	31 Dec 2004	19.98	126%
HAR	HARMONY GOLD MINING COMPANY LTD	Pens/Prov	30 Jun 2002	3.54	
HAR	HARMONY GOLD MINING COMPANY LTD	Pens/Prov	31 Jul 2002	4.36	23%
HVL	HIGHVELD STEEL & VANADIUM CORPORATION LTD	Pens/Prov	31 Jan 2003	2.70	
HVL	HIGHVELD STEEL & VANADIUM	Pens/Prov	28 Feb 2003	3.03	12%

	CORPORATION LTD				
HYP	HYPROP INVESTMENTS LTD	Pens/Prov	30 Jun 2006	5.61	
HYP	HYPROP INVESTMENTS LTD	Pens/Prov	31 Jul 2006	6.60	18%
IMP	IMPALA PLATINUM HOLDINGS LTD	Pens/Prov	31 Oct 2002	2.17	
IMP	IMPALA PLATINUM HOLDINGS LTD	Pens/Prov	30 Nov 2002	2.85	31%
INP	INVESTEC PLC	Pens/Prov	31 Oct 2003	7.00	
INP	INVESTEC PLC	Pens/Prov	30 Nov 2003	7.93	13%
ITE	ITALTILE LTD	Pens/Prov	31 Jul 2004	0.20	
ITE	ITALTILE LTD	Pens/Prov	31 Aug 2004	0.23	16%
JDG	JD GROUP LTD	Pens/Prov	31 Jul 2006	9.86	
JDG	JD GROUP LTD	Pens/Prov	31 Aug 2006	11.66	18%
JCM	JOHNNIC COMMUNICATIONS LTD	Pens/Prov	28 Feb 2003	14.63	
JCM	JOHNNIC COMMUNICATIONS LTD	Pens/Prov	31 Mar 2003	16.36	12%
LEW	LEWIS GROUP LIMITED	Pens/Prov	30 Apr 2005	3.99	
LEW	LEWIS GROUP LIMITED	Pens/Prov	31 May 2005	14.16	255%
LBT	LIBERTY INTERNATIONAL PLC	Pens/Prov	31 Dec 2002	1.99	
LBT	LIBERTY INTERNATIONAL PLC	Pens/Prov	31 Jan 2003	2.85	43%
MSM	MASSMART HOLDINGS LTD	Pens/Prov	31 Dec 2003	9.64	
MSM	MASSMART HOLDINGS LTD	Pens/Prov	31 Jan 2004	11.65	21%
MDC	MEDI-CLINIC CORPORATION LTD	Pens/Prov	31 Jan 2006	3.66	
MDC	MEDI-CLINIC CORPORATION LTD	Pens/Prov	28 Feb 2006	4.26	16%

MTX	METOREX LTD	Pens/Prov	31 May 2003	3.79	
MTX	METOREX LTD	Pens/Prov	30 Jun 2003	7.45	97%
MPC	MR PRICE GROUP LTD	Pens/Prov	28 Feb 2003	13.06	
MPC	MR PRICE GROUP LTD	Pens/Prov	31 Mar 2003	14.88	14%
MTN	MTN GROUP LTD	Pens/Prov	31 May 2003	4.14	
MTN	MTN GROUP LTD	Pens/Prov	30 Jun 2003	7.36	78%
MAF	MUTUAL & FEDERAL INSURANCE COMPANY LTD	Pens/Prov	31 May 2004	0.86	
MAF	MUTUAL & FEDERAL INSURANCE COMPANY LTD	Pens/Prov	30 Jun 2004	1.00	16%
MVL	MVELAPHANDA RESOURCES LTD	Pens/Prov	31 Dec 2005	1.09	
MVL	MVELAPHANDA RESOURCES LTD	Pens/Prov	31 Jan 2006	1.28	17%
NPN	NASPERS LTD N	Pens/Prov	30 Nov 2002	18.20	
NPN	NASPERS LTD N	Pens/Prov	31 Dec 2002	23.48	29%
NED	NEDCOR LTD	Pens/Prov	30 Sep 2004	4.04	
NED	NEDCOR LTD	Pens/Prov	31 Oct 2004	5.16	28%
NHM	NORTHAM PLATINUM LTD	Pens/Prov	30 Nov 2004	14.8794	
NHM	NORTHAM PLATINUM LTD	Pens/Prov	31 Dec 2004	17.4046	17%
OML	OLD MUTUAL PLC	Pens/Prov	31 Aug 2002	2.9789	
OML	OLD MUTUAL PLC	Pens/Prov	30 Sep 2002	3.5825	20%
PWK	PICK N PAY HOLDINGS LTD	Pens/Prov	31 Oct 2002	1.2987	
PWK	PICK N PAY HOLDINGS LTD	Pens/Prov	30 Nov 2002	1.6346	26%

