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Master's thesis

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Preface

After a long period of study, which started in 1990 at the LTS (Junior Technical School), I am going to finish my education at the University of technology in Eindhoven. My journey from LTS to University was a long and very interesting journey, which I want to finish in a special way. Since the University of Technology Eindhoven collaborates with the University of Pretoria (South Africa) it was possible to complete my master thesis in South Africa. Together with two other fellow students I went to South Africa for six months at the beginning of July 2004.

South Africa, situated at the southern most part of the African continent. Famous of its variety of cultures, beautiful scenic landscapes and wildlife. It is not a coincidence that South Africa is called the 'rainbow nation'. The interesting history and the challenges which it have to face makes this country an interesting place in the world to finish my study Technology and Innovation Sciences.

To make our researches even more exceptional we were allowed to use a dataset from a previous research; the South African Innovation Survey 2003. This enables us to do a longitudinal research, which makes our research more reliable and unique.

Months raced by and it was already December before we noticed it. Now I can look back upon a successful research period and a lot of very nice and interesting experiences.

Executive summary

According to literature, innovation in general has a positive influence on business performance. The introduction of new products, processes and services may lead to a temporary increase of total sales, and a decrease in manufacturing costs. Policymakers in Europe have recognized the positive influence of innovation on economic growth for years now. In March 2000, the European Union declared in Lisbon that their aim is to become the world's most innovative region by the year 2010. Policymakers and scientists in South Africa are recognizing the importance of innovation as well. South Africa is the first developing country to adopt a National Research and Development Strategy (NRDS).

A number of studies have shown a positive effect of innovation on business performance. However, most, or maybe all, studies have been conducted in developed countries. In this study the focus is on the relation between innovation and business performance in a developing country, specifically South Africa.

The study builds on an earlier study, the South African innovation Survey (SAIS2001), that was conducted in 2001. The SAIS2001 survey was based upon the European Community Innovation Survey or CIS. In the SAIS2001 601 business firms participated and answered questions about their innovative behaviour. One surprising finding was that relatively many, at least more than expected, South African firms had technological innovations. In this study we surveyed all those firms again, three years later that is. Many firms cooperated, and we received information on the innovative and business performance of 533 innovating and non-innovating firms in South Africa. This longitudinal dataset implies that we can study causal effects of innovation. This is an advantage over earlier cross-sectional data sets. Additionally, since we have two measurement points we are able to trace 'delayed' effects of innovation on business performance.

The data shows that innovation in general has a positive effect on business performance in South African firms, however the positive effect is limited to product innovation, where we expected positive effects of innovation of process as well. Further, although we find a positive effect of product innovation on total sales growth, we find hardly any effects of innovation on export intensity growth.

A remarkable finding, opposite to the expectation, is the effect of product innovations that are new to the market. South African firms with product innovations that are new to the market have a *negative* effect on business performance. Hence, the introduction of radical innovations is followed by a decrease in sale!

The effects of innovation on business performance are the same across different firm size classes in South Africa. This is not in accordance with literature where it is often stated that small firms are more able to gain advantage from innovations compared to large firms. Finally, a last interesting finding of this study is that 'starters', firms established in the period 1998-2000, have a higher business performance compared to more established firms.

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Bernard de Veer
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1. Introduction

This chapter introduces the subject of this report. Paragraph 1.1 will explain the problems and goals of this report. The problems and goals subsequently lead to the research question, formulated in paragraph 1.2. In paragraph 1.3 the structure of the report is specified.

1.1. Problems and goals

South Africa is a country like no other. It has a history that is unique in the world. South Africa was isolated from the rest of the world for many years, and this had a significant effect on the economical and political aspects of this country in the past, and will continue to do so in the future. After the isolation was ended many changes occurred not only on a political level, but also on an economical level. At this time South Africa is a country in development. In sustaining the endeavour to continue with development, South Africa has recognised that innovation is a key driver of economic development. Policy makers in Europe have recognized the positive influence of innovation on economic growth for years now. In March 2000, the European Union declared in Lisbon that their aim is to become the world's most innovative region by the year 2010[1].

From literature it is known that innovation has a positive influence on an economy in general (Freeman and Soete, 1997; Porter, 1990). There is no single definition of innovation that imposes itself. However, most definitions have a common core: innovation is about the introduction of new products and processes in an economy. A very well known definition of innovation is given by Freeman (1982: p. 7):

> *"The process of transforming an idea, generally generated through R&D, into a new or improved product, process or approach, which relates to the real needs of society and which involves scientific, technological, organisational or commercial activities"*

On the level of individual firms, innovations are thought to have a positive influence on performance as well (Diederen, Meijl and Wolters, 2002; Favre, Negassi and Pfister, 2002). An example where innovation leads to above average growth in performance is the 'Henry Ford case'. In the beginning of the 20th century Henry Ford invented the production line. The production line is in essence an extreme standardization of production processes. Through the increased efficiency of this new production process, it was possible to produce cars in increasing numbers. As a consequence prices went down and cars became affordable for a much larger share of the population. The economic development was not only noticeable for consumers, but also for Henry Ford who expanded his firm as a result of this innovation.

[1] European Council, bulletin 27 March 2000 (http://www.europarl.eu.int)

Since innovation increasingly receives attention from policy makers in Europe, policy makers, scientists and entrepreneurs in South Africa are trying to do the same. Therefore, the government of this country introduced the National Research and Development Strategy (NRDS) in August 2002. The ultimate purpose of the NRDS is, among other things, to foster economic growth (Government of the Republic of South Africa, 2002). The assumption in the NRSD is that innovation may lead to economic growth, and economic growth may lead to an improvement of the quality of life and growth in wealth creation. In the NRDS six major problems are addressed and a number of them are in reference to the stimulation of innovation. The following problems, which are strongly related to innovation, are addressed: South Africa spends far too little revenue on R&D, the scientific population is declining, R&D is declining in the private sector, there is a lack of a policy framework for Intellectual Property and there is fragmentation in government science and technology.

Kaplan (2004) critically evaluated the NRDS and had some comments on this report. One of his comments was about the fact that the NRDS should be more focused on technology-intensive and market dynamic products. South Africa has to upgrade more rapidly into a market dynamic medium with high technology products in order for the country to retain its current competitive position (Kaplan, 2004). Another comment of Kaplan was about the selection of sectors in the NRDS. The strategy identified eight priority sectors, which is too widespread to focus the NRDS effectively. Another point of criticism was that electronics sector, where many technology-intensive products are located in South Africa, is not included in the NRDS. Through the introduction of the NRDS the government of South Africa wants to foster economic growth. This will affect the economy on macro level, but also on firm level. The focus on innovation and the criticism of Kaplan emphasizes the relation between innovation and economic growth.

Although there have been numerous studies that paid attention to business performance, the relation between (technical) innovation and business performance on firm level is somewhat less researched, especially in developing countries. Therefore, the subject of this Master's Thesis is innovation and business performance in South Africa. In particular this study focuses on the relation between innovation and business performance on firm level in South Africa as a developing country.

1.2. Research question

In this report the relationship between innovation and business performance will be assessed, by looking at the effects of innovation on business performance. The following research question will be answered:

> *What are the effects of innovation on business performance in South African firms?*

A distinction can be made between product and process innovation. Product innovations concern improvements on earlier versions of a specific product or service. In contrast, process innovations mainly concern the improvement of production technology, which results in lower production or manufacturing costs or in higher output. The effect of these two types of innovation on business performance may differ. The effect of innovation on business performance may also differ in small and large firms. Therefore the following sub-questions will be answered in this report:

1. What is the effect of product innovation on business performance?
2. What is the effect of process innovation on business performance?
3. What is the effect of innovation on business performance in small firms?
4. What is the effect of innovation on business performance in large firms?

Business performance can be measured using measures such as employment, sales and profitability, and also export growth (Freel, 2000; Roper, 1997). In this report business performance will be measures by total sales and export growth, because data about these measurements are reasonably easy to obtain and these measures are good indicators of business performance.

To answer the research question data will be used from the South African Innovation Survey (SAIS), which was conducted in 2001. This survey was conducted to get a nationwide overview of the innovative behaviour and performance of South African firms. In this survey firms in the manufacturing and service industry sectors of South Africa were incorporated from the period 1998–2000. The survey was based on the European Community Innovation Survey (CIS). The European Community Innovation Survey is conducted regularly since 1994 within the European Union to get an overview of the innovative behaviour and performance of European firms. Because the survey was based on CIS findings, findings from South Africa can be compared with Europe.

The SAIS research data will be complemented with new micro economic data of the same firms, but now for the year 2003. Therefore this research is of a longitudinal design and conclusions can be drawn about whether innovation has had a positive effect on total sales and export growth in South African firms between 1998 and 2003

1.3. Structure

After this introductory chapter, the theoretical framework and hypothesis will be discussed in chapter 2. Chapter 3 will provide a brief introduction to South Africa. This chapter begins with a brief description of the history of South Africa and gives information about the current economic status of South Africa in general and of firms in South Africa. Chapter 4 explains the methodology of this research and the verification of the data. The descriptive analysis will be discussed in chapter 5. The explanatory analyses are described in chapter 6 and this report will be completed with conclusions and discussions in chapter 7.

2. Theoretical framework

In this chapter literature concerning that pertains to the relationship between innovation and business performance, will be discussed and hypotheses will be developed. In the first paragraph (2.1) the definition of business performance will be given and different kinds of methods to measure business performance will be described. Subsequently the effects of innovation on business performance will be described in paragraph 2.2. Since business performance is measured in this report by total sales and export, this paragraph only focuses on these two measures. In paragraph 2.3 innovation is distinguished by type of, product/service and process innovation. Finally, the control variables are described in paragraph 2.4.

2.1. Business performance

Before business performance can be explained it is necessary to know what a "business" is. To prevent any misunderstandings in this report, the words "business" and "firms" are both used and they have the same implied meaning. According to Case (1999: p. 68) a business is "an organization that transforms resources (inputs) into products (outputs)". In industry today there are many types of firms, but they can all be split up into profit-making and non-profit making organizations.

Non-profit organizations are not focused on revenues. Their centre of attention is service. Examples of non-profit organizations are Universities and medical aid services. The main objective of a university is education and research and the main objective of a medial aid is to give medical assistance. Any profits are used to support their main objective. In this example, providing better education and research or improving medical services.

In contrast, profit-making organizations endeavour to transform inputs into outputs in meeting the demands of their clients. Profit organizations deliver their products or services for more than it costs to produce them. Through this mechanism, profit organizations seek positive revenue. In case of negative revenue, i.e. a loss, a profit organization is not able to survive. As a consequence the profit organization leaves the market. In this report only the profit organizations are important since this research is focused on the relationship between innovation and the economic performance of a firm.

In the research the relation between innovation and business performance is examined. The business performance of a profit organisation is important for its competitiveness in the economic market. In this report the following definition of business performance is asserted:

> *"Business performance is the degree to which a profit organisation can manage its objectives on the competitive market."*

Different indicators like total sales, productivity and employment can measure the performance with regard to the market. A firm can increase its profit or market share. The export or export intensity is a factor that determines the degree of performance as well. In literature different objective measures are used, to indicate business performance (Freel, 2000). Below is a short list of the most common performance measures.

Total sales growth. Total sales growth is assumed as a good indicator of business performance. Sales growth is used frequently in literature since it is information, which is relatively easy to obtain (Hall, 1987; Roper, 1997; Freel, 2000; Del Monte and Papagni, 2003). The introduction of a successful product, results in a (temporary) increase in total sales. The increase of total sales will last until a firm loses the proprietary control of the new product innovation, or until another firm introduces a comparable product (Dosi, 1988).

Profits and profitability. Profit is the difference between total costs and total revenues. It is a good indicator of business performance, since profit gain is always the final goal of a profit organization. Profit organizations always will attempt to sell products or services for more than it cost to produce them. Profits or profitability are therefore a good indicator of business performance. A low profit margin is not always an indicator of bad business performance. Profit margin may differ significantly across industry. Organizations with a low profitability, i.e. in the retail trade, can have good business performance since profit margins are low throughout this sector. Due to the fact that many organizations do not want to disclose information concerning profit or profitability, this indicator is rarely used in studies of business performance and therefore it will not be used in this report either.

Productivity. Productivity (measured as total sales per Full-Time-Employee (FTE)), is used as a measure of internal efficiency. A higher total sales per full-time-employee subsequently increases business performance (output) with the same amount of employees (input). In this report productivity isn't used as a measurement of business performance since the number of employees is measured by the total number of contracted employees and not by full-time-employees.

Export intensity. Export intensity is the proportion of total sales, which is derived from exports. Export is part of total sales, which originates from abroad. Therefore it is always lower or equal to total sales. This measurement is used frequently in literature. Admittedly, this measurement isn't a perfect measurement of export performance. When for example total sales and export increases substantially, the firm's exports relative to total sales remain constant. Export growth, as a measurement of export performance, will give a better measurement of export performance. Nonetheless, this measurement provides a reasonable picture of export performance for this research. An exporting firm is better able to increase its market share in foreign countries, which means more possibilities to grow. An increase in export is therefore a good measure of business performance.

In this report business performance is measured with total sales and export. Since the impact of innovation on business performance is examined, it is necessary to know the change of business performance over a certain period. From firms that cooperated with the SAIS 2001 and the SAIS 2001 revisited is known what there export- and sales numbers were in the years 2000 and 2003. With these numbers the change in business performance over this period can be determined. The data of SAIS 2001 provided information about innovative behaviour of the same firms over the period 1998-2000 as well. With these figures it is possible to determine if innovation over the period 1998-2000 influenced the change in business performance over the period 2000-2003.

2.2. Innovation and the effect on business performance

Innovation is "the process of transforming an idea, generally generated through R&D, into a new or improved product, process or approach, which relates to the real needs of society and which involves scientific, technological, organisational or commercial activities" (Freeman, 1982: p. 7). It may be said that innovation has a positive influence on the nation's economic development in general. Porter and Freeman state that firms will benefit considerably from the introduction of new and or improved products and/or services (Freeman and Soete, 1997; Porter, 1990). According to Schumpeter's (1939) "Creative Destruction" theory, product innovation of a firm results in a great performance advantage, because it leads to a temporary monopoly. Baumol (2002: p. 1) goes a little further by reaffirming that innovation contributes to a firm's ability to survive. He stated, "Under capitalism, innovative activity... becomes mandatory, a life-and-death matter for the firm" and "innovation has replaced price as the name of the game". Also according to Schumpeter (1942: p. 84) the introduction of an innovation leads to "competition which commands a decisive cost or quality advantage and which strike, not at the margins of the profits and the outputs of the existing firms, but at their foundations and their very lives".

Diederen, Meijl and Wolters (2002) conclude from the Dutch Farm Accountancy Data Network (FADN) database a positive relationship between innovation and business performance. Innovative farmers show a significantly higher business performance than non-innovative farmers. In this study business performance was measured by, among other things, profit levels compared with non-innovative farmers. Favre, Negassi and Pfister (2002) found a positive effect from a sample of 2879 French firms between innovation and profits. Among other things, R&D intensity (as a measurement of innovativeness), will have a positive influence on profits.

Effects of innovation on business performance are not immediate. Innovations introduced in 2000 will only have an impact on business performance after some time. According to Diederen et al. (2002) this time-lag between innovation and performance will take at least one to two years. In this study we employ a longitudinal survey design. Innovation of business firms is measured in the year 2000, and the effects on business performance are measured in the year 2003. Thus, the effect of

innovation on business performance is measured three years after an innovation has been introduced.

The duration of this advantage will last until the firm loses proprietary control over the new technology or when firms introduce an alternative of this technology on the market (Dosi, 1988). In practice the length of this period differs. It can take months, years or even decades. This will differ per innovation and is mainly based on the market structure in which the firm is active. In a sector where innovations succeed each other quickly, the duration of this period will be shorter then in an industry where the time between new innovations is much longer. After this period of improved business performance, it will decrease to its normal performance level. Since the length of this period is dependent on, among other things, the type of innovation and industry, it is difficult to determine the length of this period. Lefebvre & Lefebvre (2002) used a three-year time lag by determining the effect of R&D on export performance. In this report they chose to measure the effects of innovation on business performance after the same time period of three year.

According to the studies mentioned before it is clear that innovation has a positive effect on business performance. Innovation is thus considered as a driving force of economic development and improvement of competitiveness of its firms. Products, processes and services will be improved so the general technological state will grow. However, still little is known about the effects of innovation on total sales and exports growth on firm level, especially in the South African context.

2.2.1. Innovation and the effect on total sales growth

Sales growth is used frequently in studies about the effect of innovation on business performance (Hall, 1987; Roper, 1997; Freel, 2000; Del Monte and Papagni, 2003) and will be used in this report as well. One of the expected outcomes of innovation on business performance is a temporary increase of total sales. The increase of total sales will last until a firm loses the proprietary control of the new product innovation or when another firm introduces a comparable product (Dosi, 1988). A successful product results in an (temporary) increase in sales and can even increase market share. An increased market share can have a positive influence on sales growth when the firm introduces a new product in the future. A larger market share will simplify the diffusion of a new innovation, which subsequently will increase total sales. Process innovation can reduce manufacturing costs, which may have a positive influence on total sales as well.

