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**The Shareholder-Wealth and Trading Volume
Effects of Information Technology
Infrastructure Investments in a Developing
Country**

**Submitted in partial fulfilment of the requirements for the
degree of Master of Commerce in Information Systems.**

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Abstract

Research in developed countries during the last decade has increasingly found evidence of business value being derived from information technology (IT) investment. Earlier studies that questioned the existence of a relationship between IT investment and business value have now been explained on methodological and/or data grounds. The focus has now shifted to finding better ways of defining and measuring business value. Stock market reaction has emerged as a valuable new way to measure an IT investment's perceived value.

General IT investments can be split into IT infrastructure investments and IT application-based investments. The definition of IT infrastructure has progressed from being defined as purely physical components to a service-oriented amalgamation of shared management and technical capabilities. The value of IT infrastructure has been investigated and confirmed from both theoretical and empirical perspectives. However, empirical research into the business value of IT infrastructure lags behind the quantity and quality of research into overall IT investment.

Little research has been done into the relationship between IT investment and business value in South Africa, particularly regarding the effects of IT infrastructure investment. Therefore this thesis, in a replication of a recent U.S. study, poses the research question: Do South African stock market investors perceive significant value in IT infrastructure investments? The event study methodology was identified as an innovative method to answer this question. Application of the event study methodology, for the time period of January 1998 to December 2002, generated results that are contrary to expectation and recent U.S. research. This thesis found that South African stock market investors do not perceive significant value in IT infrastructure investments. Furthermore, in contrast to recent U.S. studies, South African investors do not regard IT infrastructure investments as more beneficial to businesses than IT application-based investments.

Definitive reasons for South African investors' perceptions of IT investments are impossible to determine within the confines of this thesis. However, the two most likely explanations are: Either South African investors believe IT investments to only be worth as much as they cost, or they believe that local firms lack the necessary expertise to fully extract existing business value, in excess of the cost of the investments, from IT investments.

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Plagiarism Note

This thesis is an original work completed solely by the author.

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1 Introduction

1.1 *Research Topic*

Business leaders make few decisions more critical than deciding which information technology (IT) infrastructure investments will be required to support the firm's strategic vision (Weill, Subramani & Broadbent, 2002). IT infrastructure investments are long-term commitments that account for more than 58% of the IT budget of large North American firms and about 4% of revenues (Broadbent & Weill, 1997). An IT infrastructure provides the shared foundation of IT capability for building business applications.

At their lowest level IT infrastructures are made up of physical components, such as computer and communications technologies, that are largely commodities. The second layer comprises a set of shared services, such as management of large-scale data processing, provision of electronic data interchange capability or management of firm-wide databases. People with knowledge, skills and experience combine the lower layers into reliable, shared IT infrastructure services. Business applications, that perform business processes, utilize the shared infrastructure services.

Empirical evidence about the business impact of IT infrastructures is scarce (Chatterjee, Pacini & Sambamurthy, 2002). Although researchers have examined the effects of IT investments on business value in the form of market valuation (Brynjolfsson & Yang, 1997), firm performance (Bharadwaj, 2000; Dos Santos & Peffers, 1995) and firm efficiency (Thatcher & Oliver, 2001), most of these studies focus on the effects of overall IT investments made by a firm over several years. Fewer studies have investigated the effects of strategic investment moves, especially significant investments in IT infrastructure. To the best of the author's knowledge, none have investigated the business value of IT infrastructure investments in South Africa.

Therefore this thesis's goal is to empirically examine the business value effects of IT infrastructure investments by firms. More specifically, to examine the impact of listed South African businesses' IT infrastructure investments on their market valuations and trading volumes.

Stock market investors evaluate such investments in terms of the trade-off between their risks and their potential to shape future growth opportunities for the firm (Chatterjee, Pacini & Sambamurthy, 2002). Stock prices are expected to reflect the true value of firms, because they are assumed to reflect the discounted value of all future cash flows. The essential research question is: **Do South African stock market investors perceive significant value in IT infrastructure investments?**

The event study methodology is used to assess the impact of IT infrastructure investment announcements on the market value of a firm. The event study methodology allows for a direct estimate of the impact of IT investment announcements on firm value. It has a strong theoretical foundation and is widely used in the accounting, finance and management research disciplines (McWilliams & Siegel, 1997).

The event study methodology was first used within the information systems (IS) field by Dos Santos, Peffers & Mauer (1993) to examine the effects of innovative IT investments on the market value of the firm. In the last five years, the methodology has grown more popular. It has been used to examine the effects on the market value of firms of business-to-business electronic commerce initiatives (Subramani & Walden, 2000), IT investments (Krishnan & Sriram, 2000), business-to-consumer electronic commerce initiatives (Subramani & Walden, 2001), newly created Chief Information Officer (CIO) positions (Chatterjee, Richardson & Zmud, 2001) and IT infrastructure investments (Chatterjee, Pacini & Sambamurthy, 2002).

One of the key assumptions underlying the event study methodology is the efficiency of the market being studied (McWilliams & Siegel, 1997). Fortunately, research by Okeahalam & Jefferis (1999) has found the Johannesburg Stock Exchange (JSE) to be efficient in the semi-strong form.

This thesis is a replication of a United States study by Chatterjee, Pacini & Sambamurthy published in the fall 2002 edition of the *Journal of Management Information Systems*. South African results are compared to the findings of this study, and differences are analysed and discussed.

1.2 Motivation for Research

Research into the relationship between IT investment and business value has a long, often contradictory, history in developed countries. In the last decade this research has increasingly found a clear, positive relationship between IT investment and business value. Concurrently, the importance of IT infrastructure as a key enabler of strategic agility has emerged. See Chapter 2 for a full discussion of these points.

In recent years the event study methodology has expanded from the accounting and finance disciplines into the information systems discipline. The event study methodology allows stock market reaction to be used as an indication of investors' perceptions regarding the future earnings implications of a news announcement for a firm. See Chapter 3 for a full description of the event study methodology.

Little South African research has been done into the relationship between IT investment and business value (see the following section for details). Additionally, to the author's knowledge, no South African information systems research has used the event study methodology.

Thus, an investigation into stock market reactions to IT infrastructure investments in South Africa contributes significantly to the current body of knowledge regarding the relationship between IT investment and business value in developing countries.

1.3 Prior South African Research

A search of the National Research Foundation's current and completed research database found that this research has not been previously conducted in South Africa.

The most closely related local research studies investigated the effects of IT investment by South African banks on firm, industry and national performance (Van Aswegan, 1993), the effects of IT investment by Namibian firms on their financial performance (Lubbe, 1994) and the IT investment processes of South African firms (Lubbe, 1998).

1.4 Thesis Structure

The next chapter, Chapter 2, locates this thesis within the overall body of knowledge regarding the relationship between IT investment and business value. The literature review begins with an overview of research undertaken to clarify the relationship between IT investment and business value. The concept of IT infrastructure is explained next, with theoretical justifications for and empirical evidence of its value. The literature review continues with an argument for the use of market reaction as a measure of perceived business value. The review concludes with a summary of current knowledge and the presentation of the research hypotheses.

Chapter 3 describes how the research hypotheses derived in Chapter 2 were investigated. The chapter begins with an overview of where relevant IT investment announcements were found, how these announcements were categorised, and how confounding events were handled.

Chapter 3 continues with a description of the statistical methodology used to allow valid inferences to be drawn from the data. The event study methodology is described in detail, as well as parametric and non-parametric significance tests. The regression analysis conducted to examine the validity of hypothesized predictors is presented, followed by the trading volume analysis methodology used. The chapter concludes with a brief summary.

Chapter 4 presents the results of the application of the methodology described in Chapter 3. Only the results are given, interpretation and discussion of the findings is reserved for Chapter 5. The chapter begins with an analysis of the IT investment announcements that make up the final sample. The results of the abnormal return analysis are given next, followed by the results of the abnormal volume analysis. The presentation of the findings of the cross-sectional regression analysis concludes the results presentation. The chapter ends with a summary of the main findings.

Chapter 5 discusses the results of Chapter 4 in various contexts. The first section examines whether the results support the hypotheses proposed in Chapter 2. The next section compares the South African results with those of three previous U.S. studies.

The final section attempts to interpret the results and discusses possible rationales behind the observed market reaction. The chapter concludes with a brief summary.

Chapter 6 concludes the thesis with a review of the results and their implications for theory and practice.

2 Literature Review

2.1 Introduction

The conceptual model presented in Figure 2-1 locates this thesis within the overall body of knowledge regarding the relationship between IT investment and business value. This model is an amalgamation of prior models created by Weill (1992), Dos Santos & Peffers (1995), Mooney, Gurbaxani & Kraemer (1996), Rai, Patnayakuni & Patnayakuni (1997), Sircar, Turnbow & Bordoloi (2000) and Dedrick, Gurbaxani & Kraemer (2003).

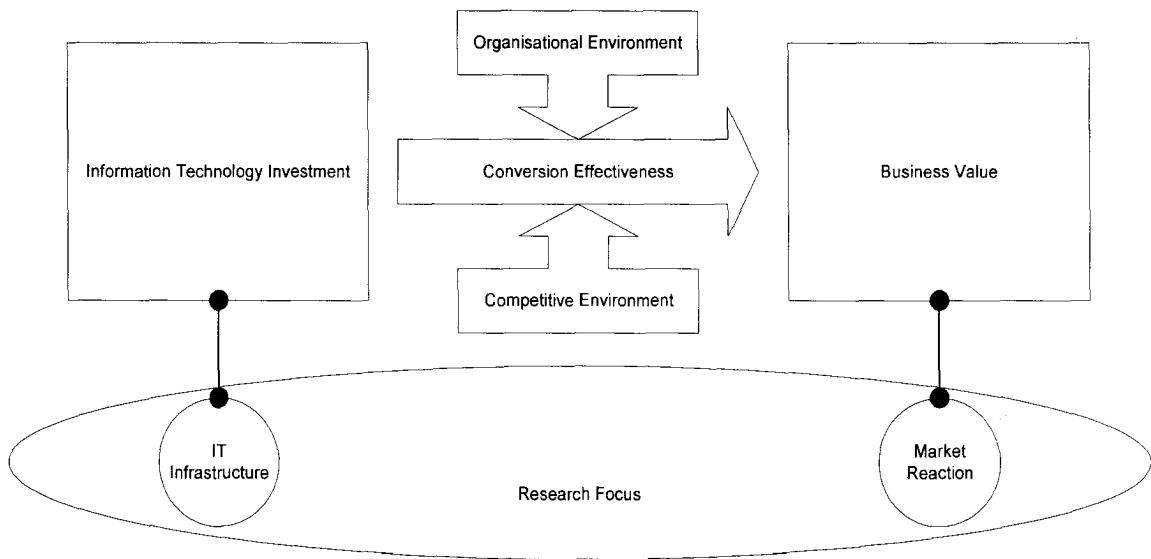


Figure 2-1 Conceptual Model of the Research

At the macro level, firms make IT investments. The degree of business value extracted from these investments by individual firms is governed by each firm's conversion effectiveness. Conversion effectiveness is a term, introduced by Weill (1992), used to describe a firm's ability to convert an IT investment into business value. A firm's internal organisational environment, such as management practices and policies, and external competitive environment, such as industry and country, influence this ability.

This thesis specifically investigates the market reaction to IT infrastructure investment. Stock market reaction is used as a proxy for business value and IT

infrastructure is a specific subset of general IT investment. The presence of environmental factors influencing a firm's conversion effectiveness is acknowledged but not investigated, although these factors are used to help explain the results obtained.

The conceptual model is further utilised to structure this literature review. The literature review begins with an overview of research undertaken to clarify the relationship between IT investment and business value. The concept of IT infrastructure is explained next, with theoretical justifications for and empirical evidence of its value. The literature review continues with an argument for the use of market reaction as a measure of perceived business value. The review concludes with a summary of current knowledge and a listing of the research hypotheses.

2.2 IT Investment and Business Value

2.2.1 Introduction

In 1991, Peter Keen (cited in Remenyi & Bannister 2000, p.234) said, "Many a scholar, consultant and practitioner has tried to devise a reliable approach to measuring the business value of IT at the level of the firm, none has succeeded". Keen argued that IT does not create benefits as such any more than does research and development. Like research and development benefits, IT benefits are the result of complex lagged effects.

Academics have conducted a great deal of theoretical and empirical work in the interim. However, definitive measures of business value and of information technology's contribution to business value remain elusive (Mooney, Gurbaxani & Kraemer, 1996).

The justification of IT investment is clearly an issue of concern to top executives as well. Seddon, Graeser & Willcocks (2002) found that 30% of the top IT executives they interviewed were in the process of introducing new measures of overall IT effectiveness.

Researchers have broadly followed two approaches in attempting to locate evidence of the business value provided by IT investment: an economic approach, based on

econometric techniques, focussing on productivity and efficiency, and an accounting approach, based on financial results and stock market valuations, focussing on profitability and shareholder wealth.

2.2.2 Economic Evidence

A simple, but provocative, study “America’s Technological Dilemma: A Profile of the Information Economy” by Morgan Stanley’s chief economist, Steven Roach, published in Morgan Stanley’s April 22, 1987 economics newsletter first drew attention to the “productivity paradox”. Roach observed that the tremendous increase in computerisation has had little effect on economic performance or productivity, particularly in the service industries. These observations resulted in Robert Solow’s now infamous quip in the New York Times Book Review (July 12, 1987) that “we see the computer age everywhere except in the productivity statistics.”

The productivity paradox prompted many studies into the relationship between IT investment and firm productivity. Initial studies in the 1980s were unable to find clear returns to firms investing in IT. Brynjolfsson & Hitt (1996) believe these results are the consequences of inadequate data on firms’ IT investments and small sample sizes.

The disappointing results continued in the early 1990s. Studies of financial services firms showed weak or no relationships between IT investment and productivity, although productivity measurement in service industries is troublesome (Alpar and Kim 1991; Harris and Katz 1991). Some studies of manufacturing firms did show positive returns on IT investment, partly because it is easier to measure the output of manufacturing and adjust for improvements in quality (Weill 1992; Barua, Kriebel & Mukhopadhyay, 1995). These studies began to highlight the importance of the accurate measurement of outputs, particularly in the technology-intensive service industries where the largest IT capital investments are made (Dedrick, Gurbaxani & Kraemer, 2003).

As a result, more rigorous studies were begun, using econometric techniques with larger samples (Brynjolfsson 1993, 1996; Brynjolfsson & Hitt 1996, 1998). Leading U.S. businesses were analysed using data on IT investment obtained from business publications, research firms and executive surveys, linked to financial data from stock markets, government agencies and other reliable sources. The field of production

economics was used to derive the methodologies used to relate firm inputs, such as labour, IT capital and non-IT capital, to estimated increases in productivity and efficiency.

Each of these studies found that IT investments contribute to firm productivity, and show higher gross marginal returns than non-IT investments. The fact that these researchers found a strong relationship between IT capital and productivity that was not evident in earlier studies may partly reflect the fact that the data was more recent, that levels of IT investment had increased, making it easier to distinguish its contribution, and that over time firms were learning to apply IT capital more productively. They may also simply reflect better data sets and analytical tools that make it possible to isolate and measure the true impacts of IT investment (Dedrick, Gurbaxani & Kraemer, 2003).

More recently, Brynjolfsson & Hitt (1998) have found that payoffs to IT investment occur not just in labour productivity increases, but also in permanent structural improvements, and that the extent of these structural improvements is maximized after a lag of 4 to 7 years. Gilchrist, Gurbaxani & Town (2001), using the same dataset, focussed on the manufacturing companies in the sample and showed that IT has a substantial impact on productivity growth in the durable goods sector, which exceeds the impact that would be predicted by its factor share. They found that, in the nondurable goods sector, the returns to labour productivity are consistent with IT factor share.

Most of the studies found that IT investments were associated with greater productivity gains than other capital investments. These are translated into “excess returns” by some authors, who point out that, in theory, all investments should yield the same risk-adjusted return. These returns do need to be adjusted to account for the high rate of obsolescence of IT capital, so that the net returns are much lower. However, Brynjolfsson & Hitt (1996) found that even after subtracting standard estimates of the cost associated with the obsolescence of IT capital of up to 42% per year from the gross returns, the net returns from IT investment were still higher than non-IT investment returns.

These results have led some authors, for example Anderson, Banker & Ravindran (2003), to suggest that firms are systematically under investing in IT, given the high marginal returns to such investments. Dedrick, Gurbaxani & Kraemer (2003) warn that claims of systematic underinvestment in IT should be viewed cautiously. As Brynjolfsson & Hitt (1998) point out, the true cost of such investments may be underestimated. Most studies include the direct investment in computer hardware; others attempt to include labour, software, and services, but it is difficult to estimate these with a high degree of precision. Importantly, they do not include the costs of complementary investments such as training and process reengineering that can be much larger than the actual direct investment in IT. If these costs are included, the returns may be significantly smaller, or even negative.