PPC	PRETORIA PORTLAND CEMENT COMPANY LTD	Pens/Prov	31 Dec 2004	0.6444	
PPC	PRETORIA PORTLAND CEMENT COMPANY LTD	Pens/Prov	31 Jan 2005	0.7271	13%
RDF	REDEFINE INCOME FUND LTD	Pens/Prov	31 May 2002	0.466	
RDF	REDEFINE INCOME FUND LTD	Pens/Prov	30 Jun 2002	0.7186	54%
RDF	REDEFINE INCOME FUND LTD	Pens/Prov	31 Oct 2006	5.7457	
RDF	REDEFINE INCOME FUND LTD	Pens/Prov	30 Nov 2006	7.9517	38%
REM	REMGRO LTD	Pens/Prov	30 Nov 2004	11.8347	
REM	REMGRO LTD	Pens/Prov	31 Dec 2004	14.0019	18%
RLO	REUNERT LTD	Pens/Prov	30 Nov 2004	8.8296	
RLO	REUNERT LTD	Pens/Prov	31 Dec 2004	11.487	30%
RCH	RICHEMONT SECURITIES AG	Pens/Prov	30 Nov 2004	2.7381	
RCH	RICHEMONT SECURITIES AG	Pens/Prov	31 Dec 2004	3.4835	27%
RMH	RMB HOLDINGS LTD	Pens/Prov	30 Nov 2004	8.3826	
RMH	RMB HOLDINGS LTD	Pens/Prov	31 Dec 2004	9.963	19%
SAB	SABMILLER PLC	Pens/Prov	30 Nov 2004	4.7754	
SAB	SABMILLER PLC	Pens/Prov	31 Dec 2004	5.9824	25%
SLM	SANLAM LTD	Pens/Prov	30 Nov 2004	7.4644	
SLM	SANLAM LTD	Pens/Prov	31 Dec 2004	9.3858	26%
SNT	SANTAM LTD	Pens/Prov	30 Apr 2002	3.5003	
SNT	SANTAM LTD	Pens/Prov	31 May 2002	4.3703	25%

SAP	SAPPI LTD	Pens/Prov	28 Feb 2003	3.9655	
SAP	SAPPI LTD	Pens/Prov	31 Mar 2003	4.4427	12%
SHF	STEINHOFF INTERNATIONAL HOLDINGS LTD	Pens/Prov	30 Nov 2004	7.5991	
SHF	STEINHOFF INTERNATIONAL HOLDINGS LTD	Pens/Prov	31 Dec 2004	8.9958	18%
SUI	SUN INTERNATIONAL LTD	Pens/Prov	31 Jul 2004	25.0077	
SUI	SUN INTERNATIONAL LTD	Pens/Prov	31 Aug 2004	27.9333	12%
TKG	TELKOM SA LIMITED	Pens/Prov	30 Jun 2004	3.9994	
TKG	TELKOM SA LIMITED	Pens/Prov	31 Jul 2004	4.4214	11%
TON	TONGAAT-HULETT GROUP LTD	Pens/Prov	31 Jul 2005	5.5881	
TON	TONGAAT-HULETT GROUP LTD	Pens/Prov	31 Aug 2005	6.2102	11%
TRE	TRENCOR LTD	Pens/Prov	31 May 2006	4.238	
TRE	TRENCOR LTD	Pens/Prov	30 Jun 2006	5.2032	23%
TRU	TRUWORTHS INTERNATIONAL LTD	Pens/Prov	30 Jun 2002	6.7397	
TRU	TRUWORTHS INTERNATIONAL LTD	Pens/Prov	31 Jul 2002	20.0428	197%
WBO	WILSON BAYLY HOLMES-OVCON LTD	Pens/Prov	30 Apr 2006	3.0637	
WBO	WILSON BAYLY HOLMES-OVCON LTD	Pens/Prov	31 May 2006	4.586	50%
WHL	WOOLWORTHS HOLDINGS LTD	Pens/Prov	30 Jun 2002	14.0175	
WHL	WOOLWORTHS HOLDINGS LTD	Pens/Prov	31 Jul 2002	26.0656	86%

APPENDIX 3: Average abnormal and cumulative average abnormal returns

Observations	Weighted Average Abnormal Returns (%)	Cumulative Abnormal Returns (%)
T-25	-0.031	-0.695
T-24	-0.025	-0.664
T-23	-0.035	-0.640
T-22	-0.037	-0.605
T-21	-0.005	-0.568
T-20	-0.017	-0.563
T-19	-0.027	-0.546
T-18	-0.029	-0.519
T-17	-0.018	-0.490
T-16	-0.010	-0.472
T-15	-0.042	-0.462
T-14	-0.027	-0.420
T-13	-0.012	-0.393
T-12	-0.028	-0.381
T-11	-0.030	-0.353
T-10	-0.026	-0.323
T-9	-0.025	-0.297
T-8	-0.027	-0.271
T-7	-0.036	-0.244
T-6	-0.038	-0.208
T-5	-0.032	-0.170
T-4	-0.036	-0.138
T-3	-0.039	-0.102
T-2	-0.025	-0.063
T-1	-0.023	-0.038
T0	-0.015	-0.015
T1	-0.029	-0.044
T2	-0.048	-0.092
T3	-0.032	-0.124
T4	-0.024	-0.148
T5	-0.024	-0.172
T6	-0.017	-0.189
T7	-0.030	-0.219