In literature the evidence of increased total sales as an outcome of innovation, is slightly ambivalent. Geroski and Machin (1992) found no permanent or generic differences between innovators and non-innovators. Geroski and Machin only found that in a macro-environment, the growth of total sales within non-innovators was more sensitive to change. In contrast with them, other studies of small firm innovation (Hall, 1987; Roper, 1997; Del Monte and Papagni, 2003), found a positive relation between innovation and turnover growth.

Hall (1987) studied manufacturing firms in the US and found a positive relation between R&D and sales growth. In his research 1,778 manufacturing firms were included. Hall noticed substantial differences in the high-tech industries. The differences can be explained by the fact that firms in high-tech industries are more dependent on R&D, which will have a strong effect on sales growth.

Roper (1997) studied the relationship between product innovation and growth in small firms. He found "... a strong positive association between (product) innovation and turnover growth" (Roper, 1997). He used the Product Development Survey (PDS) in his research, which consisted of more than 15,000 manufacturing enterprises in Germany, Ireland and the U.K. 24% (3629 firms) responded in this survey. He found a significant difference in growth of total sales in innovating and non-innovating firms. Total sales of innovating firms increased much faster in all three countries. However, there was a difference in achieving this result: Germany achieved their output growth by increasing productivity, but with a decrease in employment. Firms in the U.K. and Ireland achieved this with an increase in productivity and employment. The differences in innovation strategy can be explained, because Germany has significantly higher average labour costs, than the U.K. and Ireland. In spite of the different strategies, an increase of total sales was realised by means of innovation.

Freel (2000) found evidence that "... innovators are likely to grow more than non-innovators". Growth was measured in total sales over the period 1994 and 1996. His research was based upon 228 small manufacturing with less than 250 full-time-employees. Firms were located in the West Midlands region of England and were categorized by level of innovation.

Del Monte and Papagni (2003) found a positive effect of R&D (as a measurement of innovation) on sales growth. They collected data from 500 Italian manufacturing firms between 1989 and 1997. They found no effect of firm size on growth rates and the effect of research on firm growth is larger in traditional sectors compared with high-tech sectors.

Since known literature clearly distinguishes a positive relation between innovation and total sales, it is stated in this report that in the South African context the same relation will be found. This leads to the first hypothesis:

> ***Hypothesis 1:*** *Innovative firms have higher sales growth than non-innovative firms in South Africa.*

The main effects of innovation on business performance can be influenced by the size of the firm. Storey (1994: p. 149) states that "... innovation is associated with more rapid growth within small firms" and Heunks (1998: p. 270) found that "innovation of any kind fosters growth of small firms". In general small firms will

benefit more from innovation compared to large firms (Mueller and Tilton, 1969). This leads to the second hypothesis:

> ***Hypothesis 2:*** *Small innovative firms have higher sales growth compared to large innovative firms in South Africa.*

The age of the firms is important as well. Mueller and Tilton (1969) were the first who present the differences between small firms and small new entrants. A small new entrant will have a significant growth potential opposed to small firms, which are already on the market for a long period of time. Therefore firm age should be taken into account during analysis. This leads to the third hypothesis:

> ***Hypothesis 3:*** *New innovative entrants have higher sales growth compared to innovative firms, which are already on the market in South Africa.*

2.2.2. Innovation and the effect on export growth

Export growth will be used, besides total sales growth, as a performance measure in this study. Export is measured as a percentage of total sales. A theoretically positive relationship exists between innovation and exports. The following five studies elaborate further upon this positive relationship.

In a research project done by Lefebvre E., Lefebvre L. and Bourgault (1998), no relation was found between R&D and exports. R&D was used as a measure of innovation. Export growth was measured as export intensity (export as a percentage of total sales) and the destination of exports. They approached 692 Canadian SME firms within the province Quebec. All these firms are registered in government files and they all conduct R&D activities. The questionnaires were mailed to the CEO of each firm, because they are considered to be the best respondents for this survey. The reason for this is that they have a lot of influence on resources allocation. Finally, only 101 firms were suitable for analysis. The population of the respondents is similar compared with the population of 692 firms with respect to size and sector of economic activity. However, the population of firms with formal R&D is not representative for all Canadian or Quebec firms. These firms are more likely to have export activities and invest more in R&D. The resulting sample is therefore biased towards highly performing firms. but since their study is about R&D related capabilities this bias wouldn't influence their research negatively.

Several years later Lefebvre and Lefebvre (2002) found that, in decreasing order, size, import activities, R&D, knowledge intensity, and distribution access, have a strong influence on export. Their study was based on a longitudinal survey of 3,032 manufacturing SMEs over the period 1994 - 1997. Two conditions were applied to carry out a longitudinal analysis on exactly the same SMEs. The first requirement was that the firm must have fewer than 500 employees. The condition that firms must have fewer than 500 employees corresponds to the definition of SMEs, which is accepted by many organizations (i.e. Small Business Administration in the USA, The

European Union, the OECD or Statistics Canada). The second condition was that firms must be present at the commencement of the survey and should still be active at the end of the survey. Firms that had declared bankruptcy in the interim were excluded. The results show that more than half of the SMEs were aimed at their local market, but the large majority of these firms showed some interest in exporting. Between 1994 and 1997 the percentage of non-exports decreased from 50.1% to 31.4%. The same firms were much more active in foreign markets. In 1997, 1,634 firms extended their sales beyond their domestic markets, while in 1994 only 1,155 firms did the same. The results of the study of Lefebvre and Lefebvre (2002) show that the strongest determinants of export performance were import activities, R&D, knowledge intensity and distribution access, size. All these determinants are significant for the year 1994 and 1997. In the year 1997 size plays a slightly smaller role, which can be explained by the fact that an increasing number of SMEs have increased in size and are more active on foreign markets. R&D and knowledge intensity are one of the five strongest determinants of export performance. This suggests that international competition is knowledge-based. However, the determinants of export performance vary slightly between sectors. In high-knowledge sectors technological capabilities are better than commercial capabilities. Firms in the high-knowledge sectors seem to grow faster than in any other sector. Therefore special attention should be paid to build technological capabilities in the high-knowledge sectors. Independent variables, which had no or minimal impact on export performance were trade unions, technical quality norms and the degree of modernization of equipment.

Shefer and Frenkel (2005) found a positive relationship between high-tech firms and export rates. They interviewed 209 industrial firms in the northern part of Israel. Export was measured as export growth and a distinction was made between the high-tech group and the traditional group of firms. High-tech firms had a substantially greater rate of exports compared to the traditional group of firms. Since high-tech firms are dependent on technological innovations, the conclusion can be drawn that innovation has a positive relation to export performance.

Kleinknecht and Oostendorp (2002) concentrate on the relationship between R&D and export performance. In their research they found that R&D intensity increases the likelihood of being an exporter, while it doesn't have an influence on export intensity. In their research they didn't make a distinction in firms size. The latter was measured as exports as a percentage of total sales, in other words the export intensity. They used data from the Organization for Strategic Labour Market Research of the Netherlands (OSA). A selection was made of 1,773 Dutch firms with five or more employees.

Moini (1995) found that firms, which produce products for special or niche markets, take advantage of their technological edge, and they have a positive effect on export performance. Moini (1995) studied the data of 102 small Wisconsin exporters, with less than 500 employees, to identify which characteristics contribute to export performance. They measured export performance as a percentage of total sales and

export growth. The categories they used were firm characteristics, managerial expectations from exporting, managerial characteristic and knowledge of foreign languages.

Cooper and Kleinschmidt (1985) found some activities, which were clearly related with high export performance. The evidence of Cooper and Kleinschmidt strongly suggests that high R&D spending (as a measurement of innovation) is vital for highly successful exports. For this study Cooper and Kleinschmidt personally interviewed managers of 142 high technology electronics firms in Canada. Only small to medium sized firms were included in the data. Export performance was measured by export intensity (export as a percentage of total sales) and export growth.

In a research project conducted by Freel (2000) it was found that innovative firms are not more likely to export compared to non-innovators. Freel did not find a positive relation between innovation and export intensity since his findings weren't statistically significant ($p = 0.18$), even though the relationship between innovation and export intensity was positive.

In general, innovative firms will benefit from innovation and show above average growth in exports in comparison to non-innovative firms (Lefebvre and Lefebvre, 2002; Shefer & Frenkel, 2005; Moini, 1995; Cooper & Kleinschmidt, 1985). Innovative firms add new features, or introduce new product/services or processes to the market, which have a positive influence on export performance. However, some studies (Lefebvre, Lefebvre and Bourgault, 1998; Kleinknecht & Oostendorp, 2002; Freel, 2000) did not find a positive relationship between innovation export performance. These differences can be explained partially by the time interval between data collection, the amount of firms, which were included in the dataset and the research design (longitudinal v.s. non-longitudinal). Because of these explanations the following hypothesis is presented:

> **Hypothesis 4:** *Innovative firms have a higher export intensity than non-innovative firms in South Africa.*

The effect of technological innovation on export performance is influenced by firm size. Small firms are better able to take advantage of their innovations compared to larger firms (Acs and Audretsch, 1988). Small and mediumsized firms flourish by promoting unique products (or products with unique features) and by approaching niche markets (Julien, 1993). Many firms simply have no choice or ability to go global. This is as a result of the so-called technological market niche they want to exploit. Within a niche a protected environment is formed where specific technological innovations can be formed. Products, processes or services are becoming more and more specialised. This specialisation is illustrated by Keeble, Lawton-Smith, Moore and Wilkinson (1998), who found that in the Cambridge area more than half of the firm's indicated, have less than five competitors in the same market. Because of this limited niche market, more and more small and new firms are forced to form international linkages at a very early stage of their development,

especially concerning sales activities, because the clients are simply distributed all over the world. This is especially true when competition is increasingly technologybased. Exports will show above average growth in small firm as a result of the exploitation of niche markets (Hagedoorn and Narula, 1999). However, small firms may have a lack of knowledge and connections in foreign markets that will have a negative effect on export performance (Tödlinger, 1994). Since South African firms show above average percentages of foreign partnerships (Rooks & Oerlemans, 2005) a lack of connections in foreign markets is not expected. Therefore the following hypothesis is presented:

> **Hypothesis 5:** *Small innovative firms have higher export intensity growth compared with large innovative firms in South Africa.*

2.3. Characteristics of innovation

Besides the effect of the novelty of innovation, the type of innovation may have different effects on business performance. Schumpeter (1959) divided innovation into product/service and process innovation. The effects of these two types of innovation differ and will be explained in this chapter.

2.3.1. Product/service innovation

Product/service innovation concerns the improvement of an existing product/service or the creation of a new product/service. Product/service innovations will be defined as "*the implementation / commercialisation of a product with improved performance characteristics such as the ability to deliver objectively new or improved services to the consumer*" (OECD, 1997: p. 9) By the introduction of a product innovation a firm can sell more products by increasing their market share or it becomes viable for them to open new markets. This may eventually increase, among other things, total sales and exports.

2.3.2. Process innovation

Mostly product and process innovation comes together. A product innovation leads to process innovation, because new processes must be developed to manufacture the new improved products. Process innovation is defined as "*the implementation/adoption of new or significantly improved production or delivery method*" (OECD, 1997: p. 9). Process innovation produces a less visible output compared to product innovation. The transformation process in a firm will be improved by process innovation and will make the transformation more efficient. Profitability will be improved by reducing the manufacturing costs of a product. The increase in profitability is limited by the amount of realized cost reduction (Brouwer & van der Does de Willebois, 1990). However, sales and exports are not affected directly by process innovation, if the prices of products remain constant. However, the question is whether the price of the product will remain constant. This is dependent on the speed of diffusion of that particular process innovation, which is subsequently dependent on the market share of that firm. The diffusion of a new process innovation will eventually decrease the market price since competition forces

firms to decrease their prices to remain competitive. In literature little is known about the direct relation between process innovation and business performance. Doms, Dunne and Roberts (1995) found a positive correlation between the use of advanced manufacturing technologies and plant growth. Since the relation between product/service innovation and an increase in sales and exports growth is more direct than the relation between process innovations and sales and exports growth, the following hypothesis is presented:

Hypothesis 6: *Firms with product/service innovations only have higher sales figures than firms with process innovations.*

Hypothesis 7: *Firms with product/service innovations only have higher export intensity growth than firms with process innovations.*

2.4. Control variables

Business performance is, besides innovation, dependent on other variables, such as firm size, age, location, sector and whether or not firms belong to a larger multinational. All these factors may have an influence on the relation between innovation and business performance.

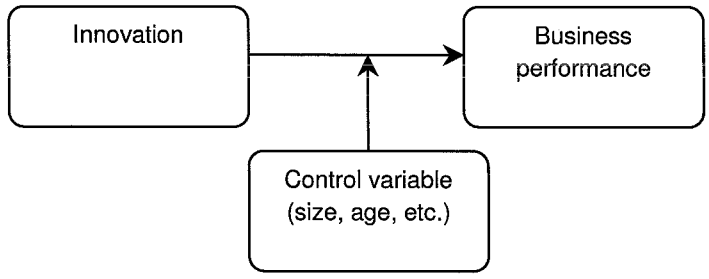


Figure 2.1 Research model

2.4.1. Firms that are a part of a larger multinational

Firms that belong to a larger multinational (i.e. foreign ownership) can take advantage of resources provided by the head office or trade agreements. This can influence the overall business performance positively, while privately held and independent firms will have much lower business performance in the same industry. Another advantage of belonging to a concern is that they are more able to obtain the necessary financing for R&D projects. Because it is easier for them to obtain the necessary financing, the risk is smaller compared to small independent firms. Small independent firms will face more difficulties in obtaining the necessary financing for R&D, which automatically increases the risk of financing (Shefer and Frenkel, 2005).

2.4.2. New entrants

The age of firm will have effects on the relation between innovation and business performance. New or small firms are more able to take advantage of innovation and gain more growth than there larger counterparts (Acs and Audretsch, 1988). According to Mueller and Tilton (1969) small new entrants will have a significant

growth potential compared to small firms. In this report new entrants are used as a control variable, since information about the age of firms is not available.

2.4.3. Firm size

The size of a firm will affect the relationship between innovation and business performance. The investment in R&D may be affected by firm size. Large firms are more able to obtain the necessary funding compared with small firms (Acs and Audretsch, 1988; Dosi, 1988). Therefore it can be suspected that it is easier for larger firms to start an R&D project and to take advantage of these activities. However, smaller firms are more able to adapt to new markets and it is easier for them to take advantage of innovation, since small firms have a lot of growth potential. Thus it will be interesting to study the effect of firm size on the effect of innovation on business performance.

2.4.4. Sector (high-tech vs. traditional firms)

It seems that high-tech firms are more dependent on technology than traditional firms. This is because high-tech sectors are more R&D intensive, firstly and secondly, because R&D expenditures are much higher compared to the traditional sectors (Acs and Audretsch; 1993). Therefore it is necessary to examine the effect of different sectors on the effect of innovation on business performance. A distinction can be made between the high-tech sectors (i.e. electronics, electro-optic and precision instruments) compared to traditional sectors (i.e. plastic and metal products). It is reasonable to assume that innovation does not have the same effect in traditional firms compared to high-tech firms. A distinction of these two sectors is needed to get a better understanding of the effect of innovation on business performance.

The *type* of industry also has an effect on the delayed outcomes of innovation. The effect of innovation on business performance is delayed, since diffusion and adoption of products need some time. This process is needed before a firm can take advantage of the innovation and it can take years before the outcomes are at their strongest. The duration of this period is strongly related to the industry, and differs considerably across industries (Pavitt, 1984). In a sector were innovations succeed each other rapidly, the duration of this period will be shorter then in an industry where the time between new innovations is much longer. Therefore the industry will have its impact on the duration the period when a firm can take advantage of their innovation.

3. Research context: South Africa

In this chapter the economic, technological and innovative status of South Africa is presented. A brief summary of the history of South Africa is given in paragraph 3.1. The history in paragraph 3.2 will provide some background information about the factors that constitute the economic climate in South Africa today. Paragraph 3.3 will provide the regional, sectorial and size distributions of South African firms. This chapter has been written by Ronnie van de Thillart, Bernard de Veer and Robbert Westerhuis.

3.1. History of South Africa

Modern humans have lived in South Africa for 100.000 years. However, even before that time the earliest ancestors of humans have lived in South Africa. Since the year 1939 the earliest known remains of the ancestors of modern man (Hominids) have been discovered in an area known as "the cradle of humankind". It is located near Johannesburg. Remains dating back from between 1.5 to 3.5 million years old, have been found there.

The earliest inhabitants of South Africa, at least the earliest that we can name, were the San people (also known as Bushman or Xhosa) and a racial grouping called Khoekhoe people (also known as Hottentots or Khoikhoi). Both were residents of the southernmost tip of the African continent. Evidence of their existence is still visible today. Bushmen paintings can be found in many locations all over South Africa. The Khoikhoi mainly lived around southern and western coastal strips. This area was a good grazing area for their cattle.