2.2.3 Accounting Evidence

The evidence is inconclusive as to the impact of IT investment on financial performance measures such as profitability and market value, partly because the linkage is less direct. While IT investments can directly affect a firm's output and many operational indicators (e.g. inventory turnover, plant productivity, product quality), a firm's financial performance is determined by a wider range of strategic and competitive factors that go beyond productivity (Dedrick, Gurbaxani & Kraemer, 2003; Thatcher & Oliver, 2001).

Several studies show a relationship between IT investment and intermediate measures of operational performance. Barua, Kriebel & Mukhopadhyay (1995) found that IT investment affects intermediate measures such as inventory turnover, but found no evidence that the benefits extended to firm performance as measured by return on assets. A comprehensive search for links between IT investment and productivity measures, combining several prior approaches, by Rai, Patnayakuni & Patnayakuni (1997) found a very significant relationship between IT infrastructure and sales, but only weak relationships between other variables.

Srinivasan, Kekre & Mukhopadhyay (1994) found that Electronic Data Interchange (EDI) technology at Chrysler benefited suppliers and buyers due to improved accuracy and precision of materials management information, thereby reducing shipment discrepancies by over 50% within 2,700 shipments across 193 suppliers.

Similarly, Mukhopadhyay, Kekre & Kalathur (1995) found that a materials management system at Chrysler reduced the costs associated with inventory holding, obsolescence of inventory, and transportation.

Efforts to relate IT investment to stock market valuation have had mixed results. Grove, Selto & Hanbery (1990) examined the marginal contribution of management information systems expenditure to market value. Contrary to expectations, the authors found a negative association between stock market value and IT investment. Thus, they concluded that management information systems expenditure is perceived as a negative net present value investment by the stock market.

Using the event study methodology, Dos Santos, Peffers and Mauer (1993) studied the stock market reaction to announcements of IT investments for a sample of 97 firms in the finance and manufacturing industries from 1981 to 1988. They found that, on average, IT investments did not add value, although the market reacted positively to announcements of innovative IT investments. However, in a replication and extension of the above study, Im, Dow & Grover (2001) found market reactions to IT investment announcements to be significantly positive after 1991.

Brown, Gatian & Hicks (1995) investigated a sample of 35 firms identified in the media for successful use of strategic information systems. The authors employed two approaches to analyse the impact of IT investment on financial performance. First, they examined various performance measures over several years to see if a positive relationship exists between employment of IT and financial performance. Second, they conducted an event study to examine the market reaction to announcements of investment in IT. The results indicate that the stock market reacted favourably to the announcements and that in years subsequent to the IT investment the sample firms tended to be more profitable than otherwise comparable firms in their industries.

Brynjolfsson & Yang (1997) found that a dollar of computer capital was associated with between \$5 and \$20 (depending on assumptions in the models) in additional market capitalisation for listed companies, pointing to a link between IT investment and market valuation. They interpreted this finding as evidence of important but unmeasured complementary organisational practices, or intangible assets, that are not

included in the accounting of firm-level investment, and not as evidence of IT investment resulting in an increase in market capitalization.

Similar market valuation multiples were found by Krishnan & Sriram (2000) and Anderson, Banker & Ravindran (2003) when investigating the effects of year 2000 spending. They also attributed the results to the creation of intangible assets, created partially by the innovative and extensive organisational changes that year 2000 spending often initiated.

Sriram & Krishnan (2003) examined the association between market value of equity and IT investments for a sample of firms in the financial services sector. Ohlson's valuation model was used to determine whether IT investments are associated with market value of equity, after controlling for earnings and book value of equity. They found a significantly positive association between investments in IT and market value, supporting the notion that investors perceive investments in IT as value-relevant.

Research into the relationship between IT investment and firm profitability has also met with mixed success. Brynjolfsson & Hitt (1996) showed that while IT investment affects productivity and contributes to consumer welfare (through lower prices or better service, for example), it does not necessarily improve profitability. They proposed that the productivity benefits associated with IT use may be passed on to consumers through lower prices and not lead to greater profitability.

A notable exception to the above studies is Dos Santos & Peffers' (1995) extensive longitudinal study of the effects of early adoption of automated teller machines by banks on market share and income. This study's results indicate that the earliest adopters were able to increase both market share and income, with both gains being sustained for a long time. These findings support qualitative case study evidence that early adoption of new IT applications can lead to long-term competitive advantage for firms.

Dedrick, Gurbaxani & Kraemer (2003) believe it is possible, and even likely, that IT investments do actually affect financial performance, but that the modelling techniques and datasets used to date are unable to measure the impacts. As better models are developed that control for additional factors a clearer relationship between IT investment and financial performance may be revealed.

2.2.4 Conversion Effectiveness

Weill (1992) first introduced the concept of conversion effectiveness, whereby no two firms will derive the same benefit from an IT investment. The benefit derived by each firm is a function of the firm's conversion effectiveness, which governs the firm's ability to convert IT investments into business value. A firm's organisational environment, such as management policies and expertise, and competitive environment, such as the firm's industry and country, are the main factors influencing conversion effectiveness.

Effect of Organisational Environment

Studies explicitly show that the value of IT investments is substantially impacted by the structure and business practices of the firms making the investments. For instance, Weill (1992) showed that the quality of a firm's management and its commitment to IT enhances the contribution of IT investments to firm performance. Francalanci & Galal (1998) showed that firms with a higher proportion of information workers gain more from their IT investments than those with a lower proportion.

In an early paper discussing IS strategy Henderson & Venkatraman (1993) argued that the inability to realise value from IT investments was due, in part, to the lack of alignment between the business and IT strategies of organisations. This view has been verified by Tallon, Kraemer & Gurbaxani (2000) who found that aligning IT with business strategy increased the payoffs from IT investments. In addition, firms with higher levels of investment gained greater payoffs from alignment.

Devaraj & Kohli (2002) found that business process reengineering enhanced the payoffs in firms that also made greater IT investments. Ramirez, Kraemer & Lawler (2001) found that organisations that invested more in IT and implemented management practices such as employee involvement and total quality management received higher IT returns.

In addition to these studies of individual management practices, Brynjolfsson, Hitt & Yang (1998) showed that firms with a cluster of management practices, involving teams, broader jobs and greater decentralisation of decision making, along with high levels of IT investments, have a disproportionately higher market valuation than

others. Interestingly, firms with traditional centralised organisations and high IT investments actually do worse than similar organisations that invest less in IT.

In the previously mentioned event study methodology research by Im, Dow & Grover (2001) no market reaction was detected for larger firms. However a positive price reaction was detected for smaller firms. A possible explanation offered is that IT investments may be disproportionately beneficial for smaller firms, a suggestion consistent with Brynjolfsson et al's (1994) findings that smaller firms provide better opportunities for exploiting IT than larger firms.

Clearly, management practices, organisational structure and prior IT investment are key factors influencing conversion effectiveness. Firm size may be another significant factor.

Effect of Competitive Environment

Results obtained from research by Dewan, Michael & Min (1998) suggest that IT payoffs may be influenced by the extent of typical firm diversification within an industry. Their research into the link between the scale and scope of firms and their IT investments emphasizes the role of IT in coordination and control. A positive correlation was found between the degree of firm diversification and greater IT investment, reflecting the greater need for coordination within diversified firms. Additionally, diversification into related lines of business was found to demand greater levels of IT investment than unrelated diversification, probably because these firms require coordination of more resources than firms with unrelated diversification.

Generally, IT-intensive industries such as financial services have been observed to derive greater benefits from IT investment than less IT-intensive industries such as manufacturing. However, evidence of IT investment being both beneficial and detrimental has been gathered across industries, with no final industry specific conclusions being reached (Lee & Mennon, 2000; Sircar, Turnbow & Bordoloi, 2000; Seddon, Graeser & Willcocks, 2002; Weill, 1992). Research into stock market reaction to IT investment found no significant industry effect prior to 1991. However, research into the stock market reaction across industries subsequent to 1991 found that only IT investments by financial firms prompted a significant positive market

reaction (Im, Dow & Grover, 2001). In contrast, market reaction to IT infrastructure investment was unaffected by industry (Chatterjee, Pacini & Sambamurthy, 2002).

Two studies by Dewan & Kraemer (1998; 2000) of 36 countries worldwide came to the interesting conclusion that wealthier, industrialised countries showed a positive and significant relationship between IT investment, growth and productivity, but that there was no evidence of such a relationship for developing countries. They hypothesized that this gap was due to the low levels of IT investment relative to GDP in developing countries, and to the lack of complementary assets such as the necessary infrastructure and knowledge base to support effective use of IT.

Ragowsky, Stern & Adams (2000) compared the benefits derived from information systems usage between manufacturing firms in the U.S. and Israel. Consistent with the results obtained by Barua, Kriebel & Mukhopadhyay (1991; 1995), they found significant relationships between firm operating characteristics and benefits derived from individual applications, but no benefits were observed at the overall organisational level. Importantly, the relationships observed at the application level were consistent between the two countries.

Tam (1998) analysed four newly industrialised Asian countries finding little to no evidence of relationships between IT investment and firm productivity or performance. However, her research is based on secondary data for the period from 1983 to 1991, which is prior to the general observations that the productivity paradox evaporated after 1991 (Brynjolfsson & Hitt, 1998).

Contrary to the expectation of Dewan & Kraemer (1998; 2000) a study of South African large insurance companies by Lubbe, Parker & Hoarde (1995) found a clear, positive relationship between IT investment levels and profitability. The most profitable companies were also found to be more likely to spend a higher proportion of non-interest expenses on IT.

Overall, a firm's competitive environment does not appear to have as important an influence on conversion effectiveness as a firm's organisational environment.

2.2.5 Summary

The main thread emerging from the research into links between IT investment and business value is the inability of academic research to provide rigorous proof of the existence of measurable, predictable returns. According to Remenyi & Bannister (2000) the research to date has used problematic data, debatable methodologies, theoretical models open to challenge, and drawn conclusions that are weak, contradictory and/or intuitively suspect.

This prompts the question: If the return on IT investments is so uncertain, why is the IT industry still growing and why are IT investments continuing unabated? If the productivity paradox is correct, “then an entire generation of global managers must be responsible for a colossal and collective act of enormous folly” (Remenyi & Bannister 2000, p. 232).

One obvious answer is that managers and executives know instinctively that IT investments yield business value and that the business and human concept of value is deeper and wider than the narrow rationalism that economic and accounting models are able to identify. Organisations would not have made and continue to make large IT investments if it were as irrational as some economists claim. This view is summed up by Metcalf (cited in Thatcher & Oliver 2001, p.22) who states, “The real meaning of the productivity paradox is that the statistics available to macroeconomists do not measure the kinds of productivity that are improved by computers”.

2.3 Information Technology Infrastructure

2.3.1 Conceptualisation of IT Infrastructure

IT Infrastructure is widely agreed to be an organisational resource typically coordinated by some form of central IS organisation and shared across organisational units (Duncan, 1995; Broadbent & Weill, 1997; Byrd & Turner, 2000; Kayworth, Chatterjee & Sambamurthy, 2001; Weill, Subramani & Broadbent, 2002). Weill, Subramani & Broadbent (2002, p. 59) define IT infrastructure as “a collection of reliable, centrally coordinated services budgeted by senior managers and comprising both technical and human capability”.

resource that consists of physical and intellectual components united by organisational standards regarding their use (Figure 2-2). In common with Broadbent & Weill (1997), Kayworth, Chatterjee & Sambamurthy (2001) define IT infrastructure as extending beyond the concept of a purely physical infrastructure.

Weill, Subramani & Broadbent (2002) advocate defining IT infrastructure components as services that can be specified, measured and controlled in service-level agreements and priced on the open market. The services concept has advantages for the IT group too, because infrastructure services remain relatively stable even when technical components change.

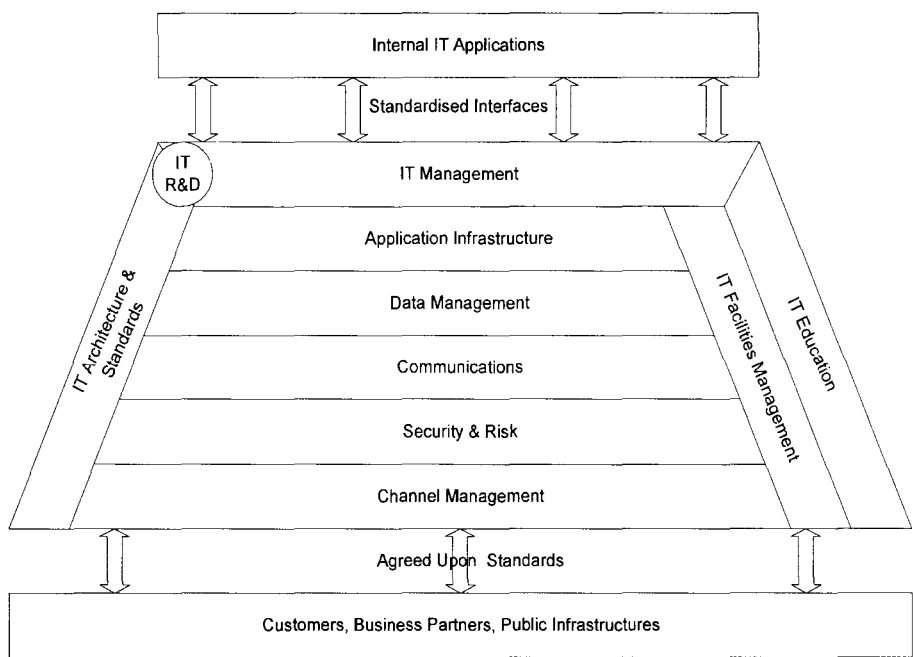


Figure 2-3 An Integrated IT Infrastructure with 10 Capability Clusters (Weill, Subramani & Broadbent 2002, p. 60)

After analysing the infrastructure services of 89 leading enterprises Weill, Subramani & Broadbent (2002) identified 70 different services in 10 clusters of IT infrastructure capability (Figure 2-3). The 10 capability clusters are split between a physical layer and a management-oriented layer. The physical layer contains channel management services; security and risk management services; communication services; data management services; application infrastructure services; and IT facilities management services. The management-oriented layer contains IT management

services; IT architecture and standards services; IT education services; and IT research and development (R&D) services.

Weill, Subramani & Broadbent (2002) note that the leading companies they studied tend not to establish their infrastructure through a few large one-time investments, but gradually, through incremental modular investments.

Although various researchers may use differing definitions, central to all IT infrastructure conceptualisations is the notion of shared IT capabilities available to the whole enterprise forming the platform upon which functionally specific business applications depend.

2.3.2 Theoretical Justification for IT Infrastructure Investment

Porter (1996) defines business strategy as the set of choices the firm intends to make so it can either perform different activities or perform activities differently as compared to rivals. This combination of activities should allow the firm to deliver greater value to customers or to create comparable value at a lower cost, or both. Thus, at its core, business strategy is a reflection of how the firm intends to create value (Kayworth, Chatterjee & Sambamurthy, 2001). A fundamental assumption of this thesis is that the development of IT infrastructure represents a core business strategy that allows firms to create value relative to their competition.

The resource-based view is presently the dominant theoretical perspective in strategic management literature (Bharadwaj, 2000). According to this theory, the internal resources of any firm can be a source of sustained competitive advantage. If one firm has a particular resource not easily created, bought, substituted or imitated by its competitors, then this resource confers some degree of sustained competitive advantage on the firm which possesses it (Barney, 1991).

If one views infrastructure solely as a set of physical components, there is no compelling argument for competitive advantage since these components of infrastructure are readily available to most firms (Mata, Fuerst & Barney, 1995). Even complex information systems are commonly perceived to be eminently imitable. In practice we see innovative systems successfully reverse-engineered and imitated rapidly (Duncan, 1995). Being a first-mover on an IT innovation is generally unlikely

to afford the developer prolonged strategic benefits unless the developer either establishes standards that make emulators dependent on some of the developer's products, or the required time or cost of imitation prohibits competitors from matching the innovation (Duncan, 1995).