T8	-0.035	-0.253
T9	-0.031	-0.285
T10	-0.046	-0.330
T11	-0.011	-0.341
T12	-0.002	-0.344
T13	-0.047	-0.391
T14	-0.039	-0.430
T15	-0.017	-0.447
T16	-0.030	-0.477
T17	-0.024	-0.501
T18	-0.032	-0.533
T19	-0.024	-0.557
T20	0.000	-0.557
T21	-0.032	-0.589
T22	-0.020	-0.609
T23	0.000	-0.609
T24	-0.031	-0.640
T25	-0.037	-0.677

APPENDIX 4: Model Output for T-25 to T+25 (Entire Event Window Span)

NB: C4 denotes CAR Observations, C5 denotes Zeros

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95.0% LCL of Mean	95.0% UCL of Mean
C4	50	-0.38366	0.1907755	2.697973E-02	-0.4378778	-0.3294422
C5	50	0	0	0	0	0

Note: T-alpha (C4) = 2.0096, T-alpha (C5) = 0.0000

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95.0% LCL Difference	95.0% UCL Difference
Equal	98	-0.38366	0.1348986	2.697973E-02	-0.4372004	-0.3301196
Unequal	49.00	-0.38366	0.1907755	2.697973E-02	-0.4378778	-0.3294422

Note: T-alpha (Equal) = 1.9845, T-alpha (Unequal) = 2.0096

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-14.2203	0.000000	Yes	1.000000	1.000000
Difference < 0	-14.2203	0.000000	Yes	1.000000	1.000000
Difference > 0	-14.2203	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-14.2203	0.000000	Yes	1.000000	1.000000
Difference < 0	-14.2203	0.000000	Yes	1.000000	1.000000
Difference > 0	-14.2203	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Tests of Assumptions Section

Assumption	Value	Probability	Decision(.050)
Skewness Normality (C4)	0.5685	0.569671	Cannot reject normality
Kurtosis Normality (C4)	-3.0606	0.002209	Reject normality
Omnibus Normality (C4)	9.6903	0.007866	Reject normality
Skewness Normality (C5)	0.0000		
Kurtosis Normality (C5)		1.000000	Cannot reject normality
Omnibus Normality (C5)			
Variance-Ratio Equal-Variance Test	9999800001.0000	0.000000	Reject equal variances
Modified-Levene Equal-Variance Test	141.0579	0.000000	Reject equal variances

Median Statistics

Variable	Count	Median	95.0% LCL of Median	95.0% UCL of Median
C4	50	-0.392	-0.49	-0.323
C5	50	0	0	0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Differflence in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
C4	0	1275	2525	135.6903
C5	2500	3775	2525	135.6903

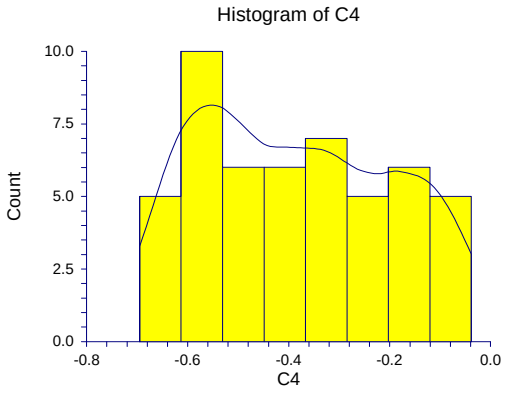
Number Sets of Ties = 4, Multiplicity Factor = 124968

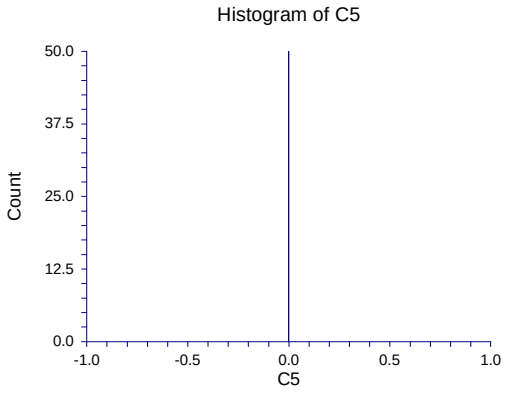
	Exact Probability		Approximation Without Correction			Approximation With Correction	
Alternative Hypothesis	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050
Diff<>0			-9.2122	0.000000	Yes	-9.2085	0.000000	Yes
Diff<0			-9.2122	0.000000	Yes	-9.2085	0.000000	Yes
Diff>0			-9.2122	1.000000	No	-9.2158	1.000000	No