These people were also the first to meet the European settlers (Ross and Cuijlburg, 2001). With the arrival of the first European settlers the written history of South Africa commences. The first European to set foot on South African soil was Jan van Riebeeck, who anchored in Table Bay, at the foot of the Table Mountain, on the 6th of April 1652. The Dutch realized the strategic and economic importance of the Cape for the Dutch-East India Trading Company. Van Riebeeck accompanied by eighty-two men and eight women, had been instructed to establish a strong base to provide the companies ships with fresh supplies on the long journey from Europe to Asia. The settlement started to flourish and the need for labour and agricultural land grew continuously. Some of the white farmers, wanted to expand their territory by moving inland. They were referred to as Trekkers or Trekboere. This did not occur without a struggle. Several armed conflicts with the native inhabitants, the Khoikhoi and the Xhosa, occurred as a result of their decision. In 1835 "Die Groot Trek" started, when more than 10,000 Boers, the "Voortrekkers" left for the north because of economic problems and the threatening danger of conflict with the Xhosa. They were also discontent with the English colonial authorities that annexed South Africa in 1806 from the Dutch. The Voortrekkers were dissatisfied because the English colonial authorities didn't provide sufficient protection, had forbidden the slave trade and postulated the equality of whites and non-whites. This Groot Trek led to several

collisions with Zulus, who eventually were completely defeated in the famous "Battle of Blood River" in 1838. The foundation of the first Boer Republic in Natal was a fact, but only for a short period. In 1842 British troops occupied Natal and annexed it as a crown colony. The Voortrekkers then moved even further northwards. The colony developed into a modern state and the whites tended more and more towards a policy of land annexation and suppression of the black population. A modern "democratic" state was formed when the British colony and the Boer Republics were united and which formed the South Africa Union.

According to the Native-Land Law, 13 percent of the land in South Africa was declared reservations for blacks. Only whites had the right to vote and no black person was allowed to purchase land from the 87 percent of the territory of the union, and vice versa. These were the beginnings of "Apartheid"

In 1910 racial separation was introduced by way of legislation. These laws diminished the rights of the black majority. Black workers were limited to only subordinate work to secure the better positions for the white population. Although the majority of the population was black, they only possessed thirteen percent of the land in South Africa, and they were excluded from buying land outside reservation areas. They had no right to vote or to strike and they had no political influence. Dispossessed and having no voice in matters resulted in the formation of several liberation movements. Among them was the African National Congress (ANC).
The National Party – a white congress – was able to suppress any resistance with little effort for many years. The conflicts got worse, however, after the Second World War and the whites became nervous. This led to a huge election victory of the right-wing National Party (NP) in 1948. Dr. D. F. Malan, the leader of the NP, upheld apartheid-policies. Interracial relations were forbidden, and racial segregation was prohibited. Different races were disallowed to use the same public amenities, such as drinking fountains, restrooms and public transport. Bantu education was introduced, which was of poor standard and kept black children at a disadvantage. Apartheid would only end fifty years later.

It is clear that South Africa is a country with a unique history. Its inhabitants are an interesting composition of Western, African and many other cultures. This uniqueness is evident from the fact that South Africa is the only country that has eleven official languages.
In 2005 apartheid has been gone for eleven years and the country is now reinventing itself. It is slowly emerging from its isolation and the lifting of all trade barriers, has opened South Africa to the rest of the world. In recent years many black empowerment regulations have been passed, obligating firms to acquire personnel that represent the different cultural backgrounds. According to the Act, "broad-based black economic empowerment" – with an emphasis on 'broad-based' - refers to the economic empowerment of all black people including women, workers, youth, and people with disabilities and people living in rural areas[2]. This will change the profile of

[2] http://www.southafrica.info

working population of South Africa completely. These developments and the more recent political shifts have had a major impact on the industry in the past and will continue to do so in the future - making the entire industry unique to the world.

3.2. South Africa today

South Africa is presently a country with a two-layered economy. On the one hand it competes with developed countries, but on the other hand it has a very basic structure. South Africa has lower resources per capita than developed countries and shortages/inadequacies in its socio-economic infrastructure[3]. It is therefore regarded as a developing country. In paragraph 3.2.1 the economic characteristics of South Africa will be compared to some other developed and developing countries. In paragraph 3.2.2 and 3.2.3 respectively, the technological and innovative status will be discussed.

3.2.1. Economic status

In this paragraph some important indicators of the state of the South African economy like GDP, Inflation and Unemployment rates are benchmarked against the same factors in some other developed or developing countries. This will give a comparison of the economic status of South Africa against other countries at present.

Economic indicators

In the table 3.1 the economic characteristics of several countries are summarised. Included are some of the largest economies of Europe and North America and some of the leading innovative countries in Europe, like Sweden and the Netherlands. Also Mozambique is included; another African country.

South Africa cannot be considered a big economic power. The GDP (Gross Domestic Product) of South Africa shows results comparable to the Netherlands. The human resources situation, however, between the two countries, are completely different. The Netherlands has 16 Million inhabitants and South Africa 44.8 Million. This means that GDP per capita shows a different result. GDP per capita is low compared to developed countries. However GDP per capita is significantly higher in South Africa than in most other African countries.

Although GDP per capita is relatively high, at least when compared to other African countries, the population below the poverty line is high (50%). This indicates that the distribution of wealth is extremely uneven in South Africa.

Unemployment and inflation are high - even compared to other African countries. The actual unemployment rates are believed to be even higher that the official percentage of 31%, and will be closer to forty than to thirty percent. In recent years there has

[3] http://www.agrement.co.za/export%20of%20build.html

been a dramatic increase in unemployment: the rate has moved up from 29 percent in 1999, to 40 percent in 2004[4].

	South Africa	Nether-lands	European Union	US	Mozam-bique	Ireland	Sweden	France	Germany
GDP (billion $)	456.7	461.4	11.05 trillion (2004)	10.99 trillion	21.23	116.2	238.3	1.661 trillion	2.271 trillion
Inhabitants (million)	42.8	16.2	457 (2005)	290,3	17.2	3,9	8,9	60.2	82.4
GDP – per capita ($)	10,700	28,600	25,700	37,800	1200	29,600	26,800	27,600	27,600
Unemployment	31	5.3	9.1	6	21 (1997)	4.7	4.9	9.7	10.5
Population below poverty line	50%	N/A	N/A	12%	70% (2001)	10% (1997)	N/A	6.5% (2000)	N/A
Inflation (%)	5.9	2.1	2	2.3	14	3.5	1.9	2.1	1.1
Exports (billion $)	36.77	253.2	850.3 (2002)	714.5	0.7	98.31	102.8	346.5	696.9

Table 3.1 Economic characteristics of the year 2003 (source: CIA-factbook 2004[5])

Only 8.05% of the GDP in South Africa involves exports. This is low compared to developed countries that have export ratios extending beyond 50%. Low export ratios are expected in developing countries, however, when comparing export growth in South Africa to other countries, it has grown less rapidly. Between 1992 and 2002 global exports of all sectors increased by 4.93% per year. However, the exports of all sectors for developing countries rose considerably faster and the figure is 10.54% per year according to Kaplan (2004).

The export growth of South Africa was only 4.44% in the period between 1992 and 2002. Export growth is more prominent in developing countries than in developed countries. South Africa's performance in terms of exports has been particularly weak (Kaplan, 2004).

South Africa has to face different challenges because of the increase in competitiveness in global exports from other developing countries (China in particular), and because of an important change of exports composition from low to middle/high technology. To overcome these problems South Africa has to increase its exports, and more importantly, South Africa has to increase the technological complexity of its exports. Looking at the figures of the last decade it is clear that South Africa's performance has been weak compared to the rest of the world and other developing and middle-income countries in particular.

[4] Afrol news source: http://www.afrol.com/articles/12037

[5] http://www.odci.gov/cia/publications/factbook

3.2.2. Technological status

The technological status of South Africa is discussed in this paragraph. Two different indicators will be used. These indicators are the "Backwards Integration Model" and the "Technology Gap".

The Backwards Integration Model

Buys (2004) used a model called the Backwards Integration Model (BIM) to assess the stage of technological development of South Africa. This model classifies five different stages of technology development as shown in see table 3.2.

Stage I:	Local distribution, marketing, sales and after-sales services of foreign products and services.
Stage II:	Local production and manufacturing of products and services using foreign process technology.
Stage III:	Local improvement of products and processes using foreign technology.
Stage IV:	Local development of new products and processes using foreign technology
Stage V:	Local technology development

Table 3.2 Backwards Integration Model (BIM) (source: Buys, 2004)

South African firms are mainly active in stage III of this model (Buys, 2004). This means that most firms in the South African industry are involved in the *improvement* of products and processes using foreign technology. De Wet calls countries that are dependent upon foreign technologies "technology colonies" (De Wet, 2001). Buys therefore states that, "South Africa is a type of technology colony whose industries are dependent upon foreign technology for the improvement of its products and processes" (Buys, 2004).

According to Alali perpetual dependency upon foreign technology can lead to a failure in developing one's own local capabilities (Alali, 1995). The 'follower' status of South Africa has even more disadvantages. Leaders set the standards, have access to monopoly power and they establish the brand names (Buys, 2004). But on the other hand is stated that in many circumstances the followers are more successful than the leaders (Christensen and Roosenbloom, 1995), on firm level as well as on national level. Many developing countries have been more successful in their follower status than the leaders and are caching up using foreign technology (Kim, 1997). Oerlemans states that the current status as follower has a positive effect on South Africa as a whole (Oerlemans et al, 2003), however, it is unknown if this follower status is sustainable in the future. The low number of export ($36.7 billion) to other countries from South Africa (30% of firms have export ratios above 10%), could be an indicator of the negative consequences the follower status already has on the

economy. Another indicator is the fact that only 12% of firms transfer or sell technology (Oerlemans et al., 2003).

The technology gap

The difference in technological development between two countries is indicated by the technology gap. In literature the technology gap is determined by measuring the rate of imitation relative to rate of innovation between countries (Glass and Saggi, 1998). The size of the technology gap determines the ability that developing countries have to absorb different types of technology from developed countries. A large technology gap limits the ability to adopt foreign technologies.

This problem originates from differences in characteristics between the two countries. In countries where capital (i.e. knowledge, buildings, machines, etc.) is relatively easy to obtain and where labour is expensive, one typically finds that production will be more capital intensive. Countries where capital is scarce and labour relatively cheap will produce products more labour intensively. Technology development is influenced by these circumstances (Katz, 1987).

Besides the difference in capital-labour ratio, the market in developing countries differs from the market in developed countries. The size of the local market is considerable smaller than that of their counterparts in developed countries. A market in a developing country is usually not more than one to ten percent of the size of a developed country. A distinction in market size induces differences in plant size and technology.

South African firms have been severely impacted by this technology gap, because it has created bottlenecks that hamper innovative projects. Between 1998 and 2000, 5.2% of innovative manufacturing firms indicated that projects were not started due to the knowledge gap (Rooks and Oerlemans, 2005). In Figure 3.1 it becomes clear that this percentage, in most cases, is double that of European countries. This data was retrieved from the comparable CIS (Europe) and the SAIS (South Africa) databases.

Another finding was that not only were many projects not even started due to the knowledge gap, the projects that were started, experienced delays as a result of the technology gap. 16.9% of South African firms indicated that innovation projects were seriously delayed due to the technology gap (Rooks and Oerlemans, 2005). This is higher than most European counties, with the exception of Finland.

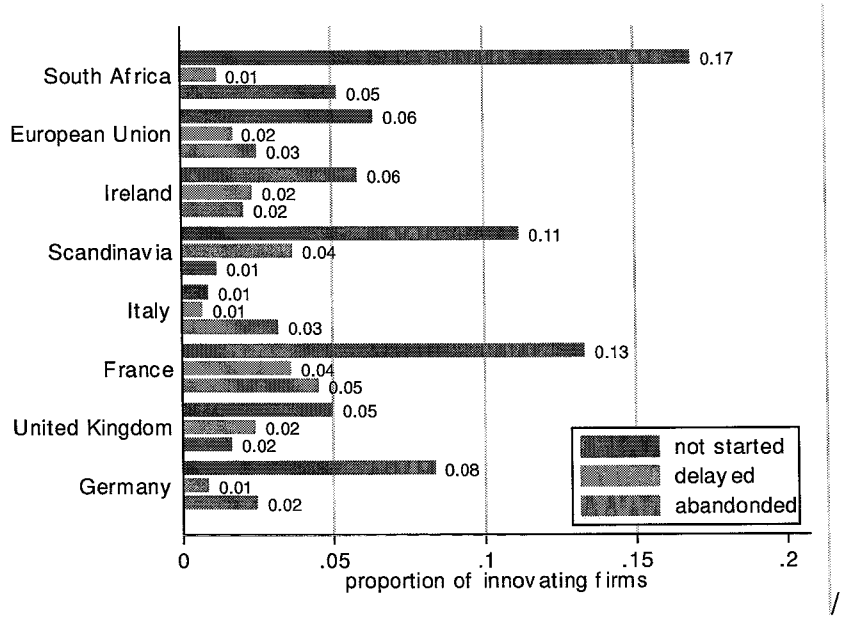


Figure 3.1 Delays or innovations not started at all due to the knowledge gap (source: Rooks et al, 2005)

Innovation projects are clearly hampered due to the technology gap. Currently South Africa is experiencing the adverse effects of the technology gap and much time and effort will need to be invested to reduce this technology gap in the future. In particular it was found that innovation projects are often not launched, because such problems are anticipated.

3.2.3. Innovative status

In business today, markets are increasingly of a global nature. Internet, global financial markets and increased foreign direct investment are all indicators of this global market. However, not all economies have the same levels of innovative and dynamic performance. And there seems to be no evidence that differences in national economic performance will become a thing of the past (Archibugi and Michie, 1997). This means that governmental action to improve a firm's competitiveness becomes more important. To determine a country's innovative and dynamic performance the concept of a National System of Innovation (NSI) was introduced by Freeman.

The innovative status of South Africa is described in the National System of Innovation (NSI).

National System of Innovation

Freeman introduced the concept of National Systems of Innovation to describe and interpret the performance of Japan after the Second World War. The body of literature today, created by Freeman, Nelson, Lundfall and others, identifies the following aspects in defining the structure and explaining the behaviour and performance of nations (Archibugi & Michie, 1997):

- *Education and training.* Education is still believed to be largely national in scope. It is found that the distribution of students by discipline varies significantly across countries. Also the proportion of students actually participating in education varies (Mowery & Oxley, 1995).
- *Science and technology capabilities.* This characteristic of the NSI refers to the level of resources committed to formal R&D in a country in expenditures or manpower. This varies across countries.
- *Industrial structure.* The industrial structure of nations firms is an important factor in determining the nature of the economic activities a country. For instance, large firms undertake more basic research programmes. The competition on the local market differs as well.
- *Science and technology strengths and weaknesses.* Some countries have their S&T resources divided uniformly over all fields and some are specialized in only a few areas.
- *Interactions within the innovation system.* The way in which institutions interact with other actors in their country differs strongly among countries. For instance, governmental regulations can be strongly present or non-existent.
- *Absorption from abroad.* The propensity to engage in international technology transfer differs across countries.

Rooks and Oerlemans (2005) have determined that six characteristics can be employed to measure the NSI of South Africa. These are:

- Efficiency
- Education and training
- National R&D alliances
- External financial resources
- Governmental regulations
- Organizational rigidities

In the next section these six determinants will be discussed and compared to European figures. This data was retrieved from the comparable CIS (Europe) and the SAIS (South Africa) databases.

Efficiency

Efficiency is described as the relation between input and output. If a larger output is obtained with the same input, the efficiency is higher. In this case the input is innovation expenditures and the output is the percentage of innovating firms. In a research performed by the Department of Arts, Culture, Science and Technology (DACST) it was found that in South Africa little time and effort is spend in areas like idea generation, R&D, prototyping and design of new products, services and or processes (DACST, 1999).

The innovation expenditures of South African firms are only 2.65% of sales, which is much lower than other countries. The R&D expenditures are only 1.55% of sales and the R&D workforce is only 1.8% of the total workforce. These figures are much lower compared to European standards.

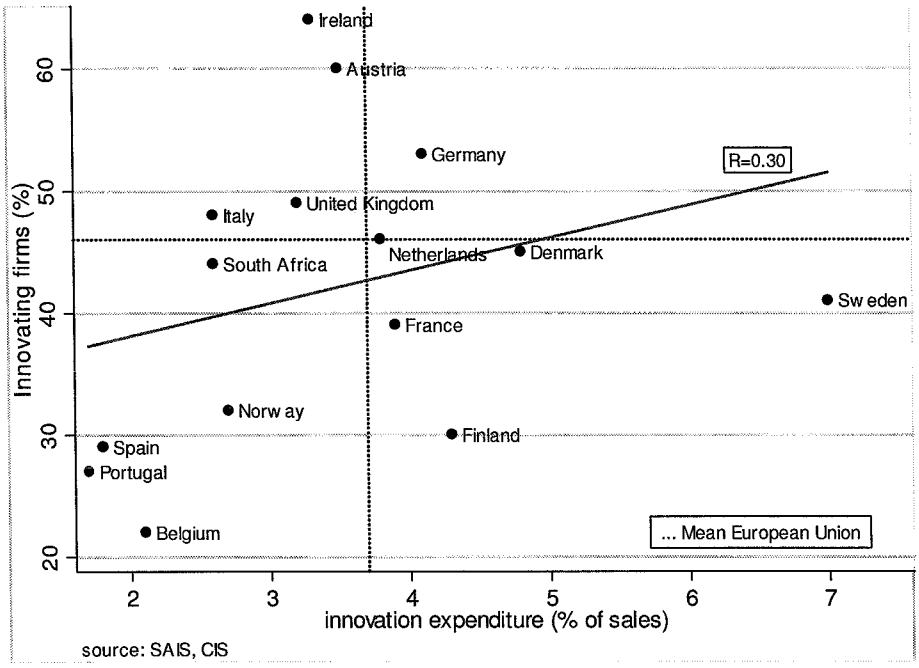


Figure 3.2 Efficiency of SA National Innovation System (source: Rooks and Oerlemans, 2005)

In figure 3.2 the innovation expenditures of many European firms as well as those of South Africa, are measured against the percentage of innovating firms per country. South Africa has low input in terms of innovative expenditures and high output in terms of innovating firms. This is an indicator for an efficient national system of innovation.