However, the management-oriented components of IT infrastructure are not easily imitated (Mata, Fuerst & Barney, 1995). The primary reason for this is that human expertise is often developed over time and is based on tacit knowledge and socially complex processes. Skills at understanding business needs, working with functional business unit managers, coordinating IT activities and anticipating future IT needs represents crucial knowledge-based management-oriented components of IT infrastructure; to the extent that these skills are heterogeneous resources and inimitable, then the firms possessing these key knowledge resources may have a source of sustained competitive advantage (Mata, Fuerst & Barney, 1995).

A firm's IT infrastructure capability is often assessed in terms of "reach and range" (Broadbent, Weill & St. Clair, 1999). Reach refers to the physical connectivity of the IT platform – the greater the reach, the greater the ability of the firm to link up not only the different functional areas within the firm, but also with the firm's customers and suppliers both domestically and internationally. Range refers to the level of functionality that can be shared automatically and seamlessly across each level of reach. An extensive reach and range is illustrated in Table 2-1, at point A. Here the firm is able to simultaneously perform transactions on multiple applications updating all databases across different business units, wherever they are located. A large reach and range indicates that the firm has a high level of IT infrastructure capability. A small reach and range would support the sending of standard messages within a single business unit location, as indicated at point B in Table 2-1.

REACH – To whom can we easily connect?				
Anyone, anywhere				
Customers, suppliers regardless of IT base				
Across different business units abroad				A
Across different business units domestically				
Across geographically spread single business unit locations				
Within a single business unit location	B			
	Send Messages	Access to Information	Perform Transactions - Simple	Perform Complex Transactions on Multiple Applications
Examples	Send Memo	Check Credit Rating	Take Orders	Process Order
RANGE – What services can we share automatically and seamlessly?				

Table 2-1 Reach and Range (Broadbent, Weill & St. Clair 1999, p. 164)

Based on a review of the IS literature Kayworth, Chatterjee & Sambamurthy (2001) identity three crucial areas of value creation for firms which are able to successfully develop and implement high capability IT infrastructures: responsiveness, innovativeness and economies of scope. The following pages describe each area of value creation.

Responsiveness

Responsive capability suggests that firms have two distinct, yet related, competencies. Firstly, firms must be able to recognise threats and opportunities in the business environment. Secondly, firms must be able to respond to these threats and opportunities through some form of coordinated action.

Kayworth, Chatterjee & Sambamurthy (2001) argue that high capability IT infrastructures may increase the firm’s learning capacity through providing seamless

connected networks that enhance the ability to make sense of the environment and to disseminate this information through all layers of the organisation. Furthermore, through providing high levels of reach and range, high capability infrastructure may also facilitate the ability to take action through leveraging the firm's ability to coordinate complex tasks.

However, not all firms' IT infrastructures are equally responsive. Duncan (1995, p.38) explains, "...one firm's infrastructure may make strategic innovations in business process feasible, while the characteristics of competitors' infrastructure may likewise cause their inability to imitate the innovation rapidly enough to mitigate the first mover's advantage. This set of characteristics has been loosely described as infrastructure 'flexibility'". This characteristic of IT infrastructure has captured much of the attention of researchers and practitioners (Byrd & Turner, 2000).

Byrd & Turner (2000) note that flexibility is a key competitive priority for many firms with increasing numbers of researchers highlighting the competitive benefits of overall organisational flexibility. As many organisations are faced with an ever increasing rate of change in their business environments Byrd & Turner (2000) view the issue of flexibility as a critical component of IT infrastructure.

Duncan (1995) offered an empirical investigation of the physical aspects of the IT infrastructure flexibility construct. She demonstrated that one way to describe physical IT infrastructure flexibility more precisely was through the qualities of connectivity, compatibility and modularity. Connectivity is the ability of any technology component to attach to any of the other components inside and outside the organisational environment. Compatibility is the ability to share any type of information across any technology component. Modularity is the ability to add, modify and remove any software, hardware or data components of the infrastructure with ease and with no major overall effect. According to Duncan (1995), an organisation with high connectivity, compatibility and modularity has high physical IT infrastructure flexibility.

Building flexibility into an IT infrastructure is a difficult task. Prahalad & Krishnan (2002) highlight the problems caused when IT infrastructure investments are made without due consideration of future flexibility requirements. The increasingly

common practices of evaluating IT infrastructure investments in terms of costs and not future flexibility requirements and of purchasing solutions to meet current business requirements without considering future flexibility requirements are highlighted as being particularly problematic.

Innovativeness

A precondition for innovation is that decision makers need to be aware of the innovation, how it functions and how it might be applied (Cohen & Levinthal, 1990; Attewell, 1992). Firms with higher embedded capacities to recognise potential IT innovations may be much more likely to engage in higher levels of innovative activity.

Absorptive capacity is one theoretical perspective used to support this argument. Absorptive capacity is “the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends” (Cohen & Levinthal 1990, p. 128). This ability is a function of organisational members’ individual absorptive capacities that are determined by members’ prior knowledge, expertise, and communication with each other and with external entities. An underlying assumption of this theory is that knowledgeable individuals act rationally to evaluate options and make decisions about technology innovation. Furthermore, the extent to which decision makers already possess knowledge, skills, experience and familiarity with a technology affects their ability to assess issues that arise in planning for the technology (Cohen & Levinthal 1990).

Following this line of reasoning, it can be argued that the presence of high capability infrastructure will, by nature, assume high levels of IT expertise and knowledge as well as tacit managerial knowledge in funding and building the infrastructure. Consequently, firms with higher capability infrastructure will very likely have higher levels of absorptive capacity, which in turn will lead to higher levels of innovation with information technology (Kayworth, Chatterjee & Sambamurthy, 2001).

Research by Boynton, Zmud & Jacobs (1994) clearly indicates that managerial IT knowledge facilitates the rich information exchanges and joint problem solving among IT and line managers that are critical in enabling an organisation to move

beyond the more obvious IT applications toward innovative applications that provide greater business value.

High capability infrastructure may also foster innovative activity through providing a range of business options that may be exercised in the future i.e. infrastructure provides a springboard from which future, yet to be determined, IT initiatives may take place (Kayworth, Chatterjee & Sambamurthy, 2001). Supporting this view, Dos Santos (1991, p. 73) recommends the use of option pricing models when evaluating IT investment projects, as “a new IT project gives the firm the ability to undertake future projects using the new IT and that it is the potential value of these future projects that accounts for a major portion of the value of the initial project”. High capability infrastructure may also spawn further IT innovation through facilitating experimentation with new technology.

Economies of Scope

There is considerable support for the notion that high capability infrastructure may reduce the cost and time for completion of strategic business applications (Duncan, 1995; Kayworth, Chatterjee & Sambamurthy, 2001). The rationale for this claim is that infrastructure provides shared organisational resources that lower marginal costs as usage is spread over a wide range of organisational stakeholders. To the extent that business units can utilise these shared assets in a recurring fashion to develop business applications, then they are able to achieve economies of scope through lowering the marginal cost of application development.

2.3.3 Empirical Evidence of Business Value

Research by Kettinger et al (1994) into the sustainability of competitive advantage found that information systems unable to sustain their competitive impact have only transient strategic value, or may offer negative value if matched by a superior response by competitors. Their investigation into the antecedent factors effecting sustainable competitive advantage found a flexible technological base to be a prerequisite for effective technology-based competition. Furthermore, they emphasised the importance of this technological base as an enabler of innovative strategic actions.

In 1995, Duncan (1995, p. 39) raised the issue that, despite widespread recognition of the importance of IT infrastructure, knowledge of the business value of IT infrastructure “remains largely in the realms of conjecture and anecdote”. Since she highlighted the problem there have been a number of studies focussing specifically on demonstrating the business value of IT infrastructure.

Broadbent, Weill & St. Clair (1999) explored the links between IT infrastructure and business process change. They concluded that all firms need a basic level of IT infrastructure capability to implement business process reengineering. Firms with higher levels of IT infrastructure capability, developed before or during a business process redesign, are able to implement extensive changes to their business processes over relatively short time frames. Firms with lower levels of IT infrastructure capability are constrained in terms of the speed and nature of business process change.

Mitchell & Zmud (1999) reached similar conclusions regarding the influence of IT infrastructure on organisational process innovation. They found that process innovations rely increasingly on the capabilities embedded in an organisation’s IT infrastructure. Specifically they noted that “each element of the IT infrastructure has the potential to make or break a redesign project and, as a result, varies in strategic potential, asset specificity, scale advantage, and market stability” (Mitchell & Zmud, 1999, p. 425).

Research by Chatterjee, Pacini & Sambamurthy (2002) into stock market investors’ reactions to firm’s IT infrastructure investments showed a clear investor belief that infrastructure investments are positive net present value projects. In contrast with prior studies that have reported that manufacturing-oriented firms do not derive much value from IT investments, they found that IT infrastructure investments enhance firm value across a diverse set of industries.

Examinations of leading enterprises’ infrastructure investments by Broadbent & Weill (1997) and Weill, Subramani & Broadbent (2002) have found that different infrastructure capabilities are required to support different strategic business initiatives. Firms able to match their infrastructure capabilities to their strategic objectives create a source of sustainable competitive advantage, as competitors are unable to cost effectively match the levels of strategic agility these firms possess.

Santhanam & Hartono (2003) conducted a test of the robustness of utilizing the resource-based view as a theoretical framework for investigating the impact of IT investments on firm performance. Their results indicate that firms with superior IT capability exhibit superior current and sustained firm performance when compared to average industry performance, even after adjusting for effects of prior firm performance.

2.4 Use of Market Reaction

The preceding pages have attempted to broadly describe research to date into the links between IT investment and business value, and to provide evidence of the business value of IT infrastructure. This section explains why market reaction can be used as a proxy for business value.

A firm's stock price is assumed to be equivalent to the present value of expected future benefits which accrue to its shareholders (Okeahalam & Jefferis, 1999). Accordingly, if expectations of the future benefits accruing to shareholders change a firm's market valuation will be affected in proportion to the magnitude of the anticipated change in benefits.

Market reaction to unanticipated events is usually measured using event studies. According to McWilliams & Siegel (1997), the event study method has become popular because it obviates the need to analyse accounting-based measures of profit which have been criticized because they are often not very good indicators of the true performance of firms. The event study methodology draws on the efficient market hypothesis that capital markets are efficient mechanisms to process firm relevant information (Fama, 1991). The logic underlying the hypothesis is the belief that investors in capital markets process publicly available information to assess the impact on firm activities, not just on current performance, but also the performance of the firm in future periods. When additional information that might affect a firm's present and future earnings becomes publicly available, the stock price changes relatively rapidly to reflect the current assessment of the value of the firm. Brooks, Patel & Su (2003) report that the New York and U.S. stock exchanges typically take less than twenty minutes to fully adjust prices to incorporate unanticipated events.

According to Subramani & Walden (2000) the strength of the method lies in the fact that it captures the overall assessment by a large number of investors of the discounted value of current and future firm performance attributable to individual events which is reflected in the stock price and the market value of the firm

2.5 Summary

Research in the last decade has increasingly found evidence of business value being derived from IT investment (Dedrick, Gurbaxani & Kraemer, 2003). Earlier studies that questioned the existence of a relationship between IT investment and business value have now been explained on methodological and/or data grounds (Brynjolfsson & Hitt, 1998). The focus has now shifted to finding better ways of defining and measuring business value (Remenyi & Bannister, 2000). Market reaction has emerged as a valuable new way to measure an IT investment's perceived value (Dos Santos, Peffers & Mauer, 1993).

IT infrastructure has progressed from being defined as purely physical components to a service-oriented amalgamation of shared capabilities (Weill, Subramani & Broadbent, 2002). The value of IT infrastructure has been investigated and confirmed from both theoretical and empirical perspectives (Mata, Fuerst & Barney, 1995; Kayworth, Chatterjee & Sambamurthy, 2001). However, empirical research into the business value of IT infrastructure lags behind the quantity and quality of research into overall IT investment.

Significantly, to the best of the author's knowledge, no research has investigated the value of IT infrastructure in South Africa and the event study methodology has not previously been used in IS research in South Africa.

2.6 Hypotheses

To aid interpretation and comparability the hypotheses from Chatterjee, Pacini & Sambamurthy's (2002) research are used in this research.

If IT infrastructure investments are perceived to confer business benefits and be positive net cash flow investments, such investments are likely to be favourably

received by the South African market. This leads to the first hypothesis, stated in the alternative:

H1: IT infrastructure investment announcements are associated with positive share price reactions.

Considering the potential benefits associated with such investments, significant trading activity is also likely to result from such announcements (Chatterjee, Pacini & Sambamurthy, 2002). Trading volume reflects changes in the expectations of individual investors, whereas price reflects changes in the expectations of the market as a whole (Karpoff, 1986; Kim & Verrecchia, 1991). More importantly, since volume contains the differences amongst traders, which are averaged out in the returns data, the use of volume in conjunction with returns could identify systematic differences in investors' knowledge or other characteristics that result in different reactions to public announcements across firms (Kim & Verrecchia, 1991). This leads to the second hypothesis, stated in the alternative:

H2: IT infrastructure investment announcements are associated with increased trading volume.

As noted by Weil, Subramani & Broadbent (2003) and discussed by Chatterjee, Pacini & Sambamurthy (2002) a firm's IT infrastructure capability is built up gradually, with many incremental investments being made over an extended period. Thus, drawing on the resource-based view of the firm (Mata, Fuerst & Barney, 1995), IT infrastructure is more likely to be a source of sustained competitive advantage than individual application investments. Thus, it is reasonable to expect the market to react more positively and favourably to IT infrastructure investment announcements. This leads to the final two hypotheses, stated in the alternative:

H3: IT infrastructure investment announcements are associated with greater positive share price reactions than IT application-based investment announcements.

H4: IT infrastructure investment announcements are associated with greater trading volume than IT application-based investment announcements.

3 Methodology

3.1 Introduction

This chapter describes how the research hypotheses derived in the previous chapter were investigated. The chapter begins with an overview of where relevant IT investment announcements were found, how these announcements were categorised, and how confounding events were handled.

The next section describes the statistical methodology used to allow valid inferences to be drawn from the data. The event study methodology is described in detail, as well as parametric and non-parametric significance tests.

The regression analysis procedure conducted to examine the validity of hypothesized predictors is presented, followed by the trading volume analysis methodology used. The chapter concludes with a brief summary.

3.2 Data Acquisition Procedure

The first group of data required for this thesis was announcements of IT investment by South African firms. Two sources were used to find these announcements: *Lexis-Nexis* and *ITWeb*. *Lexis-Nexis* is a well known international news database, archiving information from major newspapers, wire services and business publications. *ITWeb* is a South African internet site that specialises in local IT news. *ITWeb* also maintains virtual press rooms that archive press releases from most of South Africa's IT companies.

The time period covered was 1 January 1998 to 31 December 2002. This 5 year time period was chosen for both convenience and relevance. Obtaining investment announcements prior to 1997 would have been problematic. This time period is of interest to researchers as investor sentiment regarding information technology was significantly influenced by the e-commerce bubble bursting and the year 2000. This time period covers the final stages of the e-commerce build up as well as the post e-commerce and year 2000 periods.

A search of *Lexis-Nexis* yielded 91 IT investment announcements. A search through *ITWeb*'s virtual press rooms yielded a further 169 IT investment announcements, giving a total of 260 IT investment announcements.

All announcements from *Lexis-Nexis* were then discarded as they could not be reliably dated. This left 169 IT investment announcements.

These announcements were carefully examined to categorise them as either IT infrastructure investment announcements or IT application investment announcements. The following guideline, as used by Chatterjee, Pacini & Sambamurthy (2002, p. 17), was used:

“An investment would be classified as ‘infrastructure’ when the announcement claims to be an investment directed toward providing IT services like communication network services, messaging services, database management services, security services, disaster planning, and technology support services.

An investment would be classified as an ‘application investment’ when the announcement claims to be an investment directed toward purchasing or developing software to provide a specific business solution. The solution could take the form of different types of business applications like transaction processing systems, management information systems, expert systems, decision support systems, and executive information systems.”

The categorisation effort was assisted by using the list of seventy IT infrastructure services contained in the appendix of Weill, Subramani & Broadbent's 2002 article “Building IT Infrastructure for Strategic Agility”. This list is an updated version of Broadbent et al's 1996 list of 25 IT infrastructure services that was used by Chatterjee, Pacini and Sambamurthy (2002).

Fifty-five announcements were discarded as they could not be unambiguously classified as either infrastructure or application-based investments. This resulted in an intermediate sample of 114 IT investment announcements.