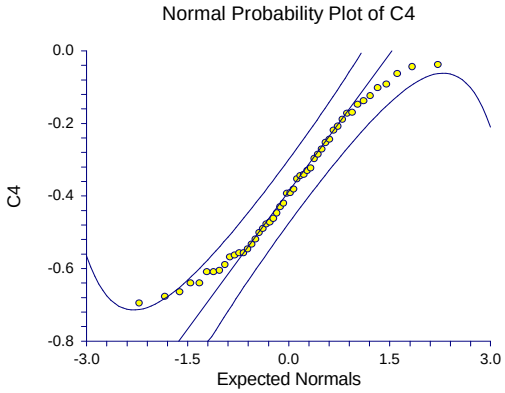
Kolmogorov-Smirnov Test For Different Distributions

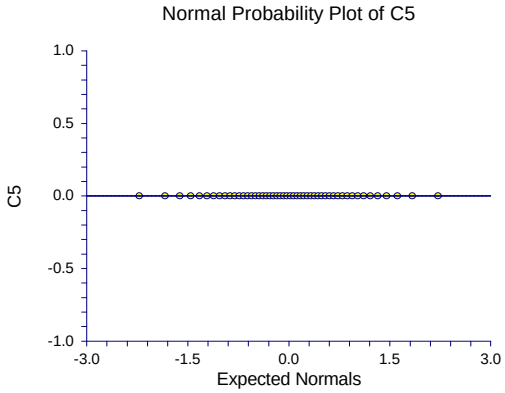
Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Reject H0 (Test Alpha)	Prob Level
D(1)<>D(2)	1.000000	0.2720	.050	Yes	0.0000
D(1)<D(2)	1.000000	0.2720	.025	Yes	
D(1)>D(2)	0.000000	0.2720	.025	No	

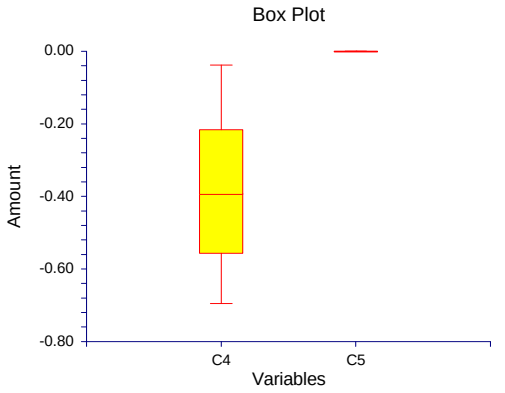
Plots Section











APPENDIX 5 : Model Output for T-1 to T-25

NB: C4 denotes CAR Observation and C5 denotes Zeros

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95.0% LCL of Mean	95.0% UCL of Mean
C4	25	-0.385	0.1947732	3.895463E-02	-0.4653984	-0.3046016
C5	25	0	0	0	0	0

Note: T-alpha (C4) = 2.0639, T-alpha (C5) = 0.0000

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95.0% LCL Difference	95.0% UCL Difference
Equal	48	-0.385	0.1377254	3.895463E-02	-0.4633235	-0.3066765
Unequal	24.00	-0.385	0.1947732	3.895463E-02	-0.4653984	-0.3046016

Note: T-alpha (Equal) = 2.0106, T-alpha (Unequal) = 2.0639

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-9.8833	0.000000	Yes	1.000000	1.000000
Difference < 0	-9.8833	0.000000	Yes	1.000000	1.000000
Difference > 0	-9.8833	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-9.8833	0.000000	Yes	1.000000	1.000000
Difference < 0	-9.8833	0.000000	Yes	1.000000	1.000000
Difference > 0	-9.8833	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Tests of Assumptions Section

Assumption	Value	Probability	Decision(.050)
Skewness Normality (C4)	0.4787	0.632162	Cannot reject normality
Kurtosis Normality (C4)	-1.5318	0.125572	Cannot reject normality
Omnibus Normality (C4)	2.5755	0.275885	Cannot reject normality
Skewness Normality (C5)	0.0000		
Kurtosis Normality (C5)		1.000000	Cannot reject normality
Omnibus Normality (C5)			
Variance-Ratio Equal-Variance Test	9999800001.0000		0.000000 Reject equal variances
Modified-Levene Equal-Variance Test	62.1696	0.000000	Reject equal variances

Median Statistics

Variable	Count	Median	95.0% LCL of Median	95.0% UCL of Median
C4	25	-0.393	-0.519	-0.271
C5	25	0	0	0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
C4	0	325	637.5	48.21429
C5	625	950	637.5	48.21429

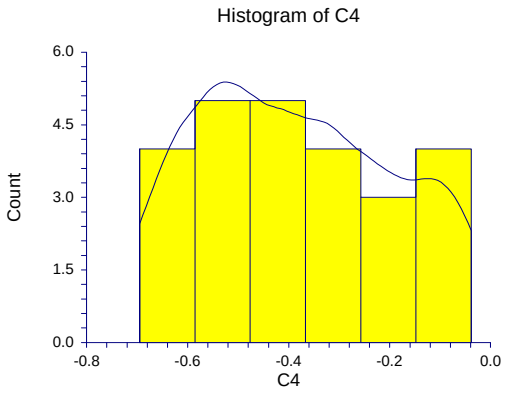
Number Sets of Ties = 1, Multiplicity Factor = 15600