Education and training

The following figure shows the percentage of firms that indicated that they had delays in innovation projects, or abandoned innovation projects, or experienced projects that did not start at all due to a lack of qualified personnel.

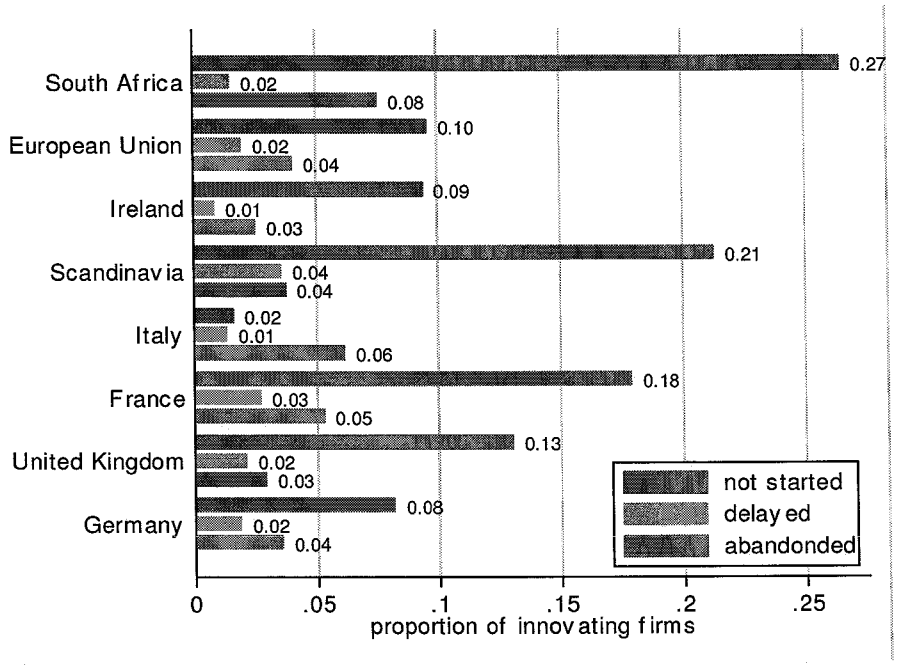


Figure 3.3 Delays or projects not started at all due to lack of qualified personnel (source: Rooks and Oerlemans, 2005)

Firms indicated that there is a lack of qualified personnel in South Africa. In comparison with European firms, South African firms often indicate that a lack of qualified personnel is a main reason for the abandonment of innovative projects or this reason caused projects not to start at all. Scandinavian firms, surprisingly, show comparable results to South African firms. However, Scandinavia has a high technology level which may create a very high demand for qualified personnel. The score of South Africa will not be affected similarly, because South Africa is not a high technology nation (Rooks and Oerlemans, 2005).

National R&D alliances

The following figure shows the percentage of firms with national, European and North American (US) innovative partnerships.

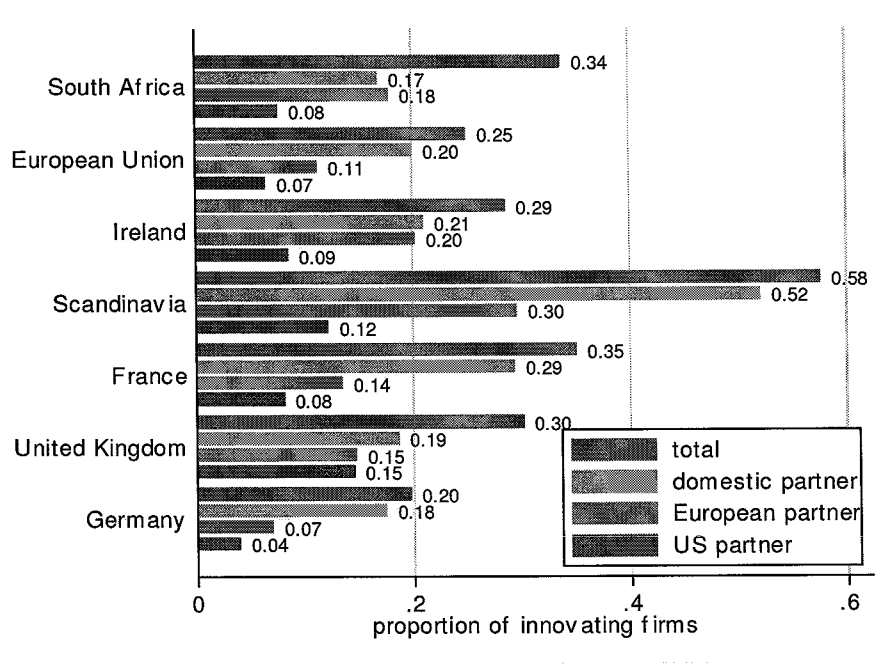


Figure 3.4 National innovative partnerships (source: Rooks and Oerlemans, 2005).

Compared to European firms, South African firms have very few national innovative partnerships. About 17% of all innovative firms have partnerships with firms in South Africa. Surprisingly, South African firms have more European partners then European firms have themselves. The network of partnering within South Africa is underdeveloped. This could mean that there simply are not enough suitable partners in South Africa.

External financial resources

The following figure shows the amount of firms that indicated they had delays in innovation projects, as well as firms, which have abandoned innovation projects, or firms that reported that projects did not start due to a lack of external financial resources. Resources like governmental institutions, banks and other investors provide those financial resources.

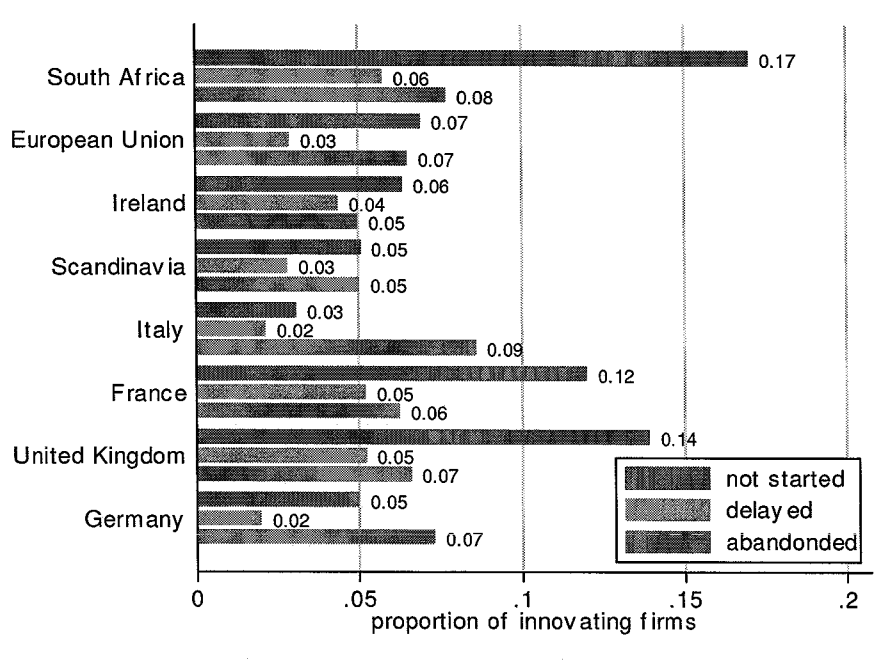


Figure 3.5 Delays or projects not started at all due to lack of external financial resources (source: Rooks and Oerlemans, 2005).

In comparison with European firms South African firms often indicate that a lack of external financial resources is a reason for the delays in innovative projects or was the reason for projects not starting at all. Financial resources seem to be scarcely available in South Africa.

Governmental regulations

Restrictive governmental regulations can also cause firms to delay innovation projects or not start them at all. Regulation can for instance entail environmental regulations, zoning plans and taxes. The following figure shows the amount of firms that indicated they experienced delays in innovation projects, abandoned innovation projects or had the situation that innovations could not start at all due to restrictive governmental regulations. These regulations can entail: 'Red tape', Intellectual property rights, Legislation on standards, Anti-trust and cooperative rules and laws.

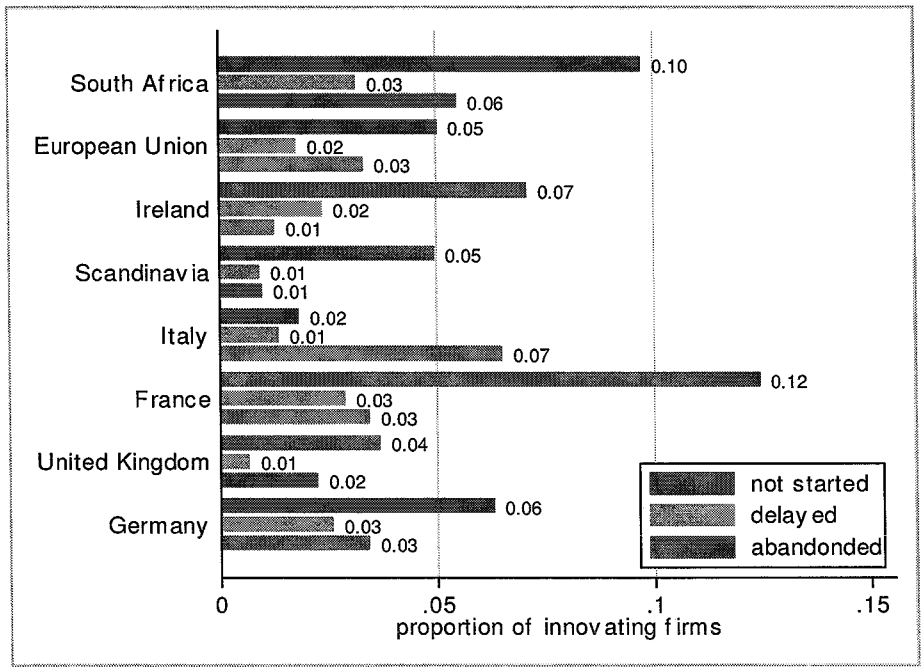


Figure 3.6 Delays or innovations not started at all due to restrictive regulations (source: Rooks and Oerlemans, 2005).

In comparison with European firms South African firms often indicate that restrictive regulations were one reason for the delay of innovative projects or was a reason that resulted in projects not starting at all.

Organizational rigidities

Internal organisational rigidities, experienced mainly in large firms, can also cause firms to experience bottlenecks in their innovation process. The process of decision-making is often a bureaucratic process in larger firms. The following figure shows the amount of firms that indicated they have had delays in innovation projects, abandoned innovation projects or found themselves in the situation that innovation projects could not to start at all due to organizational rigidities.

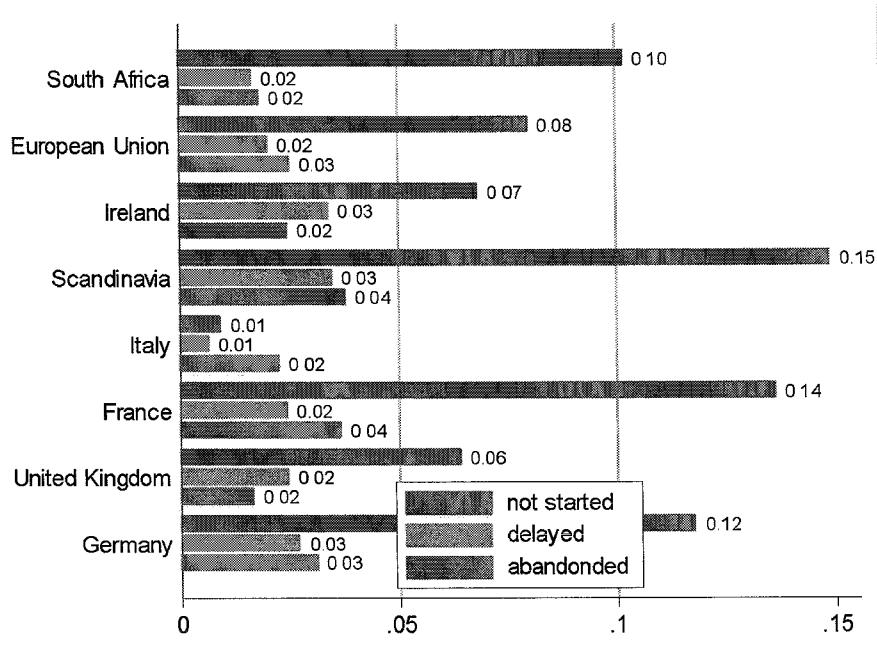


Figure 3.7 Delays or innovations not started at all due to organizational rigidities (source: Rooks and Oerlemans, 2005).

South African firms indicate that their organizations are as flexible as firms in Europe. This determinant does not support that the national system of innovation in South Africa is underdeveloped.

Summary

Rooks and Oerlemans (2005) find that South Africa has a low input of innovative expenditures and a high output of innovating firms and can therefore be regarded as efficient. South African firms indicate that their organization is flexible as firms are in Europe. However, in South Africa there is a lack of qualified personnel and a lack of external financial resources. The South African government issues restrictive regulations that have a negative influence on innovative projects.

Another finding is that in comparison with European firms, South African firms have very few national innovative partnerships. It is obvious that at least parts of the NSI of South Africa are poorly developed.

3.3. Characteristics of South African firms

With the data collected by "SAIS 2001" and "SAIS 2001 revisited" a description of the main characteristics of South African firms are given. Main economic activities and sectorial distributions of firms are discussed and also size classes and regional distributions of firms are described. This data pertains to firms in manufacturing, service industries and wholesalers with ten or more employees, which had economic activities between 1998 and 2003. Therefore this data only describes a part of the South African economy.

3.3.1. Economic activities and sectorial distribution

To categorize the main economic activities of South African firms, firms were asked in the SAIS 2001 survey to indicate the economic activity in which the highest percentage of sales were realized. Economic activities are categorized in three areas: manufacturing, service industries and wholesale. Of the 601 firms, 63% are active in the manufacturing sector, 16% are service providers and 21% are in the wholesale business.

Main economic activity	Percentage (%)
Manufacturing	63
Wholesale	21
Services	16

Table 3.3 Economic activities (source: Oerlemans et al., 2003)

Eight sectors are considered to be mainly active in manufacturing. The wholesale sector is active in wholesale and commission trade and three sectors are considered service-orientated firms. This classification is in line with the Standard Industrial Classification (SIC) system used for South African statistics and the NACE industrial classification system used in the European Union. In figure 3.8 a more detailed picture is shown.

SIC code	NACE code	Description of sector	Reedbase code	Response
30	15-16	Manufacture of food products, beverages and tobacco products	20, 21	36
31	17-19	Manufacture of textiles, clothing and leather goods	22, 23, 24	35
32	20-22	Manufacture of wood products, paper products, publishing and printing	25, 27, 28	20
33-34	23-26	Manufacture of fuel, chemicals, rubber, plastic and other non-metallic mineral products	29, 30, 31, 32, 33	90
35	27-30	Manufacture of metal products, machinery and equipment	34, 35, 36, 48, 40, 41, 42, 43, 44, 45, 46, 47, 51	126
36-37	31-33	Manufacture of electrical and optical equipment	37, 38	34
38	34-35	Manufacture of transport equipment	39	43
39	36-39	Manufacture of furniture; manufacturing n.e.c. and recycling	26, 49	26
60-61	50-51	Wholesale trade and commission trade	61, 62, 63, 64, 65, 66, 67, 68	106
71-75	60-64	Transport and Communication	72, 74, 75, 79	21
80-83	65-67	Financial Intermediation	82	17
86-88	72-74	Business services	44, 84	47
		Total		601

Figure 3.8 Sector classification (source: Oerlemans et al., 2003)

The sectorial distribution of firms in the SAIS survey is visible in figure 3.12. This figure indicates of the size of each of these three sectors in South Africa. The Sectors manufacturing metal products, those manufacturing chemicals and the wholesale

businesses are clearly the largest. These three sectors make up 55% of all firms. It must be stated however, that many firms indicated that they are involved in activities in more than one area.