The biggest threat to the validity of most event studies are confounding events (McWilliams & Siegel, 1997; McWilliams & McWilliams, 2000). Confounding

events are other firm-specific, value-relevant events occurring at the same time as the event under investigation. Following Dos Santos, Peffers & Mauer (1993), a search was made for confounding events occurring during the window from two days prior to two days after the investment announcement. *Lexis-Nexis*, specifically the *Business Day* and *Financial Mail* archives, as well as the *Business Report*'s online archives were searched for these confounding events. Fifteen investment announcements were eliminated from the sample as a result of confounding events influencing the market's perception of the firm at the time of the IT investment announcement.

Examples of confounding events which resulted in the exclusion of investment announcements included: the appointment of new board members, strikes, merger approvals, interim results and legal suits.

Daily closing prices, trading volumes and all other financial information required for each firm were obtained from a *BFA McGregor* workstation. Twenty-eight announcements were eliminated from the sample as they pertained to firms that were either unlisted or had unavailable financial data. A further 6 announcements were eliminated as the associated firms had not been listed for at least 300 business days prior to the announcement.

Of the remaining announcements, 22 were made by firms that were unlisted, but part of a larger, listed conglomerate. Any business value created by an IT investment in a subsidiary company is diluted when combined with other subsidiary companies at the holding company level. This dilution makes measuring the business value added by an investment problematic, therefore the 22 IT investment announcements made by subsidiary companies were excluded from the final sample.

The previous exclusions left 43 candidate IT investment announcements. These announcements were independently categorised by the author's supervisor using the same guidelines previously mentioned. Four announcements were categorised differently by the author and his supervisor. These announcements were excluded from the sample, giving a final sample size of 39.

A breakdown of the derivation of the final sample is given in Table 3-1. A more detailed analysis of the final sample is presented in Chapter 4.

Initial Sample Size		260
<i>ITWeb</i>	169	
<i>Lexis Nexis</i>	91	
Less: Lexis Nexis		(91)
		169
<i>Application Investments</i>	37	
<i>Infrastructure Investments</i>	77	
<i>Uncertain Investments</i>	55	
Less: Uncertain Investments		(55)
		114
Less: Events for unlisted companies or companies with unavailable data		(28)
		86
Less: Events for subsidiary companies		(22)
		64
Less: Confounding Events		(15)
		49
Less: Events for companies with an insufficient trading history		(6)
		43
Less: Events with conflicting investment categorisations		(4)
Final Sample Size		39
<i>Application</i>	12	
<i>Infrastructure</i>	27	

Table 3-1 Breakdown of Final Sample

3.3 Data Analysis Methodology

3.3.1 Event study Description

The event study methodology draws on the efficient market hypothesis (Fama, 1991) that capital markets are efficient mechanisms to process information available on firms. The logic underlying the hypothesis is the belief that investors in capital markets process publicly available information regarding firm activities to assess the impact of the information on current and future firm performance. When additional information that might affect a firm's current and future earnings becomes publicly available, the stock price changes relatively rapidly to reflect the new assessment of the value of the firm. The strength of the method lies in the fact that it captures the overall assessment by a large number of investors of the discounted value of current and future firm performance attributable to individual events. This is reflected in the stock price and the market value of the firm (Subramani & Walden, 2001).

The methodology is well accepted and widely used in the accounting, finance and management research disciplines (McWilliams & Siegel, 1997). The event study

methodology was first used within the IS field by Dos Santos, Peffers & Mauer (1993) to examine the effects of innovative IT investments on the market value of the firm. In the last five years the methodology has grown more popular. It has been used to examine the effects on the market value of firms of business-to-business electronic commerce initiatives (Subramani & Walden, 2000), IT investments (Krishnan & Sriram, 2000), business-to-consumer electronic commerce initiatives (Subramani & Walden, 2001), newly created CIO positions (Chatterjee, Richardson & Zmud, 2001) and IT infrastructure investments (Chatterjee, Pacini & Sambamurthy, 2002).

Event studies have been used in South Africa to study the market reaction to LIFO accounting adoptions (Knight & Affleck-Graves, 1988), increased capital requirements for banks (Bhana, 1995), special dividends (Bhana, 1998), new share issues (Bhana, 1999a), potential takeovers (Bhana, 1999b), and research and development announcements (Bhana, 2001). To the best of the author's knowledge the event study methodology has not been previously used in information systems research in South Africa.

The event study method was developed to measure the effect of an unanticipated event on stock prices. The standard approach estimates a market model for each firm and then calculates abnormal returns during an event window of k days surrounding the announcement date. These abnormal returns are assumed to reflect the stock market's reaction to the arrival of new information (McWilliams & Siegel, 1997).

Using the standard capital asset pricing model's market model, the rate of return on the share price of firm i on day t is:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1.)$$

where:

- R_{it} = the rate of return on the share price of firm i on day t
- R_{mt} = the rate of return on the market portfolio on day t
- α_i = the intercept term of firm i
- β_i = the systematic risk of firm i
- ε_{it} = the error term, with $E(\varepsilon_{it}) = 0$

From estimation of the above equation, estimates of daily abnormal returns (AR) for firm i on day t are obtained using the following equation:

$$AR_{it} = R_{it} - (a_i + b_i R_{mt}) \quad (2.)$$

where a_i and b_i are the ordinary least squares (OLS) parameter estimates obtained from the regression of R_{it} on R_{mt} over an estimation period (T) preceding the event.

Traditionally, parametric tests are used to test the null hypothesis of the mean cumulative abnormal return being zero across all firms during the event window. However, raw and abnormal stock returns have been shown to be right skewed and leptokurtic (Cowan, 1992). Additionally, significant kurtosis has been reported for parametric stock return test statistics (Corrado & Zivney, 1992). Since statistical inferences are based on tail weight probabilities for a normal distribution, the traditional tests might yield biased inferences in event studies using daily stock returns.

If normality assumptions are invalid then more robust, non-parametric approaches are well specified. Non-parametric tests also outperform parametric tests in the presence of thinly traded stocks and heteroskedasticity (Corrado & Zivney, 1992).

Due to the relative advantages of parametric and non-parametric approaches, both are used in this thesis.

3.3.2 Parametric Approach

The usual parametric test used to assess the significance of abnormal stock returns is the standardised residual test, defined by Patell (1976) and studied by Brown & Warner (1985). The derivation of the test statistic given below follows the derivation presented by McWilliams & Siegel (1997).

Firstly, a standardised abnormal return (SAR) for firm i on day t is computed, where the abnormal return is standardised by its standard deviation:

$$SAR_{it} = \frac{AR_{it}}{SD_{it}} \quad (3.)$$

with

$$SD_{it} = \sqrt{S_i^2 \left(1 + \frac{1}{T} + \frac{(R_{mt} - R_m)^2}{\sum_{t=1}^T (R_{mt} - R_m)^2}\right)} \quad (4.)$$

where:

- S_i^2 = the residual variance from the market model as computed for firm i
- R_m = the mean return on the market portfolio calculated during the estimation period
- T = the number of days in the estimation period.

Individual abnormal returns are assumed to be cross-sectionally independent and normally distributed, so each standardised abnormal return has a Student t distribution (Cowan & Sergeant, 1996).

The standardised abnormal returns are then combined over a number of days, k (the event window), to derive a measure of the cumulative abnormal return (CAR) for each firm:

$$CAR_i = \frac{1}{\sqrt{k}} \sum_{t=1}^k SAR_{it} \quad (5.)$$

A standard assumption is that the values of CAR_i are independent and identically distributed. With this assumption, these values are converted to identically distributed variables by dividing the CAR_i by its standard deviation, which is equal to:

$$\sqrt{\frac{(T-2)}{(T-4)}} \quad (6.)$$

Thus, the average standardised cumulative abnormal returns across n firms (ACAR) over the event window is computed as:

$$ACAR = \frac{1}{n} \times \frac{1}{\sqrt{\frac{(T-2)}{(T-4)}}} \times \sum_{i=1}^n CAR_i \quad (7.)$$

The test statistic used to assess whether the average cumulative abnormal return is significantly different from zero (its expected value) is:

$$Z = ACAR \times \sqrt{n} \quad (8.)$$

For the purposes of comparisons between event studies, it is useful to show the following equivalent, expanded version of Z:

$$Z = \frac{1}{\sqrt{n}\sqrt{k}} \times \sqrt{\frac{(T-4)}{(T-2)}} \times \sum_{i=1}^n \sum_{t=1}^k \frac{AR_{it}}{SD_{it}} \quad (9.)$$

If CAR_i are assumed to be independent, which is the typical assumption in studies involving firm-specific rather than common event dates, then Z has, approximately, a standard normal distribution under the null hypothesis of no stock price effect (McWilliams & McWilliams, 2000). The Z-statistic is tested for significance against the standard normal distribution. If significant, the average cumulative abnormal return is assumed to measure the average effect of the event on the value of the n firms. (McWilliams & Siegel, 1997)

3.3.3 Non-Parametric Approach

Traditional parametric tests are vulnerable to misspecification if their underlying assumptions are violated. Non-parametric approaches depend on fewer assumptions, while retaining, or even exceeding, the power of parametric tests in detecting abnormal performance (Cowan, 1992; Corrado & Zivney, 1992). Corrado (1989) developed a non-parametric rank test statistic specifically to test for abnormal stock price performance. Corrado's rank statistic is robust to non-normal distribution, cross-sectional dependence, increases in the variance of abnormal returns during the event period, thinly traded stocks, overlapping periods and serial dependence in abnormal returns (Campbell & Wasley, 1993). Corrado & Zivney (1992) found the rank statistic to be the most appropriate test available for assessing the statistical significance of abnormal returns.

The derivation of the test statistic given below follows the derivations presented by Corrado & Zivney (1992) and Cowan (1992).

The rank test procedure treats the estimation period, T , and the event window, k , as a single time series, and assigns a rank to each daily abnormal return for each firm. Let K_{it} represent the rank of abnormal return AR_{it} in the time series of $T+k$ daily abnormal returns of firm i . Rank one signifies the smallest abnormal return; rank $T+k$, the largest. The mean rank for all firms for the entire time series is:

$$\bar{K} = \frac{1}{2} + \frac{(T+k)}{2} \quad (10.)$$

The mean rank for n firms for k days of the event window is:

$$\bar{K}_k = \frac{\sum_{t=1}^k \sum_{i=1}^n K_{it}}{kn} \quad (11.)$$

The mean rank for n firms on day t of the combined estimation and event period is:

$$\bar{K}_t = \frac{\sum_{i=1}^n K_{it}}{n} \quad (12.)$$

The rank test statistic is:

$$Z = \sqrt{k} \frac{\bar{K}_k - \bar{K}}{\sqrt{\frac{\sum_{t=1}^{T+k} (\bar{K}_t - \bar{K})^2}{T+k}}} \quad (13.)$$

The rank test statistic has a standard normal distribution (Corrado & Zivney, 1992) and is tested for significance against the standard normal distribution.

3.3.4 Cross-Sectional Regression Analysis

McWilliams & Siegel (1997) advise using regression analysis to investigate the validity of hypothesized predictors. Hypothesis 3 predicts that IT infrastructure investments are associated with greater positive share price reactions than IT application-based investment announcements. Regression analysis enables the calculation of individual factor's contributions to day zero (the announcement day) abnormal returns.

Abnormal returns' ranks are standardised by the number of observations plus one, so that the ranked variable has a maximum value of $N/N+1$ and a minimum value of $1/N+1$. Ranks rather than actual data values are used as ranks generalise the functional form of the model, minimise heteroskedasticity that can result from using a linear function to represent a non-linear relationship, and compensate for outliers (Cheng, Hopwood & McKeown, 1992).

The key independent variable in the regression analysis is investment type (INVTYPE). Additional control variables are included in the analysis to allow for other factors that could influence abnormal returns.

The full cross-sectional regression model is:

$$ARR_{i0} = b_0 + b_1 INVTYPE_i + b_2 SIZE_i + b_3 GROW_i + b_4 IND_i + b_5 FIN_i + b_6 ITPROD_i + e_i \quad (14.)$$

where:

ARR_{i0}	= the standardised rank of firm i 's abnormal return on day 0
b_0	= the intercept term
$INVTYPE_i$	= the type of IT investment set to 1 if infrastructure, else 0
$SIZE_i$	= the standardised rank of firm i 's market capitalisation
$GROW_i$	= the standardised rank of the ratio of market value of equity to book value for firm i as of the end of the last financial year prior to the investment announcement date
IND_i	= the type of industry set to 1 for service industry firms, else 0
FIN_i	= a dummy variable set to 1 if firm i is a financial services company, else set to 0
$ITPROD_i$	= a dummy variable set to 1 if firm i is an IT producer, else set to 0
e_i	= the error term, with $E(e_i) = 0$

All independent variables are control variables, except for INVTYPE. Detailed descriptions of the control variables and their reasons for inclusion are given in Table 3-2. The control variables are the same as those used by Chatterjee, Pacini & Sambamurthy (2002), except for diversity. Diversity, which Chatterjee, Pacini & Sambamurthy (2002) measured using the number of lines of business for each firm,

was not included as no reliable source is available for this information. This omission is not concerning: Chatterjee, Pacini & Sambamurthy (2002) did not find firm diversity to be a significant factor in their analysis.

Table 3-2 Regression Control Variables

Variable Name	Reason for inclusion	Data Source
Firm Size (SIZE)	Brynjolfsson et al (1994) found that smaller firms provide better opportunities for exploiting IT than larger firms. This view was substantiated by Im, Dow & Grover (2001) who detected no market reaction to IT investments made by larger firms, however a positive price reaction was detected for smaller firms.	Market value of firm equity is used as a proxy for firm size (Fama & French, 1992).
Firm Growth (GROW)	Dewan, Michael & Min (1998) found that the level of IT investment is negatively related to firm growth.	The market-to-book value ratio is used as a proxy for firm growth (Dewan, Michael & Min, 1998).
Industry Type (IND)	Gilchrist, Gurbaxani & Town (2001) show that IT has a substantial impact on productivity growth for manufacturing firms, which exceeds the impact that would be predicted by its factor share.	Firms classified as constituents of the JSE's Cyclical Services (J050) and Non-Cyclical Services (J060) economic groups are coded 1 for non-manufacturing firms. All other firms are coded 0.
Financial Services (FIN)	Im, Dow & Grover (2001) found that subsequent to 1991 IT investments by financial firms prompted a significantly positive market reaction.	Firms classified as constituents of the JSE's Financials (J080) economic group are coded 1 for financial service firms. All other firms are coded 0.
IT Producer (ITPROD)	Firms can be both producers and users of IT. The use of this variable enables the testing of whether IT-producing firms drive the results (Chatterjee, Pacini & Sambamurthy, 2002).	Firms classified as constituents of the JSE's Information Technology (J090) economic group are coded 1 for IT producing firms. All other firms are coded 0.

3.3.5 Trading Volume Analysis

An analysis of firms' trading volume around event dates is important. A significant trade volume reaction may occur in the absence of a discernable price reaction. Differing interpretations of public announcements amongst market participants drive trading volumes. Empirical tests have shown that these differential interpretations are an important source of trading volume (Bamber, Barron & Stober, 1999).

News having no relation to price changes can still stimulate trading. Public announcements generating virtually no price change are often associated with significant trading. Such trading is inconsistent with economic models that assume news is identically interpreted, but consistent with models that incorporate differential interpretations (Bamber, Barron & Stober, 1999). Karpoff (1986) notes that abnormal volumes do not always signal conflicting interpretations, they may indicate market agreement following differing prior expectations.

Unlike the well-established event study methodology for prices, there is no generally accepted method of defining, measuring and testing abnormal trading volume (Tkac, 1999). The methodology advocated by Lobo & Tung (1997), and used by Chatterjee, Pacini & Sambamurthy (2002), is used here.

The first measure is defined as the percentage of a firm's outstanding shares traded on a given day, computed as follows:

$$VOL_{it} = \frac{SHRTRD_{it}}{SHROUT_{it}} \times 100 \quad (15.)$$

where:

$SHRTRD_{it}$ = number of firm i 's shares traded on day t

$SHROUT_{it}$ = number of firm i 's shares outstanding on day t

Abnormal volume for days in the event window is computed as the deviation of a firm's event day volume from its mean daily volume during the estimation period. The following approach is used:

$$AVOL_{it} = VOL_{it} - AVGPRTD_i \quad (16.)$$

where:

$AVGPRTD_i$ = the mean daily percentage of firm i 's outstanding shares
traded in the estimation period.

A one-tailed t -test is used to assess whether daily mean abnormal volume for each day during the event window is significantly greater than the expected value of zero (i.e. the event window mean volume is greater than the estimation period mean volume).

3.4 Summary

This chapter began by describing the data acquisition procedure used. The event study methodology was introduced next. Parametric and non-parametric test statistics for testing the significance of abnormal returns were derived. The cross-sectional regression analysis used to verify the validity of hypothesized predictors was described. Finally, a parametric test for testing the significance of abnormal trading volume was presented.