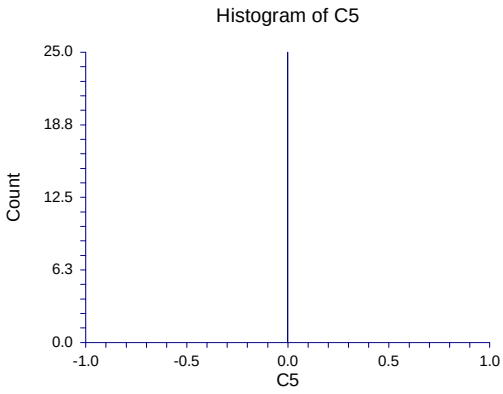
	Exact Probability		Approximation Without Correction			Approximation With Correction	
Alternative Hypothesis	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050
Diff<>0			-6.4815	0.000000	Yes	-6.4711	0.000000	Yes
Diff<0			-6.4815	0.000000	Yes	-6.4711	0.000000	Yes
Diff>0			-6.4815	1.000000	No	-6.4919	1.000000	No

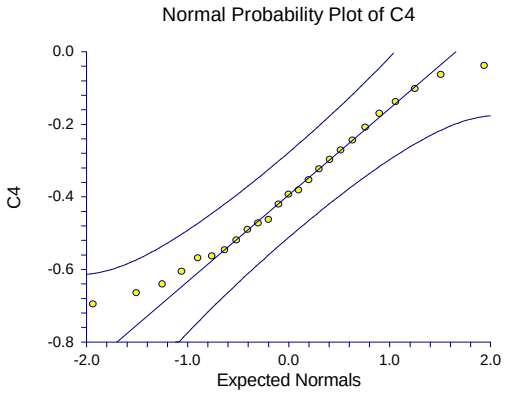
Kolmogorov-Smirnov Test For Different Distributions

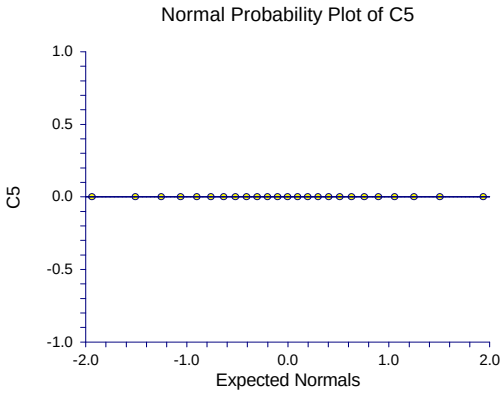
Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Reject H0 (Test Alpha)	Prob Level
D(1)<>D(2)	1.000000	0.3847	.050	Yes	0.0000
D(1)<D(2)	1.000000	0.3847	.025	Yes	
D(1)>D(2)	0.000000	0.3847	.025	No	

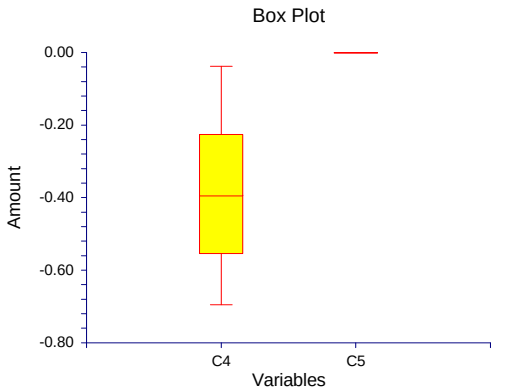
Plots Section











APPENDIX 6: Model Output for T-10 to T-1

NB: C4 denotes CAR Observations, C5 denotes Zeros

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95.0% LCL of Mean	95.0% UCL of Mean
C4	10	-0.1854	0.0993358	3.141274E-02	-0.2564605	-0.1143395
C5	10	0	0	0	0	0

Note: T-alpha (C4) = 2.2622, T-alpha (C5) = 0.0000

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95.0% LCL Difference	95.0% UCL Difference
Equal	18	-0.1854	7.024101E-02	3.141274E-02	-0.2513957	-0.1194043
Unequal	9.00	-0.1854	0.0993358	3.141274E-02	-0.2564605	-0.1143395

Note: T-alpha (Equal) = 2.1009, T-alpha (Unequal) = 2.2622

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-5.9021	0.000014	Yes	0.999844	0.997027
Difference < 0	-5.9021	0.000007	Yes	0.999971	0.999044
Difference > 0	-5.9021	0.999993	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-5.9021	0.000228	Yes	0.999398	0.984416
Difference < 0	-5.9021	0.000114	Yes	0.999914	0.995368
Difference > 0	-5.9021	0.999886	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Tests of Assumptions Section