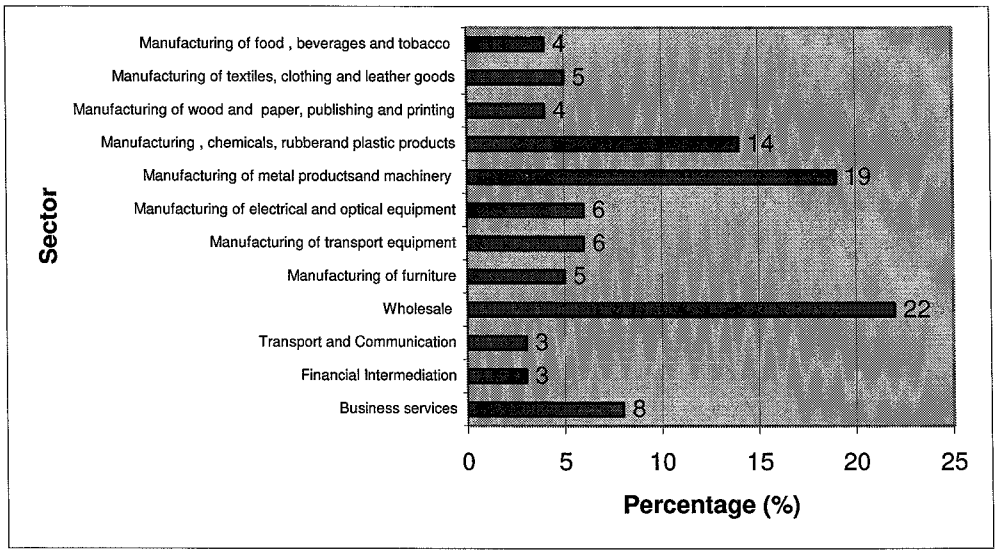


Figure 3.9 Sectorial distribution of firms (source: Oerlemans et al., 2003)

There is a large variation in sector size. The financial services sector represents 3% of the total response and the wholesale sector represents 22%.

3.3.2. Size class distribution

The majority of firms, 68%, have less than 50 employees, i.e. they are classified as small firms. 25% of all the firms have between 50 and 250 employees; and 5% of firms have 250 to 500 employees. Only 2% have 500 or more employees, and this grouping refers to the so-called large enterprises.

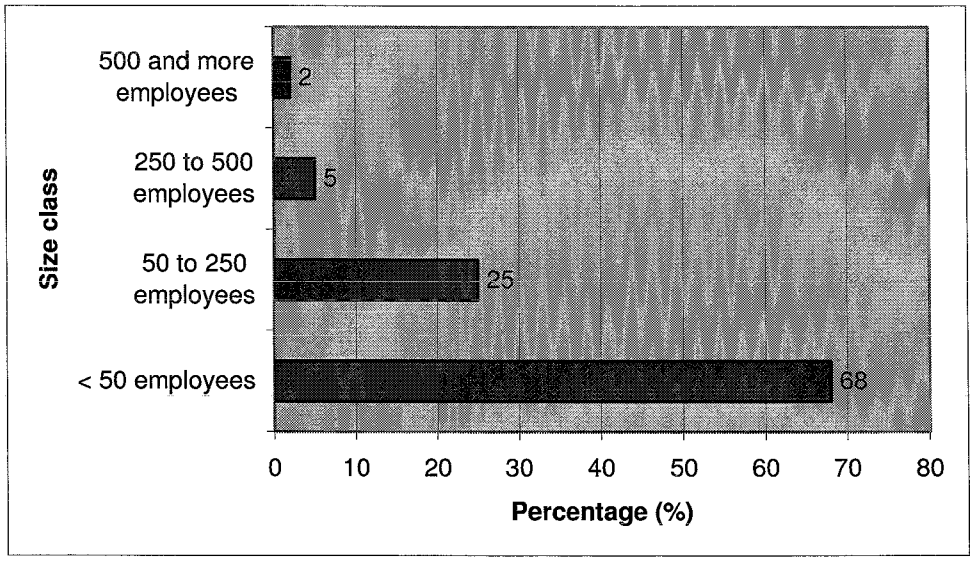


Figure 3.10 Size class distribution (source: Oerlemans et al., 2003)

3.3.3. Regional distribution

For the regional distribution South Africa is subdivided in its provinces. Economic activity is concentrated in a few areas in South Africa and therefore the regional distribution is divided in five regions: the four main provinces, with most economic activity and the remaining five provinces grouped as one region. These regions are:

- *Gauteng.* 66% of all the firms are operating in the Gauteng province. Johannesburg and Pretoria are big economic centres and are both located in this province.
- *Western Cape.* 13% of the firms are located in the Western Cape province, were in Cape Town the main activity is concentrated.
- *Kwazulu-Natal.* In Kwazulu-Natal province 12% of the firms are situated in and around Durban and Pietmaritzburg.
- *Eastern Cape.* In the Eastern Cape province 4% of the firms are located in and around Port Elizabeth.
- *Remaining provinces of South Africa.* The remaining 5% are spread out in the following provinces: Freestate, Northern Cape, Mpumalanga, Limpopo and North West province (see Figure 3.11).

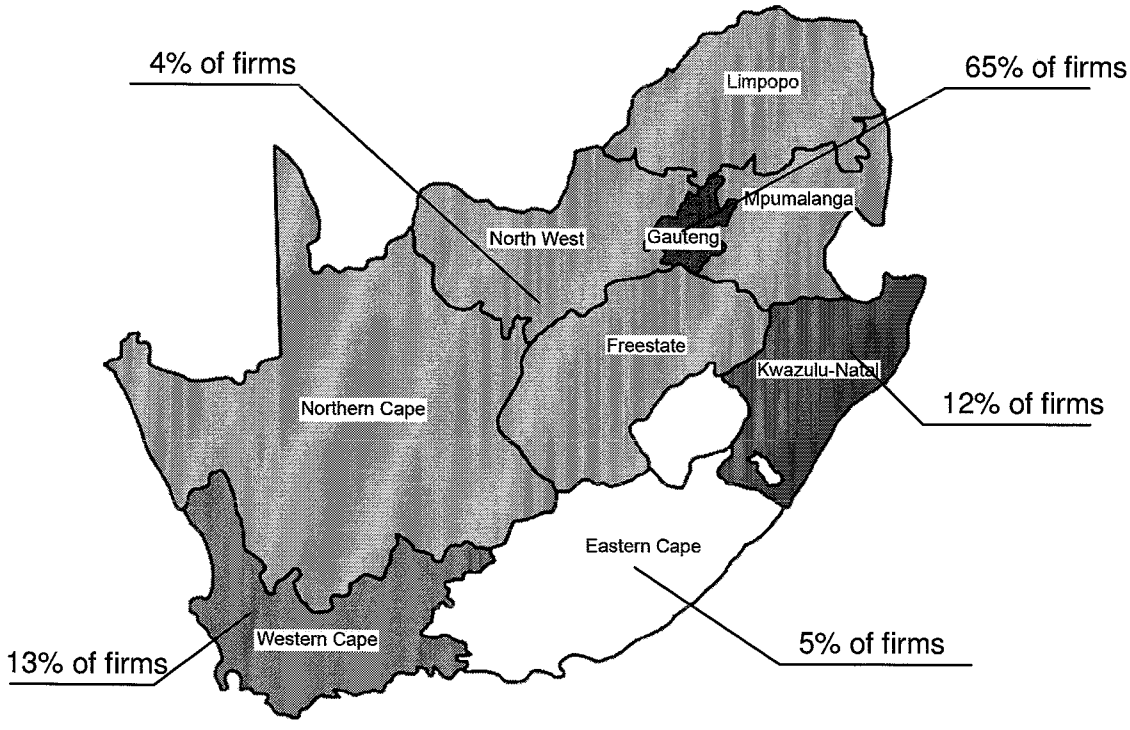


Figure 3.11 Regional distribution.

4. Methods

This chapter describes the data collection method employed to execute three research projects done on innovation in South Africa. The focus of these studies was to indicate what the status and impact of innovation is in South Africa. The following three sub-studies can be distinguished: (a) The effects of innovative partnerships, (b) innovation and job creation as well as (c) innovation regarding business performance. Chapter four has been written by Ronnie van de Thillart, Bernard de Veer and Robbert Westerhuis. The SAIS 2001 survey done in South Africa, forms the basis for this research project and it is discussed in paragraph 4.1. Further paragraphs discuss data collection and the responses (4.2), validation of data (4.3) to obtain the necessary data for the three research projects.

4.1. SAIS 2001

In 2001 a joint research group was formed between the *Department of Technology and Management* from the Eindhoven University of Technology in The Netherlands, together with the *Department of Engineering and Technology Management* from the Universiteit of Pretoria in South Africa. Their purpose was to give a comprehensive overview of the innovative behaviour and performance of South African firms in manufacturing and services sectors during the period 1998-2000. By means of a survey, data was collected from firms in the manufacturing, service and wholesale sector. This survey, the "South African Innovation Survey 2001" (SAIS 2001) was modelled on the European Community Innovation Surveys (CIS). The CIS was first employed in European countries from 1994 with the intention to gather information about innovative behaviour of European firms. In the years 1997 (CIS II) and 2002 (CIS III) the CIS was repeated.

The SAIS 2001 is based on CIS II and therefore the CIS can be seen as the foundation of standardization in this innovation survey. This standardization makes it possible to compare European results with South African results. The SAIS 2001 survey is the basis for this research.

4.1.1. Population and coverage error

The population in the SAIS 2001 was defined as:

> *All South African firms in manufacturing and service industries with ten or more employees that conducted economic activities in the period 1998-2000.*

Industrial sectors covered were: manufacturing, wholesale and commission trade, transport, storage, communications, financial intermediation and business services. This classification is in line with the Standard Industrial Classification (SIC) system used for South African statistics and the NACE industrial classification system used in the European Union. These firms were randomly selected from the Reedbase database, which consists of 16,931 firms with a known number of employees. The Reedbase is a commercial database and firms have to pay to be included. Therefore

the database does not reflect the true size-distribution of South African firms. In South Africa public databases are not yet available. The Manufacturing Census 1996 contains precise information about the distribution of size groups of the manufacturing firms in South Africa. By comparing Reedbase with the Manufacturing Census 1996 database, it was found that small firms were underrepresented in the Reedbase database (table 4.1). This is called the "coverage error". No information about the coverage error of the service sector was known. The coverage error for the manufacturing sector was used to correct the size distribution in the service sector. To address discrepancies the population figures of the acquired data were weighted. The information is now representative for the South African industry firm size distribution. The findings now "accurately describe innovation and innovative activities of South African business life" (Oerlemans et al., 2003).

Stratified sampling was used as the sampling technique. In comparison with straightforward sampling techniques, stratifying can reduce a sampling error. The European CIS was divided in the same strata and their design was proven successful. It also improves the comparability of the SAIS with the CIS.

Size classes	Census 1996	Reedbase
10-49	66%	43%
50-249	26%	38%
250-499	5%	8%
>499	3%	11%
Total	100%	100%

Table 4.1 Comparison between Census Manufacturing 1996 and Reedbase (Source: Oerlemans et al., 2003).

The SAIS 2001 population was divided into three strata (see table 4.2): (1) firms with 11 to 20 employees, (2) firms with 21 – 50 employees and (3) firms with more than 50 employees. The numbers of firms fitting in these strata is also presented, together with the mean number of employees.

Stratum	Number of firms	Mean number of employees
11-20 employees (n_1)	2166	15.99
21-50 employees (n_2)	4611	35.04
More than 50 employees (n_3)	3656	769.59

Table 4.2 Stratum size, number of firms and mean (Source: Oerlemans et al. 2003).

Out of these three strata respectively 768, 2606 and 3665 firms were randomly selected. This means that the total sample consisted of 7039 firms. The distribution is resumed in table 4.3.

Stratum	N_l	Sample size
n_1	2,166	768
n_2	4,661	2,606
n_3	3,665	3,665
Total	10,492	7,039

Table 4.3 Distribution of sample size (Source: Oerlemans et al., 2003).

4.1.2. Response and non-response SAIS 2001

To collect the required information, questionnaires were mailed to the managing directors of the firms. The questionnaire was accompanied with an introduction letter by the research team and a recommendation letter written by Dr. B.S. Ngubane. At that time Dr. B.S. Ngubane was Minister of the former Department of Arts, Culture, Science and Technology of South Africa. There was also an option for respondents to complete the questionnaire on the SAIS 2001 website. The survey started in December 2001. Because of a very low response rate the research team decided in May 2002 to change the data collection strategy. The postal surveying method was stopped and direct surveying methods were chosen. The research assistants continued the survey with telephonic interviews and by sending e-mails. Eventually 601[6] of the 7,339 firms returned the questionnaire. This corresponds with a response rate of 8.2%. Small firms responded slightly below expectation. This is shown in table 4.4.

Size class	Frequency Response	Percent Response	Percent Sample	Difference
< 50 employees	226	36.7	42.7	-6.0
50 to 250 employees	234	38.0	37.9	+0.1
250 to 500 employees	62	10.1	8.3	+1.8
500 and more employees	94	15.3	11.1	+4.2
Total	616	100.0	100.0	
Missing	1		0.0	
Total	617		(n=7339)	

Table 4.4 Size classes, Distributions of response and sample (source: Oerlemans et al., 2003)

In spite the fairly high amount of absolute responses the relative amount of firms that responded, is rather low. To make sure that there was no structural error in the response, a Non-Response Survey was carried out. This was done to examine if the firms who cooperated could be regarded as representative for the South African business community.

The size of the non-response sample was based on the Dutch CIS (1994) non-response survey. 5% of their sample size was used for the non-response survey. If this percentage is applied to the SAIS 2001 non-respondent sample, 320 non-respondents should be selected. Eventually 416 firms responded, what corresponds with 129% of the target value.

[6] In SAIS 2001 617 firms filled in the survey. Information from four firms was lost and after data verification twelve duplicates were found.

The respondents were asked three questions:

1. Why they did not complete the questionnaire
2. The continuity of Research and Development activities
3. Whether or not a firm had technological innovations in the period 1998-2000.

The answers of the first questions, which were given by the respondents, are shown in table 4.5. More than 50% of the firms mentioned that they did not receive the survey. A possible explanation is that the questionnaires were sent to the managing directors of the firms, while the respondents of the non-response survey had other positions in the firm and hence never saw the questionnaire. Lack of time was frequently mentioned as a reason for not filling in the questionnaire. Another reason was that 'I never fill in questionnaires' (3%), or it is of 'no use for the company' (5%) and 'other reasons' (7%).

Reasons mentioned for not responding (more than one answer possible)	Number of times reason was mentioned	Percentage of non responding firms that gave reason
Did not receive questionnaire	215	52%
I never fill in questionnaires	11	3%
No use for the company	20	5%
Lack of time	137	33%
Other reasons	33	7%

Table 4.5 Reasons for non-response to the SAIS 2001 survey (source: Oerlemans et al., 2003)

The answers on the second question are shown in table 4.6. This question was about the continuity of Research and Development activities in responding and non-responding firms. The response and non-response group hardly differ and a statistical test (the Mann-Whitney U-test) shows that it could be assumed that the groups are identical with respect to the continuity of their R&D activities (p=0.46).

Continuity of R&D	Response group	Non-response group
More or less continuously R&D	196 (37%)	164 (40%)
Occasionally R&D	154 (29%)	119 (29%)
Not conducting R&D	178 (34%)	132 (31%)
Total	528 (100%)	415 (100%)

Table 4.6 R&D activities for the response and the non-response group (source: Oerlemans et al., 2003)

The answers to question three is shown in table 4.7. This question was about whether or not a firm had any technological innovations in the period 1998 – 2000. In spite of the fact that the differences are somewhat larger, the non-response group contains more innovators (58%) than the response group (54%), the difference is not statistically significant (p=0.17).

Technological innovations between 1998-2000	Response group	Non-response group
Yes	319 (54%)	241 (58%)
No	277 (46%)	175 (42%)
Total	596 (100%)	416 (100%)

Table 4.7 Technological innovations; response and the non-response group (source: Oerlemans et al., 2003)

The conclusion of the non-response survey was that the information obtained via the SAIS 2001 gave a true reflection of the South African industry.