In summary, this chapter described where data was obtained and the analysis techniques applied to this data. The next chapter presents the results of this analysis.

4 Results

4.1 Introduction

This chapter presents the results of the application of the methodology described in Chapter 3. Only the results are given, interpretation and discussion of the findings is reserved for Chapter 5.

The chapter begins with an analysis of the IT investment announcements that make up the final sample. The results of the abnormal return analysis are given next, followed by the results of the abnormal volume analysis. The results of the cross-sectional regression analysis conclude the results presentation. The chapter ends with a summary of the main findings.

4.2 Announcement Sample Analysis

Announcements of companies' IT investments were obtained as described in section 3.2. Section 3.2 also describes the extensive validity controls employed to ensure that the final sample only contains clearly categorised IT investments, announced when the relevant companies had no other potentially value-relevant events occurring simultaneously.

As shown in Table 3-1 the final sample contained 39 IT investment announcements, comprised of 27 infrastructure investments and 12 application-based investments. A complete listing of the final 39 announcements used is given in Appendix A. This section describes the final sample in more detail.

Although the final number of announcements may seem low when compared to the 112 announcements analysed by Chatterjee, Pacini & Sambamurthy (2002) or the 97 analysed by Dos Santos, Peffers & Mauer (1993), the quantity is sufficient. Corrado & Zivney (1992) report that the parametric event study tests are well specified in 5 percent level tests for estimation periods greater than 100 days, even with portfolios of as few as 10 companies. Brown & Warner (1985) report reliable parametric test specification in 5 percent level tests for portfolios containing as few as 5 companies. The non-parametric rank test is well specified for as few as 10 companies with 50 day and longer estimation periods (Corrado & Zivney, 1992).

As shown in Table 4-1, 39 IT investment announcements were made by 28 different companies. Most companies (79%) had only one IT investment announcement in the sample. Almost half (44%) of the announcements were made by only 6 companies.

Number of Announcements	Number of Companies	Percentage of Companies	Announcements in Category	Percentage of Announcements
1	22	79%	22	56%
2	3	11%	6	15%
3	2	7%	6	15%
5	1	4%	5	13%
Total	28	100%	39	100%

Table 4-1 Investment Announcements by company

The announcements’ distribution is biased towards the final two years of the time period covered (Table 4-2). However, no two announcements were released on the same day and no significant announcement date clustering was observed.

Date	Number of Announcements	Percent
1998	1	3%
1999	6	15%
2000	6	15%
2001	14	36%
2002	12	31%
Total	39	100%

Table 4-2 Final Investment Announcements Sample by year

Date	Number of Announcements	Percent
1998	7	3%
1999	20	12%
2000	26	15%
2001	58	34%
2002	58	34%
Total	169	100%

Table 4-3 Initial ITWeb Investment Announcements Sample by year

The same bias towards the final two years of the time period is evident in the initial *ITWeb* investment announcements’ distribution (Table 4-3). A possible explanation for this distribution may be the high failure rate amongst IT companies around the turn of the century. Many IT companies responsible for supplying equipment or services in 1998, 1999 and 2000 are no longer in business, and thus no longer have

virtual press offices on *ITWeb*. Therefore, any announcements released by those IT companies that are no longer in business would never have been available as candidates for inclusion.

The sample is well distributed across JSE sectors. Table 4-4 shows that the announcements are spread across sixteen different sectors. Financial services firms (Banks, Life Assurance and Speciality & Other Finance) are disproportionately well represented, with 49% of the announcements.

JSE Sector (Sector Code)	Number of Companies	Percent	Number of Announcements	Percent
Banks (81)	5	18%	10	26%
Beverages (41)	1	4%	1	3%
Chemicals (11)	1	4%	1	3%
Electronic & Electrical Equipment (25)	1	4%	1	3%
Food Producers & Processors (43)	1	4%	1	3%
Forestry & Paper (15)	1	4%	1	3%
General Retailers (52)	2	7%	3	8%
Health (44)	1	4%	1	3%
Insurance (83)	1	4%	1	3%
Life Assurance (84)	3	11%	7	18%
Media & Photography (54)	1	4%	1	3%
Mining (04)	5	18%	6	15%
Oil & Gas (07)	1	4%	1	3%
Software & Computer Services (97)	1	4%	1	3%
Speciality & Other Finance (97)	2	7%	2	5%
Transport (59)	1	4%	1	3%
Total	28	100%	39	100%

Table 4-4 JSE Sector Breakdown

4.3 Abnormal Returns Analysis

An analysis of abnormal returns was conducted using parametric and non-parametric techniques, as described in sections 3.3.2 and 3.3.3 respectively.

Table 4-5 provides descriptive statistics for the 11 700 days (300 days x 39 announcements) in the longest, 300 day ($t=-301$, $t=-1$), market model estimation period used. Table 4-5 provides strong support for the use of non-parametric tests. A key assumption of parametric abnormal returns tests is that the abnormal returns follow a normal distribution (McWilliams & Siegel, 1997). The normal distribution is perfectly symmetrical (skewness = 0) and has a kurtosis of 3 (Corrado & Zivney,

1992). During the 300 day estimation period the abnormal returns had a distribution with a significant negative skewness (-0.771) and an extremely large kurtosis (23.122). A standard test of normality of abnormal returns (Cowan, 1992), the Kolmogorov-Smirnov goodness of fit test, was rejected at the 1% level ($d=0.075$, $p<0.01$; Lilliefors $p<0.01$). These results are consistent with the findings of Bowie & Bradfield (1998) who also found evidence of severe non-normality for JSE abnormal returns.

	N	Mean	Median	Min	Max	Std. Dev.	Skewness	Kurtosis
Stock Return	11700	0.000	0.000	(0.466)	0.200	0.027	(0.437)	14.504
Index Return	11700	0.000	0.000	(0.119)	0.077	0.013	(0.275)	3.612
Estimated Return	11700	0.000	0.001	(0.098)	0.092	0.012	(0.355)	6.917
Abnormal Return	11700	(0.000)	(0.001)	(0.489)	0.200	0.024	(0.771)	23.122

Table 4-5 Descriptive Statistics of Stock Returns, Index Returns, Estimated Returns & Abnormal Returns

Tables 4-6, 4-7 and 4-8 show the event study results. Events study results were generated for three event windows and eight market model estimation periods.

All of the IT investment announcements in the final sample were obtained from *ITWeb*. *ITWeb* hosts virtual press offices for most South African IT companies. Press releases are placed on *ITWeb* concurrent with their release to the general media. This allowed each announcement to be accurately dated. Therefore, in accordance with the efficient markets hypothesis (Fama, 1991), any market reaction to an announcement will occur on the day of the *ITWeb* press release ($t=0$) and a one day event window is the optimum sized window to detect abnormal returns. Longer event windows of three days ($t=-1$, $t=+1$) and five days ($t=-2$, $t=+2$) are included to facilitate better comparison with Chatterjee, Pacini and Sambamurthy's (2002) study.

Eight market model estimation periods were used. Corrado & Zivney (1992) report that longer estimation periods reduce the likelihood of rejecting null hypotheses in the absence of abnormal returns. However, they also report that shorter estimation periods, down to 50 days, enhance the power of both parametric and non-parametric

tests to detect abnormal returns. The statistical validity of shorter, 25 day, estimation periods has not been determined and these results are only included for illustration.

Unless otherwise stated all figures reported elsewhere in this chapter are derived from the use of a 300 day ($T=300$) estimation period with a one day ($k=1$) event window. This is the most theoretically sound combination.

As Table 4-6 shows, no statistically significant results were obtained from the combined infrastructure and application investment announcement sample. No clear market reaction to general IT investment announcements is discernable.

Event Window	Estimation Period								
		25	50	75	100	150	200	250	300
0	Parametric Test	0.062	(0.002)	0.002	0.007	0.014	0.016	0.015	0.010
	p	-	0.998	0.998	0.994	0.989	0.987	0.988	0.992
	Non-Parametric Test	(0.072)	(0.284)	(0.430)	(0.401)	(0.240)	(0.357)	(0.373)	(0.349)
	p	-	0.776	0.667	0.689	0.810	0.721	0.709	0.727
(-1,+1)	Parametric Test	0.141	0.096	0.085	0.083	0.077	0.064	0.060	0.045
	p	-	0.923	0.932	0.934	0.939	0.949	0.952	0.964
	Non-Parametric Test	0.028	(0.116)	(0.262)	(0.319)	(0.111)	(0.217)	(0.166)	(0.239)
	p	-	0.908	0.794	0.750	0.911	0.828	0.868	0.811
(-2,+2)	Parametric Test	0.271	0.261	0.195	0.166	0.145	0.117	0.111	0.092
	p	-	0.794	0.845	0.868	0.885	0.907	0.911	0.927
	Non-Parametric Test	1.023	1.229	0.986	0.795	1.025	0.970	1.037	0.966
	p	-	0.219	0.324	0.426	0.305	0.332	0.300	0.334

Table 4-6 Analysis of Abnormal Returns - Entire Sample ($n=39$)

As Table 4-7 shows, no statistically significant results were obtained from the infrastructure investment announcement sample either. An overall negative reaction to infrastructure investment announcements is apparent, particularly in the shorter event windows. However, this tendency is not statistically significant.

Event Window	Estimation Period								
		25	50	75	100	150	200	250	300
0	Parametric Test	(0.200)	(0.189)	(0.153)	(0.137)	(0.100)	(0.087)	(0.077)	(0.071)
	p	-	0.850	0.878	0.891	0.920	0.930	0.938	0.943
	Non-Parametric Test	(0.247)	(0.414)	(0.448)	(0.446)	(0.407)	(0.446)	(0.457)	(0.449)
	p	-	0.679	0.654	0.655	0.684	0.656	0.647	0.653
(-1,+1)	Parametric Test	(0.022)	(0.060)	(0.053)	(0.040)	(0.024)	(0.030)	(0.026)	(0.032)
	p	-	0.952	0.958	0.968	0.981	0.976	0.979	0.975
	Non-Parametric Test	(0.054)	(0.236)	(0.279)	(0.319)	(0.276)	(0.343)	(0.327)	(0.351)
	p	-	0.814	0.780	0.750	0.782	0.732	0.743	0.726
(-2,+2)	Parametric Test	0.332	0.206	0.139	0.119	0.107	0.079	0.073	0.056
	p	-	0.836	0.889	0.905	0.915	0.937	0.942	0.955
	Non-Parametric Test	0.457	0.363	0.259	0.214	0.284	0.237	0.237	0.208
	p	-	0.717	0.796	0.831	0.776	0.813	0.813	0.835

Table 4-7 Analysis of Abnormal Returns - Infrastructure Sample ($n=27$)

Table 4-8 shows no statistically significant results were obtained from the application-based investment announcement sample. An overall positive reaction to application-based investment announcements is apparent. However, this tendency is also not statistically significant.

Event Window	Estimation Period								
		25	50	75	100	150	200	250	300
0	Parametric Test	0.412	0.280	0.234	0.218	0.176	0.160	0.143	0.126
	p	-	0.779	0.815	0.828	0.860	0.873	0.886	0.900
	Non-Parametric Test	0.222	0.305	0.284	0.285	0.309	0.302	0.310	0.314
	p	-	0.761	0.777	0.776	0.757	0.763	0.757	0.754
(-1,+1)	Parametric Test	0.289	0.264	0.233	0.210	0.174	0.160	0.148	0.130
	p	-	0.792	0.816	0.833	0.862	0.873	0.882	0.897
	Non-Parametric Test	0.067	0.193	0.181	0.191	0.234	0.257	0.265	0.260
	p	-	0.847	0.857	0.849	0.815	0.797	0.791	0.795
(-2,+2)	Parametric Test	(0.010)	0.162	0.143	0.121	0.101	0.092	0.092	0.081
	p	-	0.872	0.886	0.904	0.920	0.927	0.927	0.936
	Non-Parametric Test	(0.049)	0.157	0.138	0.122	0.171	0.180	0.201	0.194
	p	-	0.875	0.890	0.903	0.864	0.857	0.840	0.846

Table 4-8 Analysis of Abnormal Returns - Application Sample ($n=12$)

Tables 4-9 and 4-10 present descriptive statistics of abnormal returns and abnormal return ranks respectively. For both the overall sample and the infrastructure sample the median standardised abnormal return is negative and the percentage of positive

returns is less than half. The application sample has a positive median standardised abnormal return and the percentage of positive abnormal returns is over half.

The same pattern is evident in the abnormal return ranks' descriptive statistics. Both the overall sample and infrastructure sample have mean and median abnormal return ranks less than the expected value of 151, while the application sample has mean and median abnormal return ranks greater than 151.

These results reinforce the previously noted tendency of a positive abnormal reaction to application investments and a negative abnormal reaction to infrastructure investments.

T=300, k=1	Mean Abnormal Return	Median Abnormal Return	Number of Positive Returns	Percentage Positive Returns	Mean Standardised Abnormal Return	Median Standardised Abnormal Return
Entire Sample	0.008%	(0.172%)	16	41%	0.168%	(0.494%)
Infrastructure Sample	(0.511%)	(0.277%)	9	33%	(1.382%)	(0.739%)
Application Sample	1.177%	0.316%	7	58%	3.656%	0.816%

Table 4-9 Abnormal Returns and Standardised Abnormal Returns (n=39)

T=300, k=1	Mean Abnormal Return Rank	Median Abnormal Return Rank
Entire Sample	146.231	141.000
Infrastructure Sample	129.481	130.000
Application Sample	183.917	173.500

Table 4-10 Abnormal Return Ranks (n=39)

Table 4-11 presents details of the abnormal returns, standardised abnormal returns and abnormal return ranks for all the IT investment announcements investigated, ordered by investment type and company. The expected abnormal return rank is 151.

Company	Date	Investment Type	Abnormal Return @ t0	Standardised Abnormal Return @ t0	Abnormal Return Rank
ANGLOPLAT	2001/06/19	Application	2.448%	5.841%	261
FIRSTRAND	2001/10/18	Application	0.116%	0.400%	167
FOSCHINI	2001/09/03	Application	1.189%	2.681%	233
GFIELDS	2001/05/23	Application	(0.949%)	(2.003%)	113
GFIELDS	2001/09/10	Application	(0.506%)	(1.170%)	134
IMPLATS	2001/11/08	Application	0.516%	1.232%	180
INVLTD	2001/05/10	Application	7.593%	26.397%	301
NETCARE	2001/07/06	Application	(1.642%)	(3.799%)	62
SAPPI	2001/09/13	Application	4.198%	12.145%	293
SASOL	2002/10/01	Application	(2.263%)	(6.247%)	38
WOOLIES	2001/04/23	Application	3.690%	9.085%	284
WOOLIES	2002/10/30	Application	(0.269%)	(0.694%)	141
ABSA	1999/11/03	Infrastructure	1.161%	2.574%	214
ABSA	2000/03/29	Infrastructure	(0.171%)	(0.423%)	147
ABSA	2001/12/06	Infrastructure	(5.443%)	(16.055%)	2
AECI	1999/05/26	Infrastructure	0.900%	1.038%	201
ANGOLD	2002/05/20	Infrastructure	4.642%	10.276%	289
BHPBILL	2002/11/18	Infrastructure	(0.094%)	(0.353%)	140
DISTELL	2000/06/01	Infrastructure	(0.443%)	(0.975%)	130
FIRSTRAND	2002/07/08	Infrastructure	(1.007%)	(3.127%)	81
FIRSTRAND	2002/11/12	Infrastructure	(2.607%)	(7.131%)	30
GRINTEK	2002/11/11	Infrastructure	(1.364%)	(2.343%)	93
ILLOVO	1998/10/14	Infrastructure	(0.788%)	(2.034%)	93
JOHNNIC	2002/02/22	Infrastructure	0.778%	1.810%	194
LIBERTY	1999/05/18	Infrastructure	(2.889%)	(6.505%)	27
LIBERTY	1999/08/11	Infrastructure	(1.045%)	(2.116%)	92
LIBERTY	2000/11/17	Infrastructure	(1.181%)	(2.332%)	71
LIBERTY	2001/06/20	Infrastructure	1.477%	4.158%	248
LIBERTY	2001/11/07	Infrastructure	(0.277%)	(0.798%)	127
MGX	2000/09/27	Infrastructure	(3.703%)	(8.872%)	15
NEDCOR	1999/07/09	Infrastructure	(1.525%)	(3.650%)	76
NEDCOR	2000/12/06	Infrastructure	(0.172%)	(0.494%)	143
OLDMUTUAL	2002/04/03	Infrastructure	1.104%	4.279%	237
PSG	1999/01/21	Infrastructure	(0.426%)	(0.739%)	130
SAAMBOU	2000/12/08	Infrastructure	(1.878%)	(5.618%)	42
SAGEGRP	2002/07/23	Infrastructure	1.031%	1.862%	213
SANTAM	2002/09/10	Infrastructure	0.044%	0.154%	144
STANBANK	2002/09/27	Infrastructure	0.153%	0.422%	163
UNITRAN	2001/08/15	Infrastructure	(0.082%)	(0.332%)	154

Table 4-11 Abnormal Returns, Standardised Abnormal Returns & Abnormal Return Ranks – Ordered by Investment Type and Company ($n=39$, $k=1$, $T=300$)

Table 4-12 presents details of the abnormal returns, standardised abnormal returns and abnormal return ranks for all the IT investment announcements investigated, ordered by standardised abnormal return. Again, the expected abnormal return rank is 151.