Assumption	Value	Probability	Decision(.050)
Skewness Normality (C4)	0.1905	0.848889	Cannot reject normality
Kurtosis Normality (C4)	-1.1944	0.232305	Cannot reject normality
Omnibus Normality (C4)	1.4630	0.481188	Cannot reject normality
Skewness Normality (C5)	0.0000		
Kurtosis Normality (C5)		1.000000	Cannot reject normality
Omnibus Normality (C5)			
Variance-Ratio Equal-Variance Test	9999800001.0000		0.000000 Reject equal variances
Modified-Levene Equal-Variance Test	31.5994	0.000025	Reject equal variances

Median Statistics

Variable	Count	Median	95.0% LCL of Median	95.0% UCL of Median
C4	10	-0.189	-0.297	-0.063
C5	10	0	0	0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
C4	0	55	105	12.38101
C5	100	155	105	12.38101

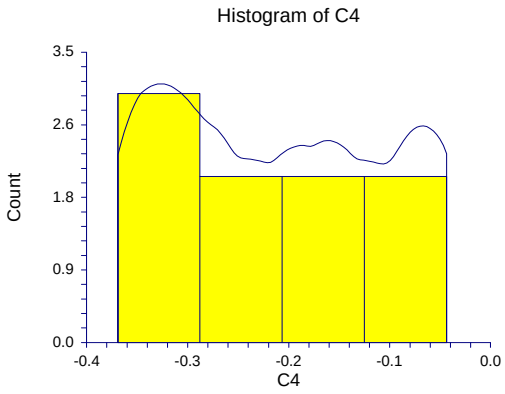
Number Sets of Ties = 1, Multiplicity Factor = 990

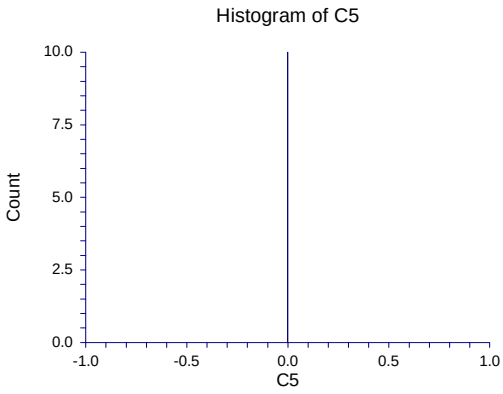
	Exact Probability		Approximation Without Correction			Approximation With Correction	
Alternative Hypothesis	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050
Diff<>0			-4.0384	0.000054	Yes	-3.9981	0.000064	Yes
Diff<0			-4.0384	0.000027	Yes	-3.9981	0.000032	Yes
Diff>0			-4.0384	0.999973	No	-4.0788	0.999977	No

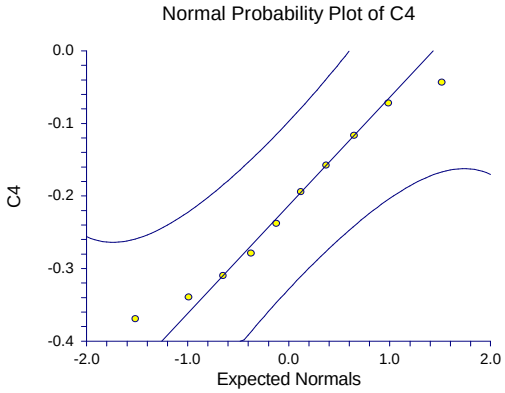
Kolmogorov-Smirnov Test For Different Distributions

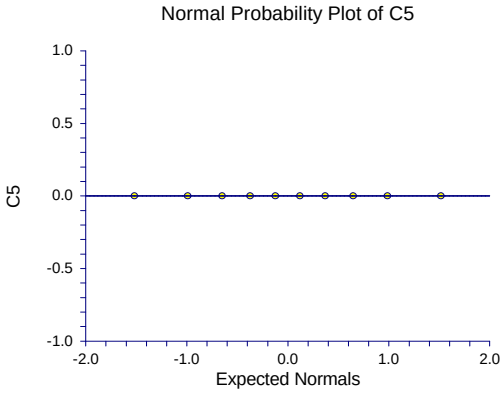
Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Reject H0 (Test Alpha)	Prob Level
D(1)<>D(2)	1.000000	0.5623	.050	Yes	0.0000
D(1)<D(2)	1.000000	0.5623	.025	Yes	
D(1)>D(2)	0.000000	0.5623	.025	No	

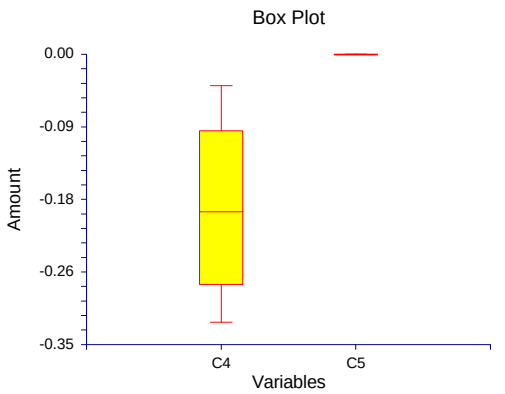
Plots Section











APPENDIX 7: Model Output for T+1 to T+25

NB: C4 Denotes CAR Observation, C5 denotes Zeros

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95.0% LCL of Mean	95.0% UCL of Mean
C4	25	-0.38232	0.1907006	3.814013E-02	-0.4610373	-0.3036027
C5	25	0	0	0	0	0