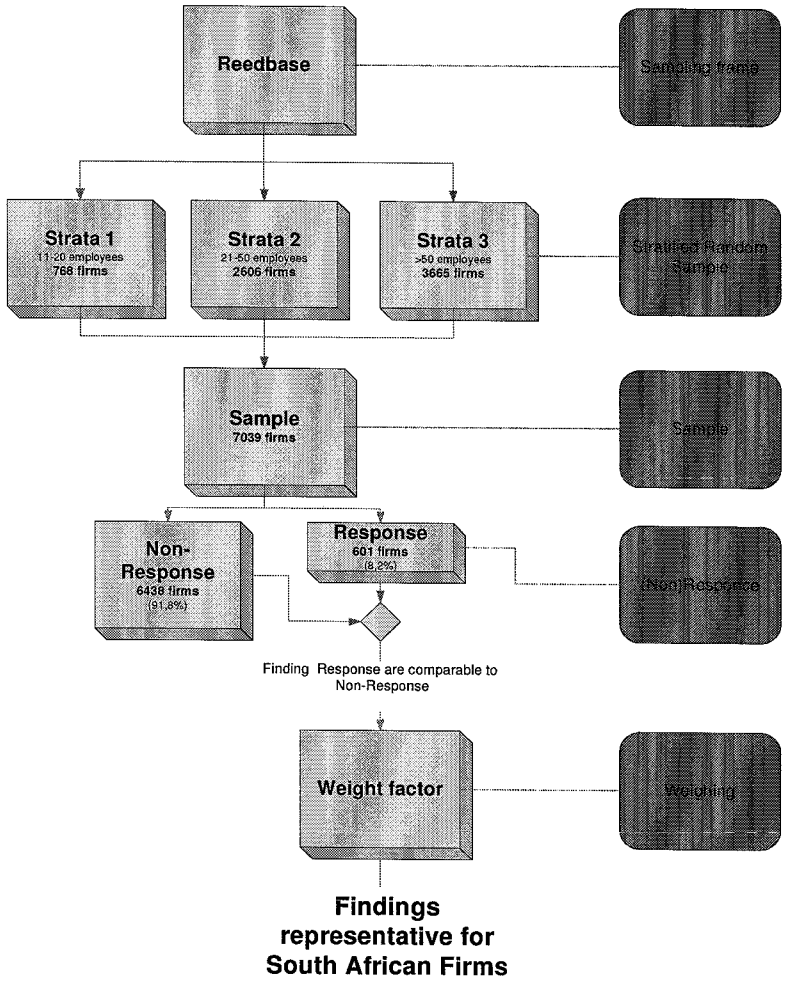


Figure 4.1 Coverage error and strata

All steps concerning the data collection and response are summarized in figure 4.1. Figure 4.1 visualizes the methods used, from the sampling frame to the weighing of the results.

4.2. Data collection and response "SAIS 2001 revisited"

Data collected in the survey of 2001 was complemented with new data. A short version of the SAIS 2001 was repeated in 2004 under the name "SAIS 2001 revisited". The firms that cooperated with the SAIS 2001 were asked for their cooperation again. The fact that the research has two points in time where data was collected makes the research a longitudinal design. More specifically this research

can be viewed as a panel-research. This is a type of longitudinal study that uses the same research units, in this case the 601 firms of SAIS 2001, at different points in time.

The big advantage of a longitudinal survey design is that it opens opportunities to make statements on causal relations since the same firms are included in the dataset (Breakwell, Hammond and Fife-Shaw, 2000). However, a longitudinal survey has some disadvantages. The main problem is the danger of a low response mainly caused by two factors. The first is the "drop out" of firms. Many firms will have left the market due to a bankruptcy or will have merged or changed making the firm incomparable to the previous situation. Secondly there may be a danger for a low response if respondents are unwilling to cooperate a second time. The response "Once is fine, but not more" is often heard in a longitudinal research. The other major disadvantage is the risk of a biased sample. Firms who cooperate in the same survey more than once, may be interested in the topic, or may be more compliant, or may have specific characteristics, which result in a biased sample. Therefore a high response rate is very important. The last disadvantage is the fact that the anonymity of respondents cannot be claimed since you will need to have some way of identifying respondents for re-contacting (Seale, 2004). It is evident that a high response in a longitudinal research is of great importance.

To gather the required information a telephone-based questionnaire was composed. A telephone-based questionnaire was used since earlier researches with written questionnaires did not give the expected results. In a related study, Roy Clerx experienced great difficulties in gathering responses on his written questionnaire (Clerx, 2005). Three explanations for this low response can be distinguished. The first is the fact that written questionnaires are a passive data collection method. The researcher is not actively persuaded to respond to the survey. Secondly, the written questionnaire consisted of too many topics and questions. Thirdly, there is a corporate atmosphere in which surveys are badly accepted. SAIS 2001 also used a written questionnaire where eventually 8.4% of the firms cooperated. The same explanations for the low response hold for the SAIS 2001 survey. Additionally, November (time of data collection SAIS 2001) is an awkward month in the year for data collection since summer holidays in South Africa are in December.

During a telephone based survey, interactive communication is possible. The interviewer can emphasize the importance of the survey to win someone over. The expectation was that this method would obtain a higher response rate than with a written survey.

Since there was no time or resources to repeat the entire research, and in an attempt to obtain higher number of responses, the number of questions in SAIS 2001 revisited was limited to 9. This low number of questions also limits the time a respondent had to complete the survey. The questions were relatively easy to answer and the survey could be completed within 5 minutes. This encouraged respondents to cooperate.

The data collection started in the beginning of September 2004, and was divided into 4 steps:

- Step 1: Verifying firm contact information
- Step 2: Composing a survey framework
- Step 3: Data collection
    - 3.1: Telephone based questionnaire
    - 3.2: Written questionnaire
    - 3.3: Covering letter
- Step 4: Analysing results

4.2.1. Step 1: Firm contact information

Before the start of SAIS 2001 revisited, all the firms' contact information had to be verified. Some firms were marked as "non-existent" because the company names had changed, or contact details had changed (i.e. telephone numbers or addresses). General information about all the firms were checked and, where necessary, updated. This was done with the use of three different databases: the Braby's Red Disc database on CD-ROM, the South African Yellow Pages internet site[7], and the Worldwide Kompass internet site[8]. These databases were used to complement and update the SAIS 2001 database as much as possible. If phone numbers could not be retrieved with these databases they could be updated using the South African telecom provider TELCOM. Calling a service number of TELCOM provided access to the best-updated database concerning telephone numbers. This was however so inefficient and time consuming that the three methods above were first exhausted.

4.2.2. Step 2: Survey framework

Since difficulties were expected in retrieving high responses, a considerable amount of time was invested in composing a survey framework. In this framework the procedure is drawn up to make first contact with the contact person. In figure 4.2 and 4.3 the telephonic procedure is presented.

[7] www.yellowpages.co.za
[8] www.kompass.com

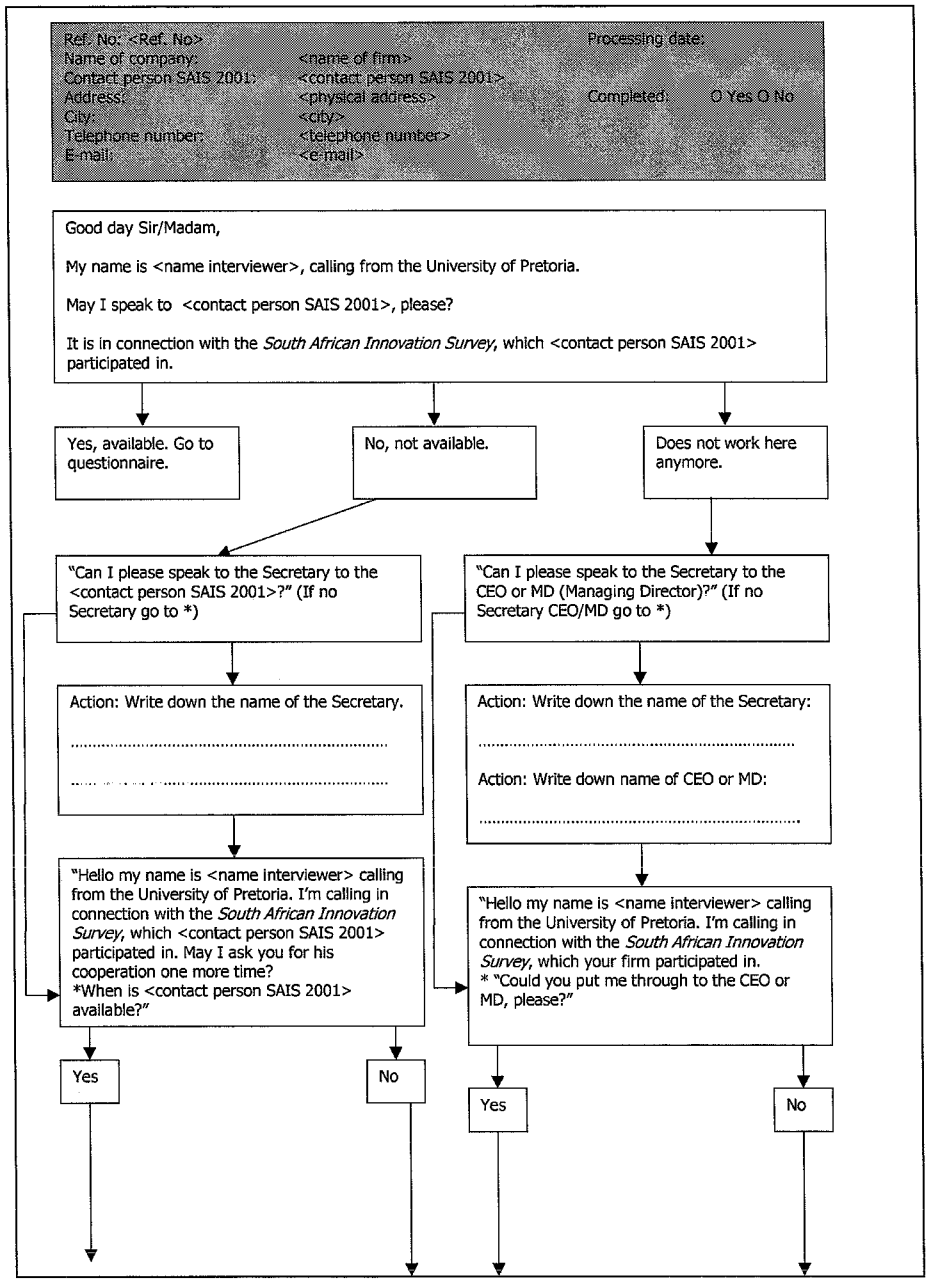


Figure 4.2 Telephonic framework (1)

A considerable amount of time was invested in first making contact with the respondent using the SAIS 2001 list. Most of the times the caller was put through to the personal assistant (secretary). The personal assistant was asked for the availability of the respondent to make an appointment for further contact. The respondent was unavailable on the first call in most circumstances (70% of all calls). If the respondent of SAIS 2001 was no longer with the firm, the CEO or Managing Director was contacted via his or her personal assistant. In 10% of the calls this method was used. This means that in only 20% of first calls, first contact with the right respondent was made. On average a firm was called 3 times. The greatest portion of time was invested in making contact with the respondents.

As a result of the first call the respondents name was known and also his or her availability. This resulted in many responses in the second and third call. Sometimes

personal assistants requested a questionnaire by e-mail or fax. The decision was made to give respondents this opportunity. In this way the respondent could complete the questionnaire at his or her own leisure. If all attempts fail to get the required responses by phone, e-mail and fax based questionnaires (written questionnaire) were also offered.

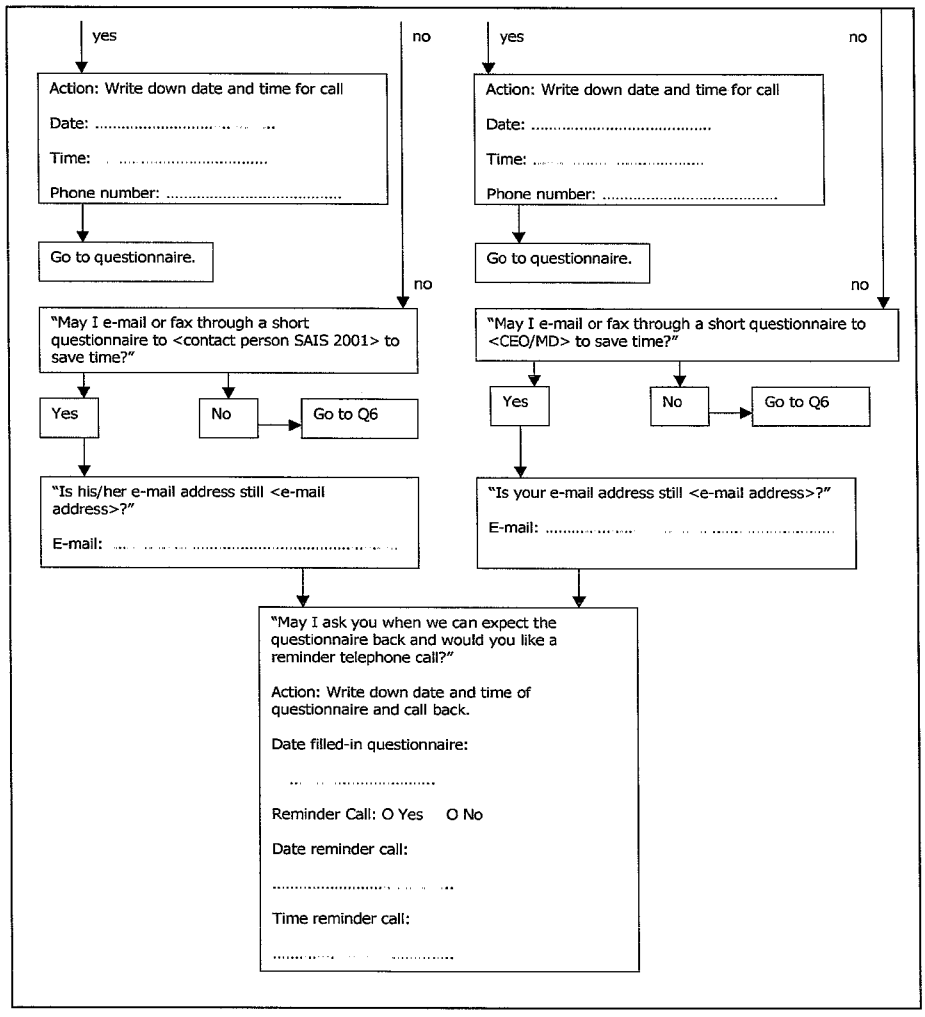


Figure 4.3 Telephonic framework (2)

To prevent that the written questionnaire would be 'forgotten', a reminder telephone call was scheduled. A spreadsheet with firms that had to be called back, firms that were mailed, firms that were faxed and firms that completed the questionnaire was updated continually.

4.2.3. Step 3: Data collection

The telephone-based questionnaire was always the preferred way of collecting the data. E-mail- or fax based questionnaires were used reluctantly. These questionnaires did not have the advantages of interactive communication.

Telephone-based questionnaire

Composing a questionnaire that provides sufficient information to base three researches on and restricting the questionnaire to only 9 questions provided some challenges. Selections had to be made to restrict the number of questions to a bare minimum. In this paragraph the questions in the questionnaire will be elaborated one by one.

Introduction

The interviewer starts by introducing him- or herself and clarifies the importance of the research (see figure 4.4). The respondent is reminded about their former cooperation with SAIS 2001 and that the final report of that research was presented to the Minister of Science and Technology at that time. This may persuade him or her to participate once again.

The interviewer asks if this is a convenient time to complete the questionnaire. If this is not the case, a telephonic appointment can be made at a later time.

Good day Sir/Madam,

My name is *<name interviewer>*. I am a member of a joint research team [from the Department of Engineering & Technology Management,] from the University of Pretoria and the University of Eindhoven from the Netherlands. A few years ago you *<contact person>* cooperated with the SAIS2001 research. This SAIS 2001 report was presented to the Minister of Science & Technology.

As a sequel to the SAIS2001 research we explore to what extent innovation has contributed to economic development and employment growth in South Africa. For this reason we are doing a short telephone based survey. Because of your cooperation on the first research, your response is exceptionally valuable.

Q: "May I ask you 8 short questions for this research?" (Yes, go to questionnaire. No, "Can I call you back at another time?")

No: "Or would you prefer to receive an e-mail or fax to complete the survey at your leisure?"

If e-mail preferred: "Is your e-mail address still *<e-mail address>*?"

If fax preferred: "What is your fax number, please?"

Figure 4.4 Introduction phone based questionnaire

Employment

The goal of question 1 is:

- To determine the number of employees in 2003.
- To double-check the number of employees in 2000.
- To determine the reason for the employment changes and the education levels where this change mainly occurred.

Verifying answers of the SAIS 2001 survey was an important tool to acquire valid longitudinal information. This contributed to a higher quality of obtained data. Some respondents give information that only concerns a part of the firm (division or department), which makes a comparison between 2000 and 2003 impossible. An example of the verification of answers is visible in question Q1b. To make sure that employment increased or decreased between 2000 and 2003, the respondent was

confronted with the number of employees that was indicated in 2001. The respondent can verify this data on the spot or revise it.

"First I would like to verify some firm specific data. Is your firm still located at *<address>* in *<city>*?"

Q1a: What was the number of employees in your firm in 2003?

Q1b: "In your response to the SAIS 2001 survey you indicated the number of employees to be *<number of employees 2000>* in the year 2000.

Is it correct that there is an increase/decrease trend in employment? Could you indicate a clear reason for this employment change?"

Q1c: "Did this trend occur at all education levels? (lower education/operator level, Medium education/supervisor level and higher education/level-jobs?)"

Figure 4.5 Q1 phone based questionnaire

Innovativeness

Question 2 referred to the innovativeness of firms concerning products and services. The following questions were asked.

Question Q2a was asked to assess what percentage of firms can be considered to be innovative in 2003. It cannot be used to distinguish trends in innovative performance since the same questions in SAIS 2001 were asked over a period of 3 years. To distinguish this trend the innovative sales figures of question Q2c was used. The last question was asked to determine whether the innovation was not only new to the firm, but also new to the market.

Q2a: "Did your firm introduce any technologically new or improved products or services in 2003?"

No → go to 3

Q2b: "Were these "step-by-step" changes or "drastic changes" in your product or services?"