Company	Date	Investment Type	Abnormal Return @ t0	Standardised Abnormal Return @ t0	Abnormal Return Rank
INVLTD	2001/05/10	Application	7.593%	26.397%	301
SAPPI	2001/09/13	Application	4.198%	12.145%	293
ANGOLD	2002/05/20	Infrastructure	4.642%	10.276%	289
WOOLIES	2001/04/23	Application	3.690%	9.085%	284
ANGLOPLAT	2001/06/19	Application	2.448%	5.841%	261
OLDMUTUAL	2002/04/03	Infrastructure	1.104%	4.279%	237
LIBERTY	2001/06/20	Infrastructure	1.477%	4.158%	248
FOSCHINI	2001/09/03	Application	1.189%	2.681%	233
ABSA	1999/11/03	Infrastructure	1.161%	2.574%	214
SAGEGRP	2002/07/23	Infrastructure	1.031%	1.862%	213
JOHNNIC	2002/02/22	Infrastructure	0.778%	1.810%	194
IMPLATS	2001/11/08	Application	0.516%	1.232%	180
AECI	1999/05/26	Infrastructure	0.900%	1.038%	201
STANBANK	2002/09/27	Infrastructure	0.153%	0.422%	163
FIRSTRAND	2001/10/18	Application	0.116%	0.400%	167
SANTAM	2002/09/10	Infrastructure	0.044%	0.154%	144
UNITRAN	2001/08/15	Infrastructure	(0.082%)	(0.332%)	154
BHPBILL	2002/11/18	Infrastructure	(0.094%)	(0.353%)	140
ABSA	2000/03/29	Infrastructure	(0.171%)	(0.423%)	147
NEDCOR	2000/12/06	Infrastructure	(0.172%)	(0.494%)	143
WOOLIES	2002/10/30	Application	(0.269%)	(0.694%)	141
PSG	1999/01/21	Infrastructure	(0.426%)	(0.739%)	130
LIBERTY	2001/11/07	Infrastructure	(0.277%)	(0.798%)	127
DISTELL	2000/06/01	Infrastructure	(0.443%)	(0.975%)	130
GFIELDS	2001/09/10	Application	(0.506%)	(1.170%)	134
GFIELDS	2001/05/23	Application	(0.949%)	(2.003%)	113
ILLOVO	1998/10/14	Infrastructure	(0.788%)	(2.034%)	93
LIBERTY	1999/08/11	Infrastructure	(1.045%)	(2.116%)	92
LIBERTY	2000/11/17	Infrastructure	(1.181%)	(2.332%)	71
GRINTEK	2002/11/11	Infrastructure	(1.364%)	(2.343%)	93
FIRSTRAND	2002/07/08	Infrastructure	(1.007%)	(3.127%)	81
NEDCOR	1999/07/09	Infrastructure	(1.525%)	(3.650%)	76
NETCARE	2001/07/06	Application	(1.642%)	(3.799%)	62
SAAMBOU	2000/12/08	Infrastructure	(1.878%)	(5.618%)	42
SASOL	2002/10/01	Application	(2.263%)	(6.247%)	38
LIBERTY	1999/05/18	Infrastructure	(2.889%)	(6.505%)	27
FIRSTRAND	2002/11/12	Infrastructure	(2.607%)	(7.131%)	30
MGX	2000/09/27	Infrastructure	(3.703%)	(8.872%)	15
ABSA	2001/12/06	Infrastructure	(5.443%)	(16.055%)	2

Table 4-12 Abnormal Returns, Standardised Abnormal Returns & Abnormal Return Ranks – Ordered by Standardised Abnormal Return ($n=39$, $k=1$, $T=300$)

Figure 4-1 presents the distribution of standardised abnormal returns across the time period investigated. No date-related trends are evident. An inexplicable clustering of application-based investment announcements occurs in 2001.

More importantly, however, Table 4-12 and Figure 4-1 highlight the existence of five announcements with standardised abnormal returns very different to the rest of the group. The top four and last announcements in Table 4-12 all deviate noticeably from the rest. These deviations raise the question of how strongly the results and comments presented thus far are influenced by these outlying points.

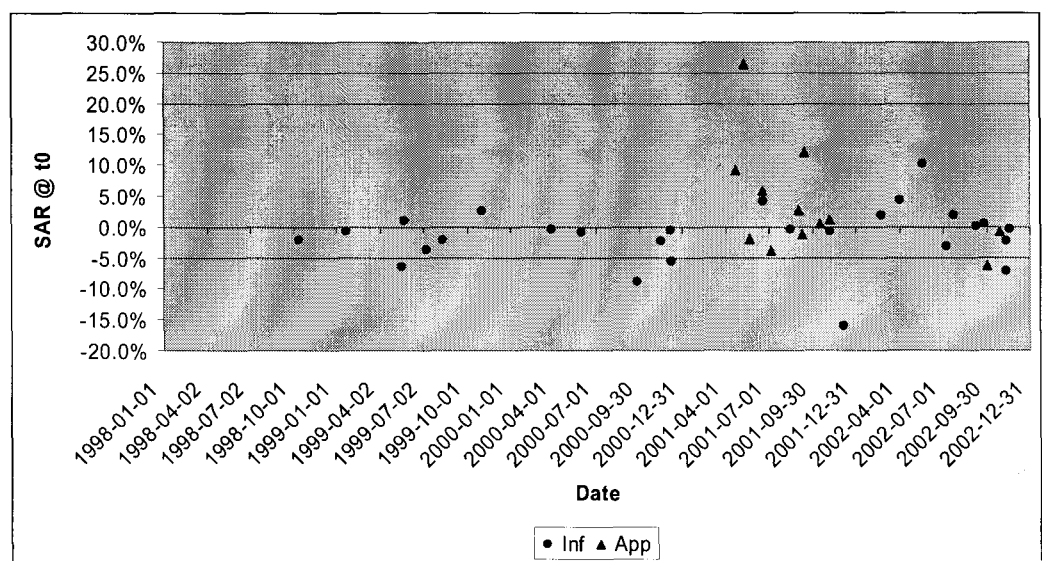


Figure 4-1 Standardised Abnormal Returns by Date (n=39)

Tables 4-13 and 4-14 present descriptive statistics of abnormal returns and abnormal return ranks respectively, after removing the outlying points highlighted in Table 4-12 and Figure 4-1. The 34 remaining announcements have lower, negative mean and median abnormal returns across all groupings. Likewise, mean and median standardised abnormal returns are all lower and less than zero. The mean and median abnormal return ranks are further below their expected values of 151 for all groups.

The previously noted tendency of negative abnormal reactions to infrastructure investments is still present after removing the outlying points. However, the overall abnormal reactions to application investments have changed from positive to negative. Clearly the full application samples results are driven by the four outlying points and care should be taken in the interpretation thereof. Interestingly, the three application

investments that prompted extremely positive abnormal reactions were all financial consolidation, reporting and management applications.

The abnormal returns remain statistically insignificant for the reduced sample.

	Mean Abnormal Return	Median Abnormal Return	Number of Positive Returns	Percentage Positive Returns	Mean Standardised Abnormal Return	Median Standardised Abnormal Return
T=300, k=1						
Entire Sample	(0.422%)	(0.273%)	12	35%	(1.038%)	(0.717%)
Infrastructure Sample	(0.520%)	(0.277%)	8	32%	(1.262%)	(0.739%)
Application Sample	(0.151%)	(0.269%)	4	44%	(0.418%)	(0.694%)

Table 4-13 Abnormal Returns and Standardised Abnormal Returns ($n=34$)

	Mean Abnormal Return Rank	Median Abnormal Return Rank
T=300, k=1		
Entire Sample	133.353	137.000
Infrastructure Sample	128.200	130.000
Application Sample	147.667	141.000

Table 4-14 Abnormal Return Ranks ($n=34$)

Figure 4-2 is included to allow direct comparison with Figure 2 from Chatterjee, Pacini & Sambamurthy (2002, p. 32). Figure 4-2 plots cumulative daily average standardised abnormal returns from event day -2 to event day +2. Only the application sample exhibits explainable behaviour, the cumulative market reaction is clearly positive on the day of an application investment announcement. No clear trend is present in the overall or infrastructure samples' behaviour.

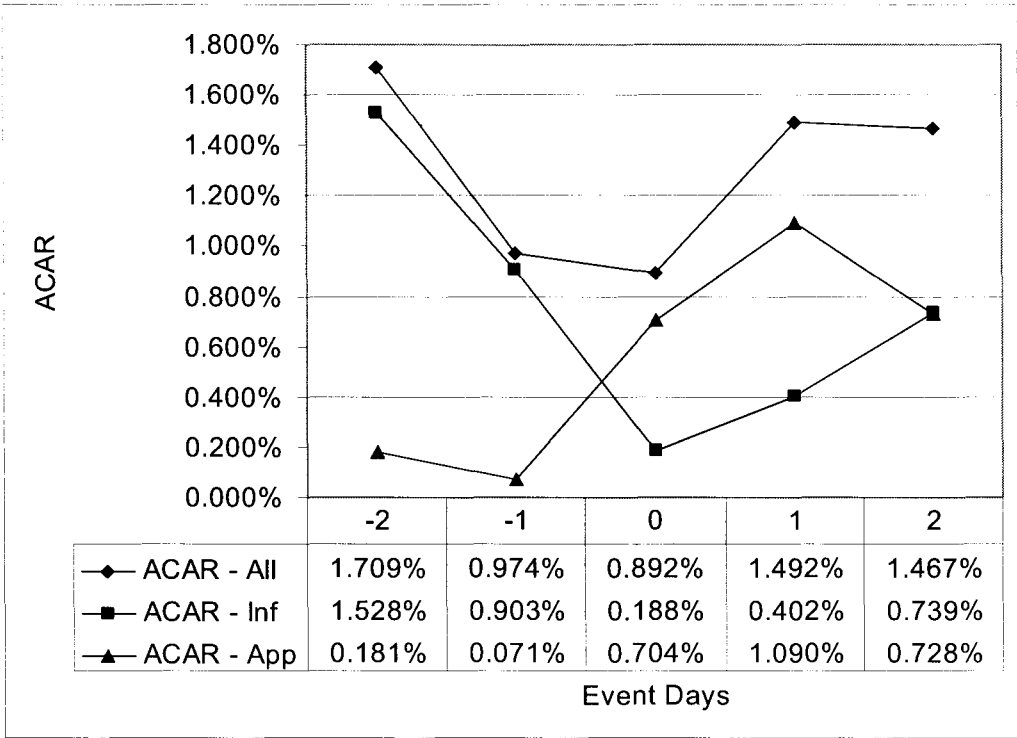


Figure 4-2 Cumulative Average Standardised Abnormal Returns from Event Day -2 to Event Day +2 ($n=39$)

Figure 4-3 investigates the possibility of a relationship between standardised abnormal returns and the share's Capital Asset Pricing Model beta coefficient. Beta coefficients are frequently used as a measure of a share's volatility relative to the overall market (Fuller & Farrell, 1987). As can be seen, there is no relationship between the two variables, thus market reactions to IT investments are not being masked by share volatilities.

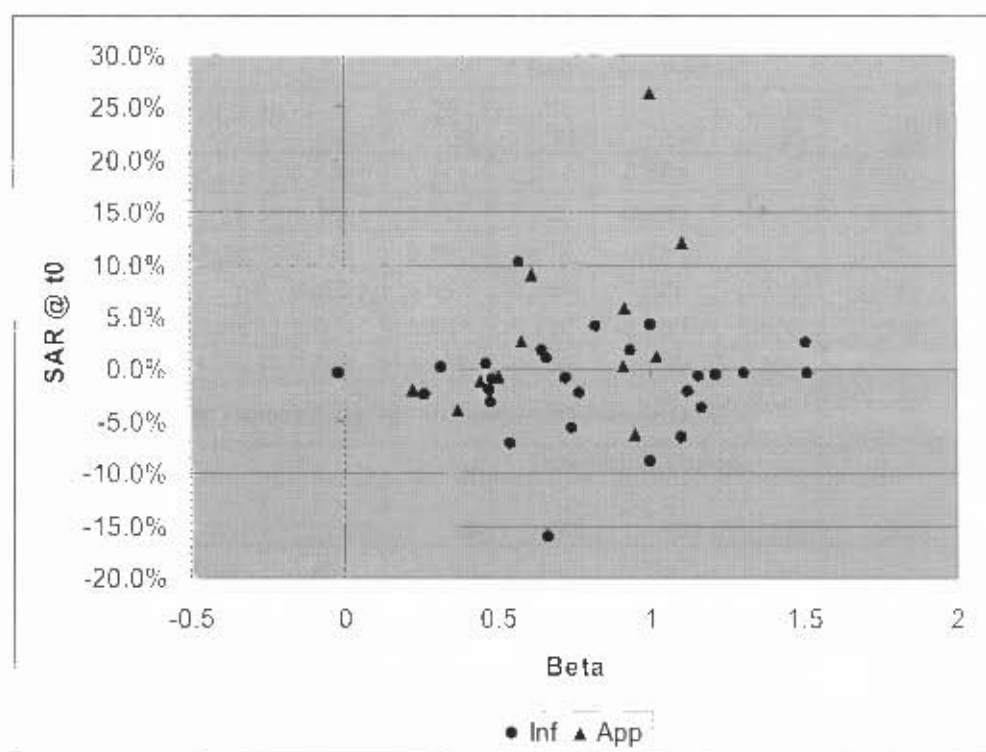


Figure 4-3 Standardised Abnormal Returns by Beta Coefficient ($n = 39$)

4.4 Abnormal Volume Analysis

An analysis of abnormal volume was conducted as described in section 3.3.5. Results were calculated for the same event windows and estimation periods used for the abnormal return analysis. Tables 4-12, 4-13 and 4-14 present the results for the overall, infrastructure and application samples respectively. No significant trading volume reactions to IT investments were detected.

Event Window		Estimation Period							
		25	50	75	100	150	200	250	300
0	t-statistic	(0.010)	0.006	(0.001)	(0.011)	(0.025)	(0.030)	(0.007)	0.009
	p	0.992	0.995	0.999	0.991	0.980	0.976	0.994	0.993
(-1,+1)	t-statistic	0.036	0.055	0.042	0.028	0.007	(0.000)	0.025	0.041
	p	0.971	0.956	0.967	0.978	0.994	1.000	0.980	0.967
(-2,+2)	t-statistic	0.033	0.051	0.038	0.018	(0.000)	(0.007)	0.019	0.035
	p	0.974	0.960	0.970	0.985	1.000	0.995	0.985	0.972

Table 4-15 Trading Volume Analysis – Entire Sample ($n=39$)

Event Window	Estimation Period								
		25	50	75	100	150	200	250	300
0	<i>t</i> -statistic	0.141	0.211	0.211	0.182	0.149	0.161	0.183	0.174
	p	0.889	0.834	0.833	0.856	0.881	0.872	0.855	0.862
(-1,+1)	<i>t</i> -statistic	0.118	0.181	0.171	0.141	0.113	0.121	0.145	0.139
	p	0.907	0.857	0.864	0.888	0.910	0.904	0.885	0.890
(-2,+2)	<i>t</i> -statistic	0.074	0.131	0.120	0.089	0.063	0.068	0.094	0.091
	p	0.941	0.897	0.905	0.929	0.950	0.946	0.925	0.927

Table 4-16 Trading Volume Analysis - Infrastructure Sample ($n=27$)

Event Window	Estimation Period								
		25	50	75	100	150	200	250	300
0	<i>t</i> -statistic	(0.460)	(0.470)	(0.442)	(0.392)	(0.284)	(0.267)	(0.257)	(0.239)
	p	0.650	0.640	0.660	0.696	0.777	0.790	0.798	0.811
(-1,+1)	<i>t</i> -statistic	(0.205)	(0.236)	(0.225)	(0.197)	(0.150)	(0.148)	(0.130)	(0.104)
	p	0.839	0.814	0.822	0.844	0.881	0.882	0.897	0.917
(-2,+2)	<i>t</i> -statistic	(0.089)	(0.134)	(0.131)	(0.120)	(0.094)	(0.100)	(0.077)	(0.048)
	p	0.930	0.894	0.896	0.905	0.925	0.920	0.939	0.962

Table 4-17 Trading Volume Analysis - Application Sample ($n=12$)

Although not statistically significant, an interesting trend is evident. Infrastructure investment announcements are associated with consistently higher than expected trading volumes during the various event windows, while application-based investment announcements are associated with consistently lower than expected trading volumes. As trading volume reflects changes in the expectations of individual investors (Kim & Verrecchia, 1991), these results suggest a greater level of agreement amongst investors regarding the treatment of application-based investments than infrastructure investments.