Note: T-alpha (C4) = 2.0639, T-alpha (C5) = 0.0000

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95.0% LCL Difference	95.0% UCL Difference
Equal	48	-0.38232	0.1348457	3.814013E-02	-0.4590059	-0.3056341
Unequal	24.00	-0.38232	0.1907006	3.814013E-02	-0.4610373	-0.3036027

Note: T-alpha (Equal) = 2.0106, T-alpha (Unequal) = 2.0639

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-10.0241	0.000000	Yes	1.000000	1.000000
Difference < 0	-10.0241	0.000000	Yes	1.000000	1.000000
Difference > 0	-10.0241	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-10.0241	0.000000	Yes	1.000000	1.000000
Difference < 0	-10.0241	0.000000	Yes	1.000000	1.000000
Difference > 0	-10.0241	1.000000	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Tests of Assumptions Section

Assumption	Value	Probability	Decision(.050)
Skewness Normality (C4)	0.3841	0.700891	Cannot reject normality
Kurtosis Normality (C4)	-2.1349	0.032768	Reject normality
Omnibus Normality (C4)	4.7054	0.095112	Cannot reject normality
Skewness Normality (C5)	0.0000		
Kurtosis Normality (C5)		1.000000	Cannot reject normality
Omnibus Normality (C5)			
Variance-Ratio Equal-Variance Test	9999800001.0000	0.000000	Reject equal variances
Modified-Levene Equal-Variance Test	77.3168	0.000000	Reject equal variances

Median Statistics

Variable	Count	Median	95.0% LCL of Median	95.0% UCL of Median
C4	25	-0.391	-0.533	-0.253
C5	25	0	0	0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
C4	0	325	637.5	48.21164
C5	625	950	637.5	48.21164

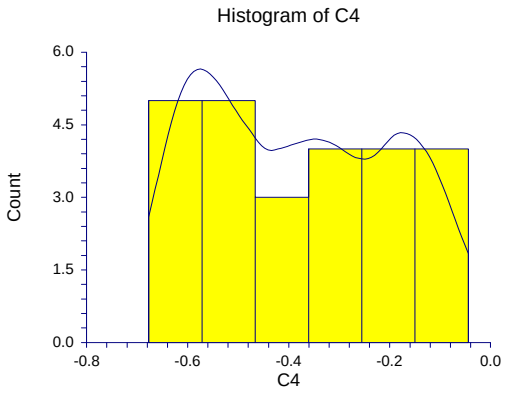
Number Sets of Ties = 3, Multiplicity Factor = 15612

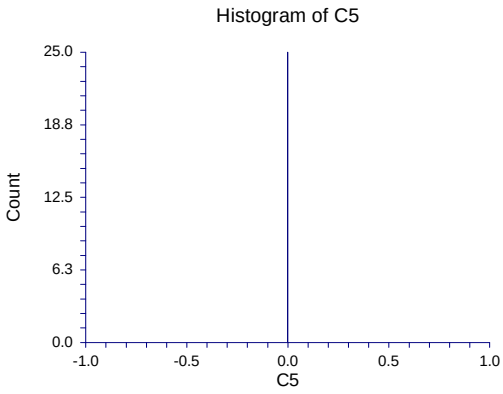
	Exact Probability		Approximation Without Correction			Approximation With Correction	
Alternative Hypothesis	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050
Diff<>0			-6.4818	0.000000	Yes	-6.4715	0.000000	Yes
Diff<0			-6.4818	0.000000	Yes	-6.4715	0.000000	Yes
Diff>0			-6.4818	1.000000	No	-6.4922	1.000000	No

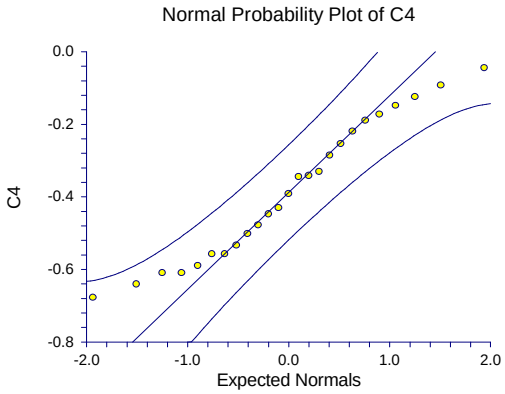
Kolmogorov-Smirnov Test For Different Distributions