Q2c: "What is the sales percentage of/from the drastically changed products or services in 2003?"
"What is the sales percentage of/from the step-by-step changed products or services in 2003?"

Q2d: "Where these products/services new to the market? Or have competitors already introduced such products?"

Figure 4.6 Q2 phone based questionnaire

Question 3 refers to the innovativeness of firms concerning process innovation.

Q3: "Did your firm introduce any technologically new or improved production processes in the period 2003?"

Figure 4.7 Q3 phone based questionnaire

Economic performance

To establish the economic performance of firms the total sales of the year 2003 was asked. Again the information of SAIS 2001 was verified. Information on sales can be confidential and managers are often reluctant to disclose this information, especially

over the phone. Therefore the respondent was offered the opportunity to limit the supplied information to indicate an increase or decrease percentage of sales growth.

> The next few questions concerns the economic performance of your firm.
>
> Q4: "What were the total sales in 2003?"
>
> In SAIS 2001 you indicated that the total sales of your firm were <total sales 2000>. It is correct that there is an increase/decrease trend in sales?"
>
> Or if you don't have the figures off hand would you say there was an increase or decrease in sales over the last 3 years? Could you indicate this as an percentage?"

Figure 4.8 Q4 phone based questionnaire

The second measure of economic performance, more specific the performance on foreign markets, was determined with the export ratio of firms.

> Q5: "What were the exports as a percentage of total sales in 2003?"
>
> In SAIS 2001 you indicated that export, as a percentage of total sales of your firm were <export 2000>% in the year 2000. It is correct that there is an increase/decrease trend in exports?"
>
> Or if you don't have the figures off hand would you say there was an increase or decrease in exports over the last 3 years? Could you indicate this as an percentage?"

Figure 4.9 Q5 phone based questionnaire

Conclusion

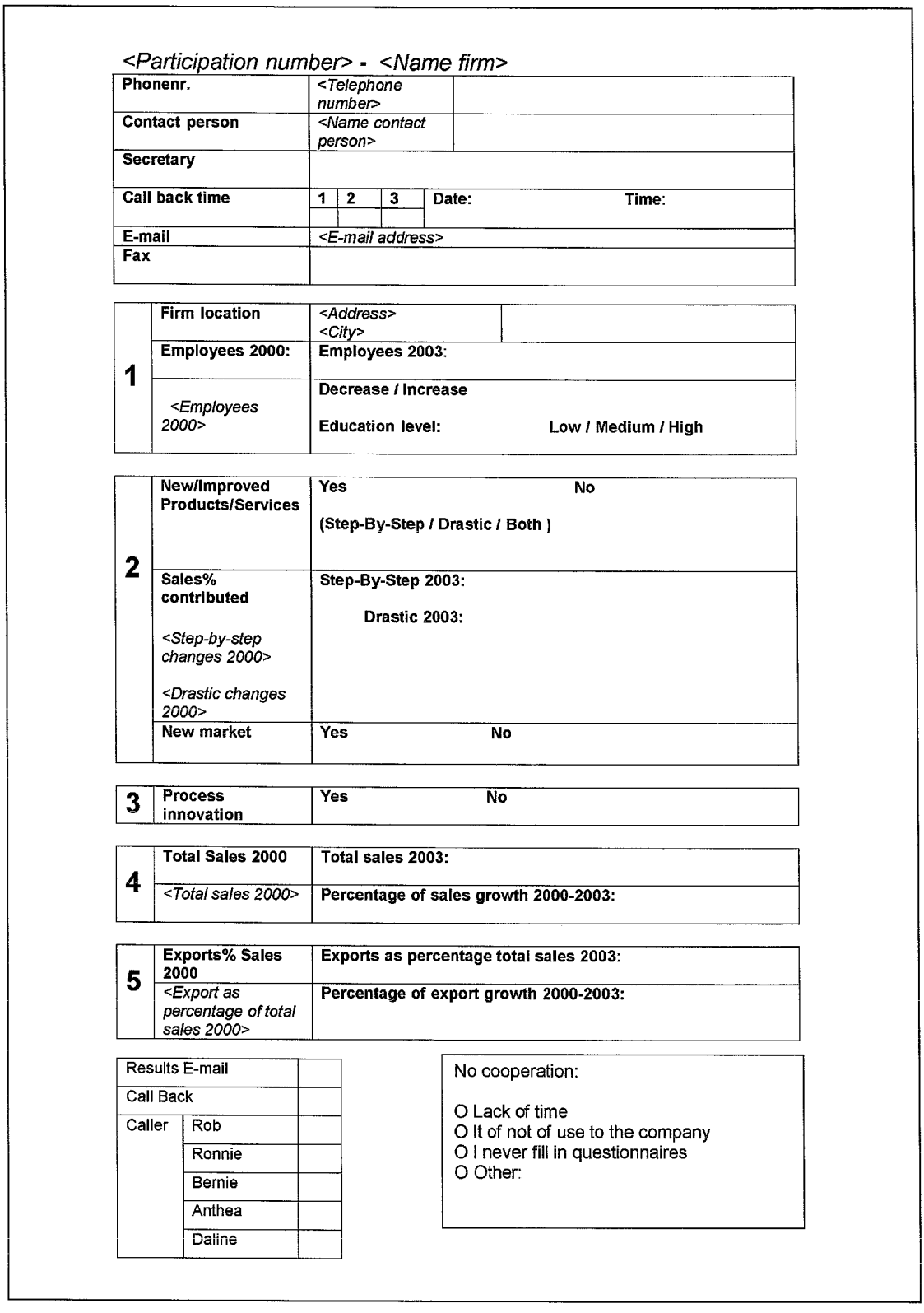
Finally the respondent was thanked for there time and the assurance was given that all information provided would be handled confidentially. Question 6 was asked if the respondent was not willing to cooperate with the survey.

> This was the last question. I would like to thank you for your cooperation on behalf of the department technology management of the university of Pretoria! Finally I would like to reconfirm that the provided data will be dealt confidentially. Would you like to receive an e-mail with the results of the research?
>
> Q6: Would you kindly state why you do not want to cooperate with the survey?

Figure 4.10 Q6 phone based questionnaire

One standard datasheet was composed to gather the notes and answers from a firm.

The firm's phone number and name was printed on top of the sheet. As has been said previously, firm information from the year 2000 was verified during the interview. Therefore this information was also printed on the datasheet. Inserting the firm specific information in the standard datasheet was a fully automated process. By linking Microsoft Word and Microsoft Excel, the firm specific information out of an Excel database was automatically inserted in the Microsoft Word datasheet. A couple of advantages accompany this method. All information of a particular firm was on one sheet. Using one sheet was also labour saving.



<Participation number> - <Name firm>

Phonenr.	*<Telephone number>*	
Contact person	*<Name contact person>*	
Secretary		
Call back time	**1** **2** **3** **Date:** **Time:**	
E-mail	*<E-mail address>*	
Fax		

1	**Firm location**	*<Address>* *<City>*	
	Employees 2000:	**Employees 2003:**	
	<Employees 2000>	**Decrease / Increase** **Education level:** **Low / Medium / High**	

2	**New/Improved Products/Services**	**Yes** **No** **(Step-By-Step / Drastic / Both)**
	Sales% contributed *<Step-by-step changes 2000>* *<Drastic changes 2000>*	**Step-By-Step 2003:** **Drastic 2003:**
	New market	**Yes** **No**

3	**Process innovation**	**Yes** **No**

4	**Total Sales 2000**	**Total sales 2003:**
	<Total sales 2000>	**Percentage of sales growth 2000-2003:**

5	**Exports% Sales 2000**	**Exports as percentage total sales 2003:**
	<Export as percentage of total sales 2000>	**Percentage of export growth 2000-2003:**

Results E-mail		
Call Back		
Caller	Rob	
	Ronnie	
	Bernie	
	Anthea	
	Daline	

No cooperation:

O Lack of time
O It of not of use to the company
O I never fill in questionnaires
O Other:

Figure 4.11 Datasheet

Written questionnaire

Not all respondents were willing or able to provide the data by phone. If requested there was a possibility to complete the questionnaire by use of e-mail or fax. This means that data of SAIS 2001 could not be verified on the spot. The survey on paper therefore differs slightly from the telephone-based version. In the fax and mail

questionnaire three methods were used to verify the data supplied. Employment figures were checked by asking for the exact number of employees and than asking if there was an increase of decrease of employment over the last three years. The same was done with sales and export data. If the provided growth figures differed to the calculated growth figures between SAIS 2001 and SAIS 2001 revisited, the firm was contacted a second time. This manner allowed researchers to address discrepancies in the data.

E-mails were sent from one specially made E-mail address (SAIS2004@up.ac.za). In this way all responses were gathered centrally. The same was done with faxes. All faxes were sent by computer allowing faxes to be easily traced. The e-mail questionnaire is included in Appendix B. The time and the date of sending were monitored. If a firm did not respond in one week, the firm was approached a second time. The setup of the fax and e-mail, the professional way of approaching the firms and keeping up the pressure in case of non-response, lead to a contribution of many responses. The data collection started in the beginning of September and was concluded in November 2004.

Covering letter

If requested, a covering letter was sent to the respondent from the Head of the Department of Engineering and Technology Management. The covering letter gives the respondent the possibility to verify the information provided by a caller. It also describes the background and importance of this research. The letter is signed by the professor to emphasize the validity of this document. The covering letter is included in Appendix A.

A covering letter was also included with the fax and mail questionnaires. The covering letter is available in different formats to suit the respondent's wishes (Microsoft Word, PDF and fax).

4.2.4. Step 4: Response and non response

Of the 601 firms, 16 could not be traced because of a lack of contact information and 19 firms had gone out of business between 2000 and 2003. That left 566 firms who were able to respond to the questionnaire. The response was high, 97.7% of the firms responded. The choice for a telephonic survey turned out to be the right one. 80% of the responses were contributed by the telephonic survey. And 17.7% by e-mail and fax surveys. That means that only 13 firms indicated that they did not want to cooperate. In 80% of instances the reason for the non-cooperation was a lack of time. Other reasons were 'I never fill in questionnaires' (5%), it is of 'no use for the company' (5%) and 'other reasons' (10%).

13 firms merged with other firms or were taken over. These firms will not be a part of the data analysis, since data from 2003 cannot be compared with the situation in 2000. An overview of all this information is visible in figure 4.12.

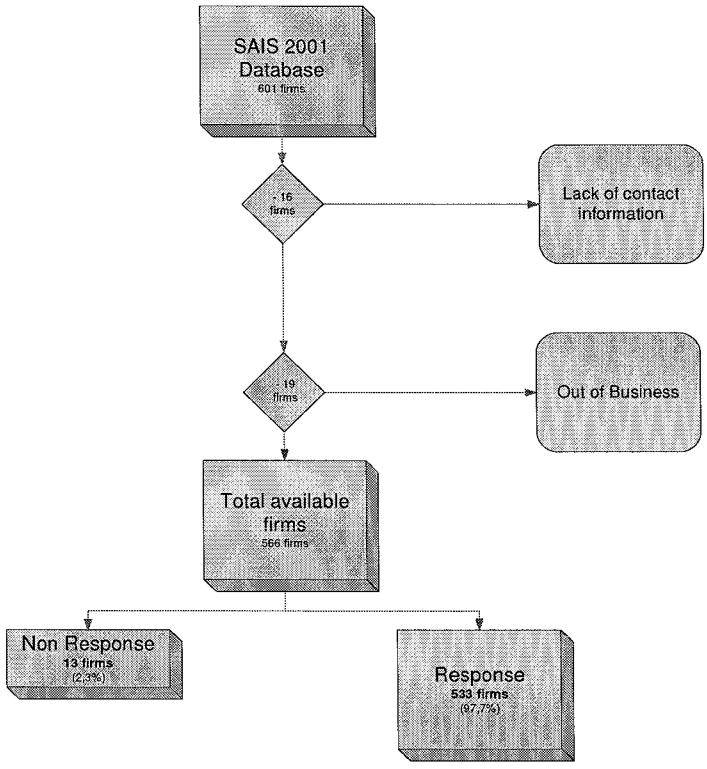


Figure 4.12 Response rate

All the firms provided data, which had to be inserted in an excel database. During this process copy failures had to be reduced to a minimum. Therefore a Microsoft Access form was designed as illustrated by Figure 4.13. It made the data import simpler, failures were reduced and afterwards the verification was easier.

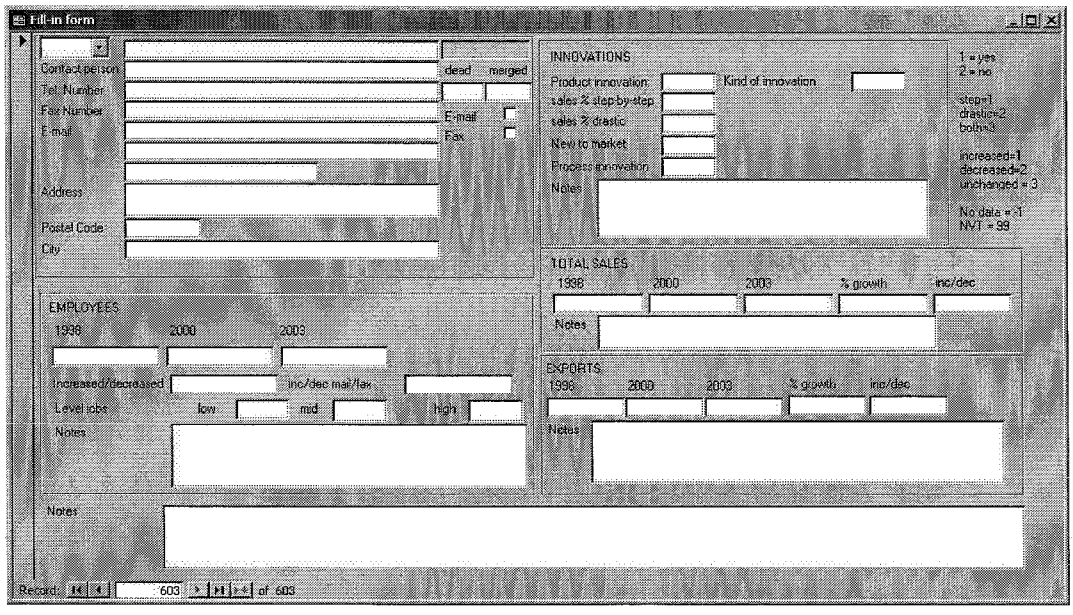


Figure 4.13 Access data sheet

After finishing the data entry and the data verification, the Access data could be easily converted to an excel database.

4.3. *Validation of data*

With the data collected by 'SAIS 2001' and 'SAIS 2001 revisited' a description of the main characteristics of South African firms are given. The obtained data will be compared with national South African means according to Statistics South Africa. This will give an interpretation of the validity of the data and the latter conclusions.

4.3.1. Employment

Employment figures are available for the years 2000 and 2003. This data is obtained from the SAIS 2001 survey and the "SAIS 2001 revisited" survey. With this data employment growth over this period can be calculated. This was done for all firms combined, per sector and per size class.

Sector	Employment growth between 2000 and 2003	Annual % employment growth	Annual % employment growth[9]
Manufacturing	4.4	1.46	
Food, beverages & tobacco	0.1	0.03	--
Textiles, clothing & leather products	-1.0	-0.3	--
Wood and paper (products) & publishing	15.6	5.2	--
Chemicals, rubber and plastic products	-0.4	-0.13	--
Metal product, machinery, and equipment	7.1	2.3	--
Electrical & optical equipment	10.1	3.4	--
Transport equipment	11.2	3.7	--
Furniture, and n.e.c.	-6.6	-2.2	--
Wholesale	4.1	1.3	--
Services	0.25	0.1	--
Transport and communication services	26.9	8.9	--
Financial intermediation services	14.3	4.7	--
Business services	-11.4	-3.8	--
Total	3.8	1.2	1.2

Table 4.8 Employment Growth.

Between 2000 and 2003 a yearly employment increase of 1.2% is found. These figures correspond with the Statistics South Africa (StatsSa, 2002). In the survey of 2002, employment in the measured component of the formal non- agricultural business sector increased by 1.2% between December 2001 and December 2002 (Statistics South Africa, 2002). The StatsSa survey is a cooperation between Statistics South Africa, the citizens of the country, the private sector and government institutions [9].

4.3.2. Sales

In 2001 and in 2004 firms were asked to indicate the total sales of their firm of the previous year at the year-end. From this data growth figures can be calculated between 2000 and 2003. The total sales growth of all firms, per sector, per size class and economic activity is calculated.

[9] Statistics South Africa. Source: www.statssa.gov.za

Total sales increased between 2000 and 2003 with 8.6% each year. This is comparable with the findings of Statistics South Africa[10]. Between 2000 and 2003 total sales per month of the manufactured products of all manufacturing firms went from R47.936.871 in December 2000 to R60.825.214 in December 2003 (StatSa, 2003). This means a growth of 26.9 % between 2000 and 2003, and a yearly growth of 8.9%. In this research the firms in manufacturing increased sales with 8.8% on a yearly basis.