4.5 Cross-Sectional Regression Analysis

A cross-sectional regression analysis was conducted as described in section 3.3.4. Table 4-18 presents descriptive statistics of the two ratio-scaled control variables: firm size and firm growth.

	N	Mean	Median	Minimum	Maximum	Std. Dev.
Firm Size (Rm)	28	21343.988	5924.091	10.371	109585.727	26236.045
Firm Growth	28	1.548	1.411	(5.359)	6.293	2.162

Table 4-18 Descriptive Statistics of Regression Control Variables

A backward stepwise regression was run with standardised abnormal return ranks as the dependent variable. The purpose of the backward stepwise regression was to determine whether investment type is associated with greater positive abnormal returns in the presence of other control variables.

The regression results are presented in Table 4-19. Each model corresponds to a different stage of the backward stepwise regression, with Model 6 being the last stage. Investment type is statistically significant ($p<0.05$) in 2 of the 6 models in which it appears. The negative coefficient for investment type across all models is consistent with the previous sections’ observations that infrastructure investments generate negative abnormal returns and application-based investments generate positive abnormal returns. No control variables were significant in any of the models.

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	Coefficient	0.643	0.627	0.599	0.717	0.769	0.606
	t-statistic	3.624	3.720	3.592	4.879	5.410	7.512
	p	0.001	0.001	0.001	0.000	0.000	0.000
Investment Type	Coefficient	(0.142)	(0.156)	(0.161)	(0.216)	(0.216)	(0.153)
	t-statistic	(1.194)	(1.414)	(1.456)	(2.058)*	(2.038)*	(1.582)
	p	0.241	0.167	0.155	0.047	0.049	0.122
Std Size Rank	Coefficient	0.253	0.245	0.311	0.236	-	-
	t-statistic	1.232	1.219	1.618	1.258	-	-
	p	0.227	0.232	0.115	0.217	-	-
Std Growth Rank	Coefficient	(0.330)	(0.316)	(0.339)	(0.373)	(0.245)	-
	t-statistic	(1.575)	(1.558)	(1.683)	(1.837)	(1.382)	-
	p	0.125	0.129	0.102	0.075	0.176	-
Industry Type	Coefficient	0.166	0.185	0.206	-	-	-
	t-statistic	1.060	1.271	1.422	-	-	-
	p	0.297	0.213	0.164	-	-	-
Financial Services	Coefficient	(0.038)	-	-	-	-	-
	t-statistic	(0.344)	-	-	-	-	-
	p	0.733	-	-	-	-	-
IT Producer	Coefficient	(0.333)	(0.308)	-	-	-	-
	t-statistic	(1.105)	(1.067)	-	-	-	-
	p	0.277	0.294	-	-	-	-
	Multiple R ²	0.226	0.224	0.197	0.149	0.111	0.063
	Adjusted R ²	0.081	0.106	0.102	0.076	0.061	0.038

Table 4-19 Stepwise Backward Regression Results for Standardised Abnormal Return Ranks (n=39) (*p<0.05)

Although the adjusted R^2 for the full model (Model 1) is only 0.081, this is characteristic of many event studies in accounting and finance (Chatterjee, Pacini & Sambamurthy, 2002).

4.6 Summary

The results show no statistically significant market reactions to IT investment announcements, although some general trends were observed. Price reactions to general IT investments, IT infrastructure investments and IT application-based investments were all not statistically significant. Similarly, no statistically significant trading volume reactions were observed. Investment type was only a significant predictor of standardised abnormal return rank in two of six regression models. No other control variables were significant.

The next chapter discusses and interprets these results. The implications of these results for the hypotheses proposed in Chapter 2 are analysed.

5 Discussion

5.1 Introduction

This chapter discusses the results of Chapter 4 in various contexts. The first section examines whether the results support the hypotheses proposed in Chapter 2. The next section compares the South African results with those of three previous U.S. studies. The final section attempts to interpret the results and discusses possible rationales behind the observed market reaction. The chapter concludes with a brief summary.

5.2 Support for Hypotheses

This section examines the results presented in Chapter 4 in the context of the hypotheses derived in Chapter 2.

For convenience the hypotheses presented in section 2.6 are restated (in the alternative) below:

H1: IT infrastructure investment announcements are associated with positive share price reactions.

H2: IT infrastructure investment announcements are associated with increased trading volume.

H3: IT infrastructure investment announcements are associated with greater positive share price reactions than IT application-based investment announcements.

H4: IT infrastructure investment announcements are associated with greater trading volume than IT application-based investment announcements.

5.2.1 Hypothesis 1

As shown in Table 4-7, the null hypothesis of IT infrastructure investment announcements having no association with positive share price reactions cannot be rejected. No statistically significant evidence of a relationship between IT infrastructure investment announcements and share price reactions was found.

5.2.2 Hypothesis 2

As shown in Table 4-16, the null hypothesis of IT infrastructure investment announcements having no association with increased trading volume cannot be rejected. No statistically significant evidence of a relationship between IT infrastructure investment announcements and trading volume was found.

5.2.3 Hypothesis 3

As shown in Tables 4-7 and 4-8, neither IT infrastructure investment announcements nor IT application-based investment announcements were found to have a statistically significant relationship with share price reactions. Therefore, intuitively, no evidence of IT infrastructure investments being associated with a greater share price reaction than IT application-based investments would be expected. The regression results presented in Table 4-19 confirm that investment type is not a consistently significant predictor of abnormal returns. The null hypothesis of IT infrastructure investment announcements not being associated with greater share price reactions than IT application-based investment announcements cannot be rejected.

5.2.4 Hypothesis 4

As shown in Tables 4-12, 4-13 and 4-14, no statistically significant relationships were found between IT infrastructure, IT application-based or overall IT investments and trading volume. The null hypothesis of IT infrastructure investment announcements not being associated with greater trading volume than IT application-based investment announcements cannot be rejected.

To summarise, none of the four alternative hypotheses proposed are supported by the results presented in Chapter 4. The results indicate that South African IT infrastructure investment announcements are not associated with positive share price reactions or greater trading volumes. Furthermore, the IT investment type, whether infrastructure or application-based, does not influence share price reactions or trading volumes.

5.3 Comparison with United States Research

This section compares the results reported in Chapter 4 with prior U.S. event study research investigating stock market reaction to IT investment announcements in the United States. Three U.S. studies have used the event study methodology to investigate the relationship between IT investment and market value.

The first study was conducted by Dos Santos, Peffers & Mauer (1993). They examined share price reactions to IT investment announcements issued by firms in the financial services and manufacturing industries from 1981 to 1988. Consistent with this thesis, no significant market reaction was observed. However, cross-sectional analysis revealed that the stock market reacted differently to announcements of innovative IT investments than to non-innovative investments in IT. Investors perceived innovative IT investments to be positive net present value investments, while non-innovative investments were seen as zero net present value investments, or worth as much as they cost. Similarly, this thesis found that IT application-based investments generated more favourable market reactions than IT infrastructure investments (Tables 4-7 and 4-8), although this finding is not statistically significant. Application-based investments are more likely to be innovative (Dos Santos, 1991; Dos Santos & Peffers, 1995), suggesting that a good area for future research may be an investigation into the South African stock market reaction to innovative investments versus non-innovative IT investments. Interestingly, Dos Santos, Peffers & Mauer (1993) did not find a significant industry effect, whether firms were in the financial services or manufacturing industries did not affect the market reaction.

The second study, by Im, Dow & Grover (2001), replicated and extended the research of Dos Santos, Peffers & Mauer (1993). Im, Dow & Grover (2001) extended the time period covered to include 1989 to 1996. The full period, covering from 1981 to 1996, showed no significant price or volume reactions to IT investment announcements. Consistent with Dos Santos, Peffers & Mauer (1993), financial firms were not associated with more positive market reactions than non-financial firms. Significantly, smaller firms generated consistently positive abnormal returns while larger firms did not generate significant returns. This is consistent with the findings of Brynjolfsson et al (1994) that smaller firms provide better incentives for exploiting IT. Both price and volume reactions were found to be more positive during their more recent sub-sample

time period (1991 to 1996). Industry was a significant factor and firm size effects were stronger during this more recent time period.

The most recent study, by Chatterjee, Pacini & Sambamurthy (2002), focussed on the market reaction to IT infrastructure investments announced between 1992 and 1995. They found evidence of significant abnormal returns associated with IT infrastructure investment announcements. They also found significant increases in trading volume associated with IT investment disclosures. Furthermore, their study found that positive abnormal returns are not as strongly associated with investments in IT applications. Consistent with Im, Dow & Grover (2001), smaller firms were significantly correlated with positive abnormal returns. Consistent with Dos Santos, Peffers & Mauer (1993), no industry effects were detected.

This thesis is a replication of Chatterjee, Pacini & Sambamurthy's (2002) research within the South African context. Their research methodology has been followed as closely as possible. However, comparison of results is problematic as this thesis covers a different time period, 1998 to 2002 as opposed to 1992 to 1995, and was conducted in a different country, South Africa as opposed to the United States. Despite these limitations, comparison with the results of Chatterjee, Pacini & Sambamurthy (2002) and the other United States studies is still useful and relevant.

This thesis found that general IT investment announcements did not generate a significant share price or volume reaction. This result is consistent with the findings of Dos Santos, Peffers & Mauer (1993), but in contradiction to the more recent findings of Im, Dow & Grover (2001) (for their sub-sample covering events from 1991 to 1996) and Chatterjee, Pacini & Sambamurthy (2002).

Unlike Chatterjee, Pacini & Sambamurthy (2002), this thesis did not find evidence of a more positive market reaction to IT infrastructure investments than IT application-based investments. Unexpectedly, a clearly more positive, although not statistically significant, market reaction to IT application-based investment was observed. This suggests a lack of appreciation of the business value of IT infrastructure amongst South African investors and further suggests the need for a study focussing on the market reaction to application-based, specifically innovative application-based, IT investments.

Interestingly smaller firms, which both Im, Dow & Grover (2001) and Chatterjee, Pacini & Sambamurthy (2002) found to be associated with greater positive abnormal returns, were not found to be a significant predictor of abnormal returns in South Africa. This result may be due to the South African sample mainly consisting of larger firms, the median market capitalisation was just under R6 billion.

Consistent with Dos Santos, Peffers & Mauer (1993) and Chatterjee, Pacini & Sambamurthy (2002), South African abnormal returns were not affected by industry.

5.4 Interpretation

This section interprets the results reported in Chapter 4 within the context of the previous two sections, as well as the theoretical framework provided in Chapter 2. As shown in Figure 2-1, this thesis investigated the relationship between IT investment and business value. The research focussed on IT infrastructure investments and used stock market reaction as a measure of business value.

The first important observation is that no significant South African market reactions were detected at all. The market did not react positively, however, the market did not react negatively either. The question then becomes: what does this lack of reaction mean?

Bhattacharya et al (2000) conducted an event study of the Mexican stock exchange's reaction to company news. Their study is particularly relevant as both South Africa and Mexico are developing countries, and both countries are classified as emerging markets by international investors. As with this study, they were unable to detect any reaction to firm-specific announcements. They present four scenarios in which firms' stock prices do not react to firm-specific news announcements:

The first scenario presented by Bhattacharya et al (2000) is that the stock market may be informationally inefficient, which implies that stock prices are not linked to firm values. In such a market firm prices will not change when new information about firm value is released through corporate announcements. However, Okeahalam & Jefferis (1999) have tested the information efficiency of the JSE and found the stock market to be semi-strong efficient, discounting this scenario. The semi-strong form of

information processing efficiency implies that share prices quickly adjust to incorporate new, value-relevant information (Fama, 1991).

The second scenario presented by Bhattacharya et al (2000) is that stock market investors do not regard the news as value-relevant. Thus, even if the stock market is informationally efficient, prices are left with no announcement stimuli against which to respond. Within this scenario two interpretations are possible:

Looking at the theoretical model presented in Figure 2-1, South African investors may believe that local companies do not possess the necessary conversion effectiveness to effectively convert IT investments into business value. This belief would be consistent with the findings of Dewan & Kraemer (1998; 2000), who found no significant relationship between IT investment, growth and productivity in developing countries. They hypothesized that this gap was due to the low levels of IT investment relative to GDP in developing countries, and to the lack of complementary assets such as the necessary infrastructure and knowledge base to support the effective use of IT. However, this belief would be refuted by a study of large South African insurance companies conducted by Lubbe, Parker & Hoarde (1995) that found a clear, positive relationship between IT investment levels and profitability. The most profitable companies were also found to be more likely to spend a higher proportion of non-interest expenses on IT.

Another interpretation within this scenario is that South African investors do not regard IT investment announcements as being value-relevant. This could be due to general investor ignorance regarding the nature and benefits of IT investment. Chapter 2 provides a review of the increasingly clear, positive relationships found between IT investment and business value in the developed world. Sambamurthy, Bharadwaj & Grover (2003) present a compelling argument for continued IT investment by contemporary firms, detailing the strategic agility successful IT investment creates. The observed trend of South African investors to react more favourably to IT application-based investments than IT infrastructure investments (see Tables 4-7 & 4-8) further supports the notion of general South African investor ignorance regarding IT, as this observed trend is in stark contradiction to the predicted more favourable reaction to infrastructure investments. The rationale for predicting a more favourable investor reaction to IT infrastructure investments is comprehensively covered in

Chapter 2, which details empirically validated, theoretical justifications for IT infrastructure investment.

Alternatively South African investors may be at the cutting-edge of contemporary business thinking. In the May 2003 edition of the *Harvard Business Review* Carr (2003) argues that as information technology's power and ubiquity have grown, its strategic importance has diminished. Comparing the rapid investment in IT over the last decade with the growth of railways and electrical utilities in the late 1800's, he persuasively argues that IT is no longer a source of competitive advantage, but has become a basic requirement for businesses' existence. If South African investors agreed with Carr (2003) they would treat IT investments as zero net present value investments and not adjust their future benefit expectations, and thus share price, for the firm. This is consistent with the reactions observed in this thesis.

Bhattacharya et al's (2000) third scenario is that though the stock market may be efficient, and the news may be value-relevant, the news provided may be completely anticipated. In such a market announcement days bring no surprise. This scenario applies mainly to news of changes in government macro-economic policy, such as interest rate changes, and can thus be discounted.

The last scenario presented by Bhattacharya et al (2000) is that insider trading prohibitions may not exist in the stock market or, if they exist, are not enforced. In such a stock market, the superior information of insiders may have been incorporated in stock prices through their trades prior to the announcement. The King Task Group into Insider Trading Legislation produced the new Insider Trading Act of 1998 which allows for both criminal prosecution and civil actions to be taken against alleged insider trading participants. This new act has catapulted South African insider trading legislation to be amongst the most progressive and equitable in the world (*New Insider Trading Act 1998*). Although there has not yet been a single successful prosecution for insider trading in South Africa (*Insider-trading probes sink to a new low*, 2003) prosecutions for insider trading are rare in any country. The recent focus of the JSE and Financial Services Board on eliminating insider trading, combined with the unlikelihood of insider trading being responsible for the lack of market reaction amongst 28 different companies, render this last scenario very unlikely.

The second and last scenarios cannot be excluded. The observed market reaction, or lack thereof, to IT investment announcements is either due to investors not regarding IT investments as value-relevant or insider trading is taking place. In the author's opinion the latter option is extremely unlikely, as previously explained, thus the overall conclusion must be that South African investors see IT investments as not value-relevant, zero net present value investments. This is the same conclusion reached by Dos Santos, Peffers & Mauer (1993) regarding U.S. investors' sentiments towards IT investment between 1981 and 1988.