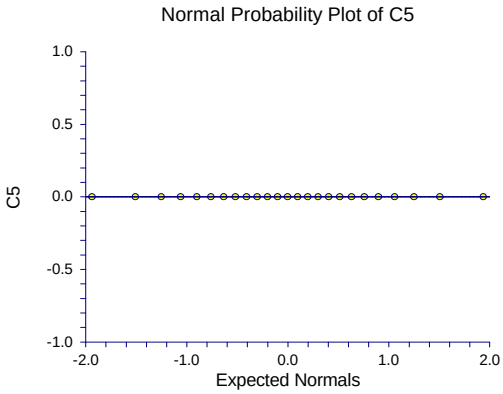
Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Reject H0 (Test Alpha)	Prob Level
D(1)<>D(2)	1.000000	0.3847	.050	Yes	0.0000
D(1)<D(2)	1.000000	0.3847	.025	Yes	
D(1)>D(2)	0.000000	0.3847	.025	No	

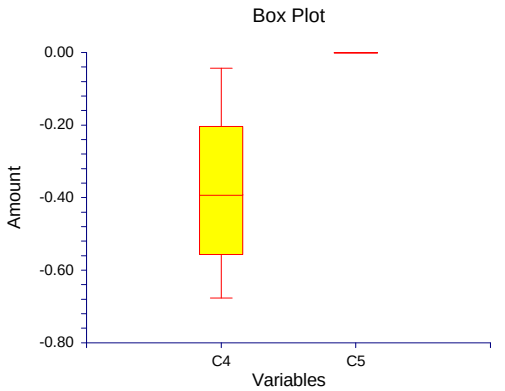
Plots Section











APPENDIX 8: Model Output for T+1 to T+10

NB: C4 denotes CAR Observations; C5 Denotes Zeros

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95.0% LCL of Mean	95.0% UCL of Mean
C4	10	-0.1856	8.857288E-02	0.0280092	-0.2489612	-0.1222388
C5	10	0	0	0	0	0

Note: T-alpha (C4) = 2.2622, T-alpha (C5) = 0.0000

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95.0% LCL Difference	95.0% UCL Difference
Equal	18	-0.1856	6.263049E-02	0.0280092	-0.2444452	-0.1267549
Unequal	9.00	-0.1856	8.857288E-02	0.0280092	-0.2489612	-0.1222388

Note: T-alpha (Equal) = 2.1009, T-alpha (Unequal) = 2.2622

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-6.6264	0.000003	Yes	0.999991	0.999658
Difference < 0	-6.6264	0.000002	Yes	0.999999	0.999916
Difference > 0	-6.6264	0.999998	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Aspin-Welch Unequal-Variance Test Section

Alternative Hypothesis	T-Value	Prob Level	Reject H0 at .050	Power (Alpha=.050)	Power (Alpha=.010)
Difference <> 0	-6.6264	0.000096	Yes	0.999944	0.996632
Difference < 0	-6.6264	0.000048	Yes	0.999995	0.999279
Difference > 0	-6.6264	0.999952	No	0.000000	0.000000

Difference: (C4)-(C5)

The randomization test results are based on 1000 Monte Carlo samples.

Tests of Assumptions Section

Assumption	Value	Probability	Decision(.050)
Skewness Normality (C4)	-0.1170	0.906853	Cannot reject normality
Kurtosis Normality (C4)	-0.3463	0.729096	Cannot reject normality
Omnibus Normality (C4)	0.1336	0.935366	Cannot reject normality
Skewness Normality (C5)	0.0000		
Kurtosis Normality (C5)		1.000000	Cannot reject normality
Omnibus Normality (C5)			
Variance-Ratio Equal-Variance Test	9999800001.0000	0.000000	Reject equal variances
Modified-Levene Equal-Variance Test	19.4415	0.000338	Reject equal variances

Median Statistics

Variable	Count	Median	95.0% LCL of Median	95.0% UCL of Median
C4	10	-0.1805	-0.285	-0.092
C5	10	0	0	0

Mann-Whitney U or Wilcoxon Rank-Sum Test for Difference in Medians

Variable	Mann Whitney U	W Sum Ranks	Mean of W	Std Dev of W
C4	0	55	105	12.38101
C5	100	155	105	12.38101

Number Sets of Ties = 1, Multiplicity Factor = 990

	Exact Probability		Approximation Without Correction			Approximation With Correction	
Alternative Hypothesis	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050	Z-Value	Prob Level	Reject H0 at .050
Diff<>0			-4.0384	0.000054	Yes	-3.9981	0.000064	Yes
Diff<0			-4.0384	0.000027	Yes	-3.9981	0.000032	Yes
Diff>0			-4.0384	0.999973	No	-4.0788	0.999977	No

Kolmogorov-Smirnov Test For Different Distributions

Alternative Hypothesis	Dmn Criterion Value	Reject H0 if Greater Than	Test Alpha Level	Reject H0 (Test Alpha)	Prob Level
D(1)<>D(2)	1.000000	0.5623	.050	Yes	0.0000
D(1)<D(2)	1.000000	0.5623	.025	Yes	
D(1)>D(2)	0.000000	0.5623	.025	No	

Plots Section