Within the confines of this thesis it is not possible to deduce the rationale behind South African investors' sentiments towards IT investments made between 1998 and 2002. It is impossible to determine whether South African investors believe that IT investments do not change a firm's future earnings potential, and are thus not value-relevant, or whether South African investors believe that IT investments have the potential to increase business value, but local firms are perceived as lacking the necessary expertise to extract this value.

5.5 Summary

In summary the results obtained are different to those of past U.S. studies, although a few similarities were observed, and very different to the results predicted. The considered interpretation is that South African investors do not regard IT investments by companies as either beneficial or detrimental to future earnings potential. This research is unable to definitively isolate the rationale behind this perception. Either South African investors believe IT investments to only be worth as much as they cost, or they believe that local firms lack the necessary expertise to fully extract existing business value, beyond the cost of the investments, from IT investments.

6 Conclusion

6.1 *Review of Thesis*

The research question posed in the introduction was: Do South African stock market investors perceive significant value in IT infrastructure investments? The event study methodology was identified as an innovative method to answer this question. Application of the event study methodology generated results that are contrary to expectation and recent U.S. research. This thesis found that South African stock market investors do not perceive significant value in IT infrastructure investments. Furthermore, South African investors do not regard IT infrastructure investments as more beneficial to businesses than IT application-based investments.

Definitive reasons for South African investors' perceptions of IT investments are impossible to determine within the confines of this thesis. However, the two most likely explanations are: Either South African investors believe IT investments to only be worth as much as they cost, or they believe that local firms lack the necessary expertise to fully extract existing business value, in excess of the cost of the investments, from IT investments.

6.2 *Implications for Theory*

Firstly, this thesis again shows that results from developed countries cannot always be generalised to developing countries. The results may also reaffirm the existence of the oft-lamented "digital divide" between developed and developing countries.

Secondly, this thesis has uncovered several promising areas for future research. Little research has been done to clarify the relationship between IT investment and business value in South Africa. This thesis's results suggest that an investigation into the business value of South African application-based IT investments, particularly innovative investments, may be very rewarding. An investigation into the reasons for the South African investors' perceptions of IT investments' business value is also called for.

Finally, perhaps most significantly, this thesis introduces the event study methodology to South African IS researchers.

6.3 Implications for Practitioners

The results of this thesis are rather concerning for South African IS practitioners. The South African investment community, whose members are presumably also influential members of the business community, either doesn't see investment in the tools of the IS profession as a source of excess business value, or, perhaps even more worryingly, regard South African members of the IS profession as inept and thus incapable of fully extracting the latent business value present in IT investments.

6.4 Research Limitations

This research covers the time period from January 1998 to December 2002, the research results and conclusions cannot be generalised beyond these dates. Similarly, the research results are only valid for South Africa, and cannot be generalised to other developing countries.

The research methodology used does not include investment cost as a variable. An expanded methodology that takes the size of the investment made into account may generate valuable results.

All of the IT investment announcements in the final sample came from a single source, *ITWeb*'s virtual press rooms. This resulted in a small sample size. Additional IT investment announcement sources may generate a larger sample and different research results.

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Appendix A – IT Investment Announcement Sample

Investment Type	Date	Company	Vendor	Text
Application	19 June 2001	Anglo Platinum	Business Edge	[Johannesburg, 19 June 2001] - Anglo American Platinum Corporation Limited (Anglo Platinum), the world's largest platinum producer, has successfully replaced its mainframe system for its Group Provident Fund, with a Windows 2000-based system.
Application	18 October 2001	FNB	DiData	[Johannesburg, 18 October 2001] - SA's second largest corporate bank, FNB Corporate - a division of FirstRand - is rolling out a tailored customer information system to provide strategic insight on the bank's client information to its key executives.
Application	01 September 2001	Foschini	Realyst	[Johannesburg, 1 September 2001] - Foschini has implemented Realyst Premises Manager. Gerry Brand of Foschini states that with 1200 stores within the group, the administration and timeous payment of rentals as well as the rental and turnover rental projection capabilities of Realyst will greatly improve their ability to manage Foschini's leased properties.

Application	10 September 2001	Gold Fields	AST	[Johannesburg, 10 September 2001] - GMSI, a subsidiary of AST Mining, has been contracted by Gold Fields (GFL) to implement the GMSI CADSMine system. This will enable Gold Fields to perform 3D digital mine planning, designing and scheduling.
Application	23 May 2001	Gold Fields	Solit	[Johannesburg, 23 May 2001] - Gold Fields Limited, the second largest gold mining group in South Africa, has awarded one of the most ambitious human resources and payroll software contracts yet seen in the local market to Centurion-based software group Solit.
Application	08 November 2001	Impala Platinum	Solit	[Johannesburg, 8 November 2001] - Impala Platinum (Implats) Mineral Processes in Rustenburg has gone live with an integrated process plant operations system supplied by Solit, a leading developer of e-business software and an implementer and integrator of enterprise software.
Application	10 May 2001	Investec	MGX	[Johannesburg, 10 May 2001] - BMC Software, Inc, the leading provider of enterprise systems management, today announced that Investec, an independent, international specialist banking group, has become one of the first banks in the world to move to a model of automated risk management.

Application	10 September 2001	Gold Fields	AST	[Johannesburg, 10 September 2001] - GMSI, a subsidiary of AST Mining, has been contracted by Gold Fields (GFL) to implement the GMSI CADSMine system. This will enable Gold Fields to perform 3D digital mine planning, designing and scheduling.
Application	23 May 2001	Gold Fields	Solit	[Johannesburg, 23 May 2001] - Gold Fields Limited, the second largest gold mining group in South Africa, has awarded one of the most ambitious human resources and payroll software contracts yet seen in the local market to Centurion-based software group Solit.
Application	08 November 2001	Impala Platinum	Solit	[Johannesburg, 8 November 2001] - Impala Platinum (Implats) Mineral Processes in Rustenburg has gone live with an integrated process plant operations system supplied by Solit, a leading developer of e-business software and an implementer and integrator of enterprise software.
Application	10 May 2001	Investec	MGX	[Johannesburg, 10 May 2001] - BMC Software, Inc, the leading provider of enterprise systems management, today announced that Investec, an independent, international specialist banking group, has become one of the first banks in the world to move to a model of automated risk management.

Application	06 July 2001	Netcare	CS Holdings	[Johannesburg, 6 July 2001] - JSE-listed systems integrator CS Holdings has concluded a R10.4 million contract with the Netcare Group, the largest privately owned healthcare facilities network in South Africa, to provide Netcare with a nation-wide frontline labour management solution. In terms of the contract, CS Holdings' division CS Systems Integration will install the Kronos Frontline labour management suite at 43 hospitals and clinics within the Netcare Group. CS Holdings is the sole distributor of Kronos frontline labour management products in sub-Saharan Africa.
Application	13 September 2001	Sappi	Global Tech	[Johannesburg, 13 September 2001] - Sappi, the global producer of coated fine paper and forest products, has completed the roll-out of the Hyperion Enterprise financial consolidation, reporting and analysis solution to more than 150 users around the world.
Application	01 October 2002	Sasol	Oakwell	[1 October 2002] - Oakwell today announced that it has completed the roll-out of an equipment inspection system for Sasol at the chemical giant's solvents plant in Secunda. The paperless inspection system for Sasol Solvents now enables proactive management of equipment on the plant, as well as the ability to monitor and adjust ISO inspection cycles according to historic data analyses.

Application	23 April 2001	Woolworths	DiData	[Johannesburg, 23 April 2001] - One of South Africa's largest retailers will implement a sophisticated Web-based financial analysis, reporting and budgeting system for improved strategic planning, linking budgets to strategy, and improved ease and integrity of management reporting and analysis.
Application	30 October 2002	Woolworths	PIC Solutions	[Tokyo Reuters News Service, 30 October 2002] - Woolworths, one of the leading retailers in southern Africa, has implemented StrategyWare version 2.0, the world's leading applications management system, from Fair, Isaac. PIC Solutions was chosen to assist with the project, which is a first for the South African financial services industry
Infrastructure	29 March 2000	ABSA	Comparex	[Johannesburg, 29 March 2000] - As part of its vision to utilise leading edge technology to deliver a better service to its customers, Absa has appointed PQ Networks, a member of the PQ Africa / Comparex group of companies, to standardise its LAN / Campus technology on a Nortel Networks Unified Network solution.
Infrastructure	03 November 1999	ABSA	CS Holdings	[Johannesburg, 3 November 1999] - South Africa's largest banking group, ABSA, has awarded CS Holdings the contract to train up its technical support staff in preparation for its migration to Windows NT.

Infrastructure	06 December 2001	ABSA	CS Holdings	[Johannesburg, 6 December 2001] - Absa has reaffirmed its training agreement with JSE-listed CS Holdings for another year. This will be the second term of a three-year training contract with CS Education Solutions, the training arm of CS Holdings, that was signed in June last year.
Infrastructure	26 May 1999	AECI	MGX	[Johannesburg, 26 May 1999] - AECI Explosives has implemented a locally developed document management system from Exsol to manage the explosion of documents being generated by daily business.
Infrastructure	20 May 2002	AngloGold	Bytes Technologies	[Johannesburg, 20 May 2002] - "AngloGold has cut its report generation times for its South African operations from weeks to days since implementing Bytes Business Solutions' Business Intelligence tool known as Business Objects (BO)," says AngloGold, Manager: Survey and Planning, Jurgens Visser.
Infrastructure	18 November 2002	BHP Billiton	CSC	[Johannesburg, 18 November 2002] - Computer Sciences Corporation in South Africa has won its second Local Area Network (LAN) re-engineering contract this year for international resources giant BHP Billiton. The latest contract, worth in excess of R8-million, involves total replacement of the LANs at Hillside Aluminium, Strang Rennies Metal Terminal and Bayside Aluminium in Richards Bay, KwaZulu-Natal. Work has already started and is due for completion in April 2003

Infrastructure	01 June 2000	Distellers Corp	CS Holdings	[Johannesburg, 1 June 2000] - A major IT skills upgrade involving about 500 people, from clerks to executives, at liquor giant Distillers Corporation Ltd's offices across the country has been successfully undertaken inhouse by JSE-listed CS Holdings through its subsidiary CS Education Solutions.
Infrastructure	08 July 2002	FNB	Global Tech	[Johannesburg, 8 July 2002] - First National Bank (FNB) HomeLoans has awarded Global Technology Business Intelligence a Hyperion-based business intelligence platform implementation contract worth R2.2 million.
Infrastructure	12 November 2002	FNB	Sybase	[Johannesburg, 12 November 2002] - FNB Corporate, the corporate banking division of First Rand Bank, has bought Sybase's Adaptive Server IQ Multiplex 12.0 analytical database to power its data warehouse, enabling the financial institution to identify its most profitable customers.
Infrastructure	11 November 2002	Grintek	Datacentrix	[Johannesburg, 11 November 2002] - Two divisions within the Grintek Group, Grintek Electronics and Grintek Ewation, have embarked on a project that is bound to bolster their performance as they refresh their software inventory. Datacentrix, Centricity and internal Grintek personnel will spearhead this R2.8 million project, focusing on Microsoft software.

Infrastructure	14 October 1998	Illovo Sugar	Bytes Technologies	The JSE listed USKO group has signed an agreement worth more than R100 million with Illovo Sugar to develop networking and desktop solutions for this major sugar group. The project will roll out over 5 years and will include Illovo Sugar operations in Mozambique, Tanzania, Mauritius, Swaziland, Malawi and South africa. The project was won on tender against IBM, ICL, Denel, PQ Africa, Atio and EDS.
Infrastructure	22 February 2002	Johnnic	Datacentrix	[Johannesburg, 22 February 2002] - News and information provider Johnnic Publishing has completed a R1 million backup and data protection project, installing a larger library with new tape drives to cut down on back-up and retrieval time.
Infrastructure	11 August 1999	Liberty	Atio	[Johannesburg, 11 August 1999] - Financial services group, Liberty, has installed Periphonics interactive voice response (IVR) equipment, purchased from Infotel company, ATIO Corporation. The new system will replace the current IBM Direct Talk system, ensuring greater scalability and enhanced functionality in providing improved telephony application systems to clients.
Infrastructure	20 June 2001	Liberty	DiData	[Johannesburg, 20 June 2001] - Liberty Group has invested in storage area network (SAN) technology to dramatically consolidate its server environment, improve reliability and reduce costs. The SAN solution, designed and implemented by Dimension Data Enterprise Systems, is already providing the financial services giant with tangible benefits.

Infrastructure	18 May 1999	Liberty	MGX	[Johannesburg, 18 May 1999] - Liberty Life has upgraded its data storage facilities at a cost of R3 million with the creation of a disaster recovery library at Liberty Life Centre in Braamfontein.
Infrastructure	17 November 2000	Liberty	MGX	[Johannesburg, 17 November 2000] - As part of its IT infrastructure upgrade, the Liberty Group's Braamfontein head office has acquired a StorageTek Automated Tape Library with high capacity tape drives which provide a storage capacity equivalent to over 14 million individual volumes of the Encyclopaedia Britannica.
Infrastructure	07 November 2001	Liberty	Shoden	[Johannesburg, 7 November 2001] - Liberty Group has selected Shoden Data Systems as its data storage partner, in a deal that sees the supply and implementation of over 4TB of storage.
Infrastructure	27 September 2000	MGX	Spescom	[Johannesburg, 27 September 2000] - MGX Business Continuity Solutions has installed a complete voice communication and contact centre infrastructure, based on an Avaya (formerly Lucent Technologies Enterprise Networks Division) Definity Enterprise Communications Server (ECS) contact centre platform from Spescom DataFusion, at its disaster recovery centre in Midrand.

Infrastructure	06 December 2000	Nedcor	DiData	[Johannesburg, 6 December 2000] - Nedcor Bank Limited, Nedcor's major banking and technology arm, has signed a R20 million deal with Dimension Data for a trading room solution - the largest deal of its kind in South Africa to date.
Infrastructure	09 July 1999	Nedcor	Xerox	[Johannesburg, 9 July 1999] - Xerox Channels Group (XCG), the channel-focused operation marketing Xerox' network and personal lasers, inkjets and copiers, has announced its largest win to date - 440 DocuPrint N32 laser printers to local financial services giant, Nedcor.
Infrastructure	03 April 2002	Old Mutual	MGX	[3 April 2002] - Old Mutual Bank, the wholly owned financial services subsidiary of insurance giant Old Mutual, has implemented a backup and recovery system from Storage Solutions at MGX to safeguard its multi-terabyte information repository.
Infrastructure	21 January 1999	PSG Group	3Com	[Johannesburg, 21 January 1999] - Network integrator, Infovu, has installed a total IT solution for PSG Channel Group Limited, an employee benefit organisation, comprising a 3Com Local Area Network (LAN), data-telephone and power cabling, automatic fire protection and an Uninterrupted Power Supply (UPS). The installation is worth an estimated R340, 000 and is aimed at creating efficiency and increasing productivity, service levels and profitability.

Infrastructure	08 December 2000	Saambou	Comparex	[Johannesburg, 8 December 2000] - After unprecedented business growth over the last 18 months, Saambou has increased its investment in enterprise servers to the tune of R2.6 million with the purchase of a large IBM CPU upgrade from PQ Africa's data centre specialists, Persetel.
Infrastructure	23 July 2002	Sage Life	Atio	[Johannesburg, 23 July 2002] - Sage Life has chosen ATIO Corporation as its partner for the contact centre recently installed at its Johannesburg head office. As part of a R2 million deal, Sage Life has purchased licences for 36 seats using ATIO's ContactPro solution. Although only 15 seats were activated at the time of going live, it is expected that the centre will grow to 100 seats within the next two years.
Infrastructure	10 September 2002	Santam	CS Holdings	[Johannesburg, 10 September 2002] - Santam, provider of short-term insurance products to the corporate, commercial and personal markets, has renewed its contract with preferred training provider CS Holdings for the fifth consecutive year. CS Holdings provides end-user Windows training to employees at Santam's countrywide branch offices.
Infrastructure	27 September 2002	SCMB	Software Futures	[Johannesburg, 27 September 2002] - Standard Corporate and Merchant Bank (SCMB) has made a significant investment in Rational Software tools from Software Futures, a wholly owned subsidiary of JSE Securities Exchange-listed MGX, uniting its diverse development teams under a common development framework.

Infrastructure	15 August 2001	Unitrans	Comparex	[Johannesburg, 15 August 2001] - Unitrans Freight, a division of JSE-listed transport, distribution and logistics company Unitrans, has completed a six-week Oracle migration project, part of a larger system migration project designed to improve data access across Unitrans Freight's four operational divisions.
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