Sector	Annual % Sales growth (2000-2003)	Annual % Sales growth per economic activity (2000-2003)	Annual % Sales growth per economic activity (2000-2003)[10]
Manufacturing	26.4	8.8	8.9
Food, beverages & tobacco	5.9		
Textiles, clothing & leather products	4.1		
Wood and paper (products) & publishing	12.5		
Chemicals, rubber and plastic products	8.5		
Metal product, machinery, and equipment	9.1		
Electrical & optical equipment	12.5		
Transport equipment	10.3		
Furniture, and n.e.c.	8.3		
Wholesale	31.8	10.6	--
Services	15.4	5.1	--
Transport and communication services	3.2		
Financial intermediation services	5.7		
Business services	5.2		
Total	8.6	8.6	--

Table 4.9 Sales Growth.

4.3.3. Exports

Export is an important factor to assess the performance of an organisation in foreign markets. Firms were asked to indicate exports as a percentage of total sales (sales ratio). Data is represented for all firms combined, per sector and per size class.

In 2000 and 2003 the export ratio of all firms was respectively 12.9% and 12.1%. The CIA fact book shows that the South African industry generated 456.7 billion US Dollars GDP in 2003 and an export value of 36.77 billion US Dollars. This means an export ratio of 8.05% in 2003. This is somewhat lower as firms indicated in this research. It is not clear what the reason is for this difference.

[10] Statistics South Africa. Source: www.statssa.gov.za

The strong Rand influenced the export ratios. In 2002 the value of the rand was R10.5407 per US Dollar and in 2003 R7.5648 per US Dollar. Many export oriented firms complained about this phenomenon.

Sector	Export ratio 2000	Export ratio 2003	Export ratio 2003[11]
Manufacturing	14.6	15.5	--
Food, beverages & tobacco	40.1	34.9	--
Textiles, clothing & leather products	8.7	10.8	--
Wood and paper (products) & publishing	11.5	8.9	--
Chemicals, rubber and plastic products	8.9	13.0	--
Metal product, machinery, and equipment	14.1	14.2	--
Electrical & optical equipment	23.4	17.2	--
Transport equipment	20.0	17.7	--
Furniture, and n.e.c.	9.2	9.7	--
Wholesale	9.7	4.9	--
Services	8.7	7.7	--
Transport and communication services	16.6	38.3	--
Financial intermediation services	1.6	1.9	--
Business services	10.4	6.7	--
Total	12.9	12.1	8.5

Table 4.10 Export ratio and export growth.

[11] CIA factbook. Source: www.cia.gov/cia/publications/factbook

5. Descriptive analyses

Innovation seems to be the key driver for business performance. The dependent, independent and control variables which are used for analyses to examine this relationship are described in paragraph 5.1. Subsequently a description of South African firms is given. Firms are divided by innovation (paragraph 5.2), total sales (paragraph 5.3) and export intensity (paragraph 5.4).

5.1. Variables

In this report different variables are used. Variables are divided into dependent, independent and control variables (see Table 5.1). The dependent variables are variables, which is caused or predicted by other variables. In this report the dependent variable is business performance, which is measured by total sales growth and export (intensity) growth both in the period 2000-2003.

The independent variables are variables, which have an influence on the dependent variable. In this report the independent variable is innovation, which is measured by technological innovation, type of innovation (product/service or process) and novelty of innovation (incremental vs. radical) in the period 1998-2000.

Table 5.1 Dependent, independent and control variables

Dependent variable	**Measured by**
Business performance	Total sales growth in the period 2000-2003 Export (intensity) growth in the period 2000-2003
Independent variables	**Measured by**
Innovation	Technological innovation in the period 1998-2000 Product/service innovation in the period 1998-2000 Process innovation in the period 1998-2000
Control variables	
Firm size	Number of employees in 2000
New entrants	Firm started in the period 1998-2000
Region	Province
Firm that is part of multinational	Location firm's head office

Other variables can interfere with the selected independent variables. Therefore control variables are used to check whether they have an influence on the dependent variables. The selected control variables in this report are number of employees in 2000, firm established in the period 1998-2000 and province and innovation funds in 2000. More information about these variables can be found in paragraph 2.4.

In the next paragraphs figures are used to show the distribution of innovation, total sales and exports. These figures are weighted so the distributions are representative for South African firms. More information about this can be found in paragraph 4.1.1.

5.2. Distribution of innovative firms

Innovation is expected to have an influence on business performance. Before the effects of innovation on business performance are examined, the distribution of

innovation across different factors will be discussed in this paragraph. This will give a better understanding where innovation is concentrated. A distribution is made by firm size, sector and region.

5.2.1. Distribution of innovation across firm size

From the distribution of technological innovation divided by size class it is evident that innovation is more present in large firms than in small South African firms (see Figure 5.1). Since missing values aren't included in the figure the total amount of innovative and non-innovative firms is less than 100%. In small firms (less than 50 employees) a small share has technological innovations (36%). This is clearly lesser compared with large firms (more than 500 employees) from which 73% have technological innovations. It seems that in the South African context large firms are more innovative than small firms. It must be noted that innovation is measured as a simple binary variable (i.e. does the firm has technological innovations or not?) The strength or number of technological innovations wasn't measured.

The findings in South Africa correspond to literature on studies found a positive effect of the level of R&D expenditure (measure of innovation) and firm size (Acs and Audretsch, 1988; Dosi, 1988). Large firms have the advantage of economies of scale in expenditures on R&D and have more resources (people, equipment, money, etc.) for innovation.

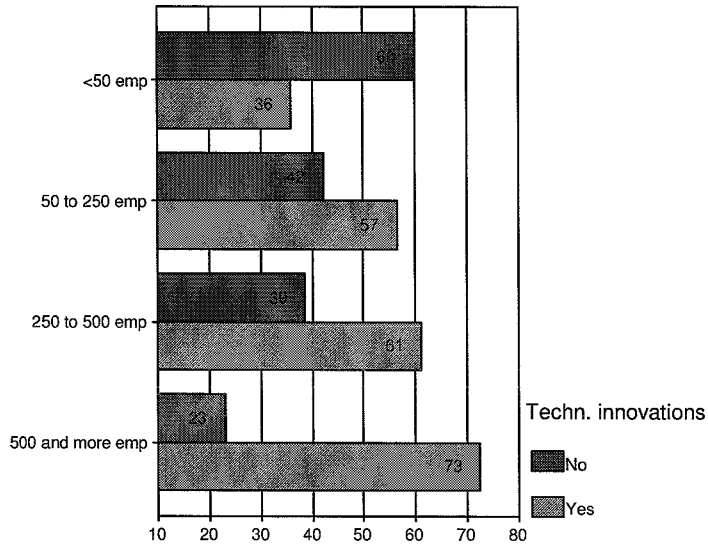


Figure 5.1 Innovative firms distributed across firms size.

5.2.2. Distribution of innovation across sectors

The proportion of innovative firms differs across industries. Looking at Figure 5.2 it is clear that the sector "manufacturing of electrical & optical equipment" and the sector "manufacturing of transport equipment" have above average numbers of innovative firms, respectively 76 and 66 percent. Also the sectors "manufacturing of chemicals, rubber and plastic products", "manufacturing of metal products, machinery & equipment" and "business services" have an above average proportion of innovative

firms. Sectors with the lowest proportion of technological innovations are "manufacturing of textiles, clothing & leather products" (26%) and wholesale (20%).

This different ratio of technological innovations across sectors is expected and well documented in literature. In literature a distinction is made between high-tech sectors and low-tech sectors (Acs and Audretsch, 1993). High-tech sectors have a high ratio of technological innovation while traditional firm have a low ratio of technological innovations. This explains the high number of innovative firms in sectors like "manufacturing of electrical & optical equipment" and "manufacturing of chemicals, rubber and plastic products" since these are high-tech industries.

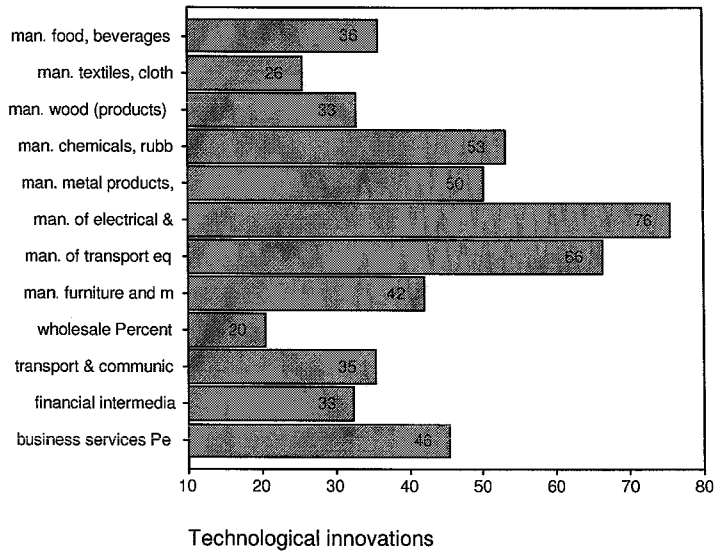


Figure 5.2 Innovative firms distributed across sectors.

5.2.3. Distribution of innovation across regions

The distribution of innovative firms across regions shows little variation. Besides Eastern Cape the average number of innovative firms across regions is 40%. However, the Eastern Cape has a notable higher proportion of innovative firms (64%) compared with the other provinces in South Africa. It is striking that the remaining provinces have a high amount of innovative firms, while these regions have the lowest income in South Africa (Statistics South Africa, 2000: p. 11).

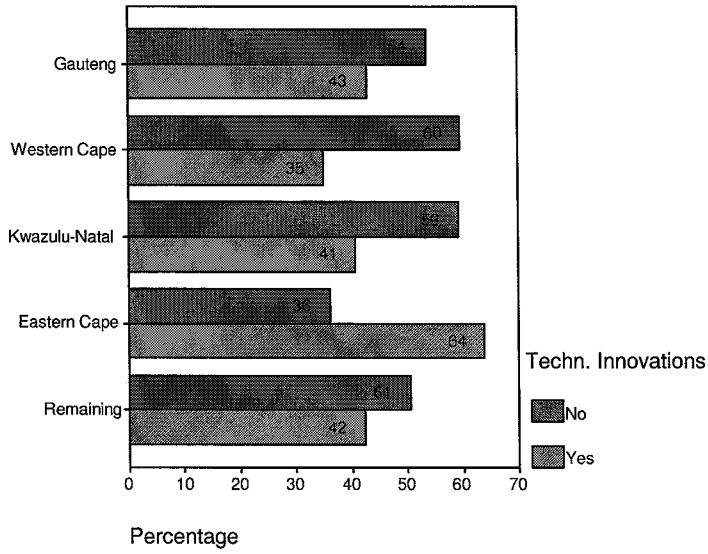


Figure 5.3 Mean total sales growth 2000-2003 distributed by region.

5.3. Distribution of sales growth

Business performance is measured by, among other things, total sales. Before the effects of innovation on business performance are examined, the distribution of innovation across different factors will be discussed in this paragraph. This will give a better understanding where innovation is concentrates. Total sales is distributed by firm size (paragraph 5.3.1) and region (paragraph 5.3.2).

For the results the cases are weighted and only firms with more than ten employees and with a sales growth of less than 100 % are included.

5.3.1. Distribution of total sales growth across firm size

Sales growth differs a slightly across different firm size classes (see Figure 5.4). Total sales increased with 8.6% between 2000 and 2003 each year. This is comparable with findings of Statistics South Africa[12]. In the period 2000-2003 the large firms (more then 500 employees) showed the highest sales growth (29%) compared with the other size classes. This means an annual growth of about 9,6%. The lowest sales growth occurred in small firms (less than 50 employees) but was still 25%, which is an annual growth of 8,3%. The middle large firms (50 to 500 employees) showed a total sales growth of 28 and 27 percent, which lay in between the small and large firms. Since the differences between different size classes aren't statistically significant the average sales growth will be considered as equal.

[12] Statistics South Africa. Source: www.statssa.gov.za

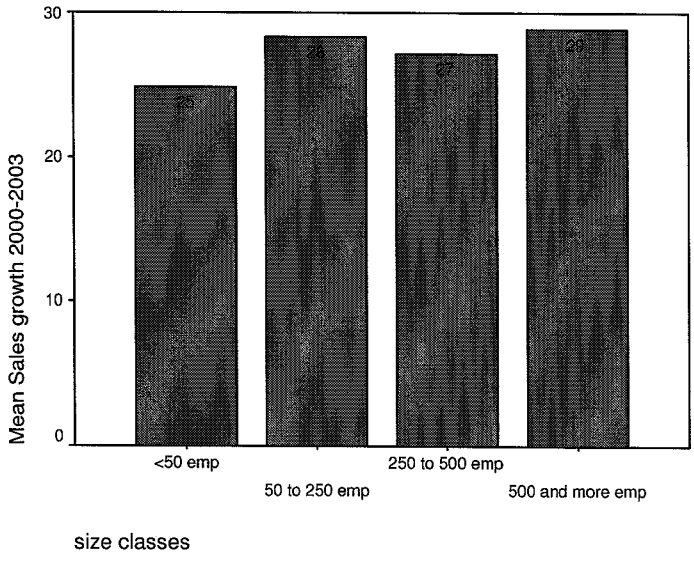


Figure 5.4 Mean total sales growth 2000-2003 distributed by firm size.

Small firms seem to benefit more from technological innovations since they have higher growth in total sales compared with non-innovative firms. Large firms without technological innovations show higher growth in total sales than firms with technological innovations. It seems that total sales in large firms is dependent on other factors (see Figure 5.5).

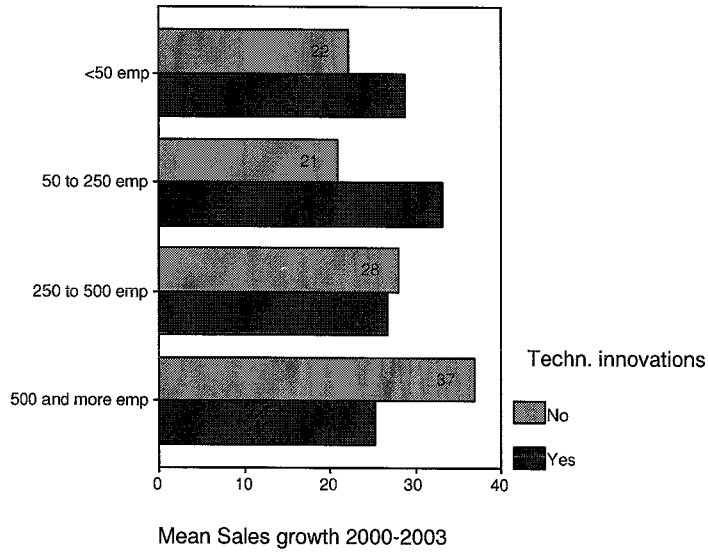


Figure 5.5 Mean total sales growth distributed by firms size (divided by technological innovations).

5.3.2. Distribution of total sales growth across regions

Sales growth across regions differs considerably (see Figure 5.6). In the provinces Gauteng, Western Cape and Eastern Cape the average total sales growth is 30%. This means an annual sales growth of 10%. The two remaining regions, "Kwazulu-Natal" and the "remaining provinces" achieved a lower sales growth of 15 and 18 percent over the period 2000-2003. This means on average an annual sales growth

of 5 and 6%. The low sales growth in the remaining provinces can be explained since this region is characterized by the lowest income of South Africa (Statistics South Africa, 2000: p. 11).

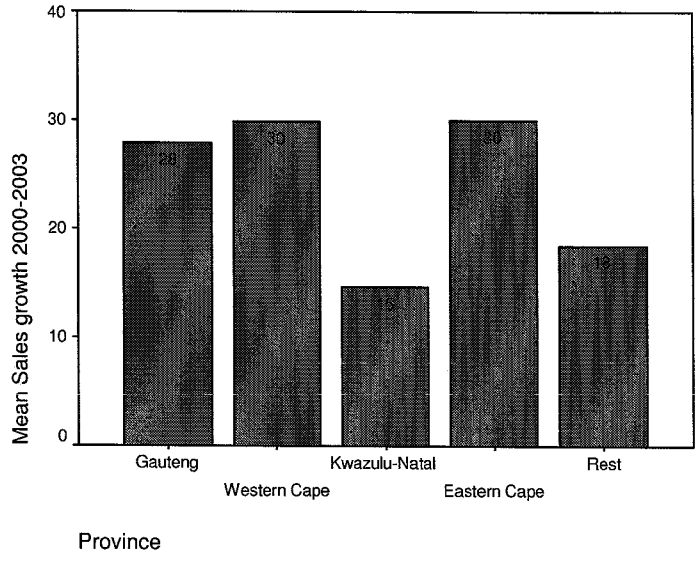


Figure 5.6 Mean total sales growth 2000-2003 distributed by region.

Gauteng, Western Cape and Kwazulu-Natal take advantage of innovations since firms with technological innovations show higher sales growth compared with firms without technological innovations (see Figure 5.7). In the provinces/regions Eastern Cape and the remaining provinces this is the other way around. This can be explained by the fact that these regions are the least economic developed regions of South Africa (StatSa, 2004). To be able to introduce a successful innovation on the market many resources are needed which may be not available in these regions. When education and skilled people are scarce this will have a negative effect on innovation projects. Projects can be cancelled because of these shortages. Growth in total sales can therefore be more dependent on non-innovative (little resource required) activities.

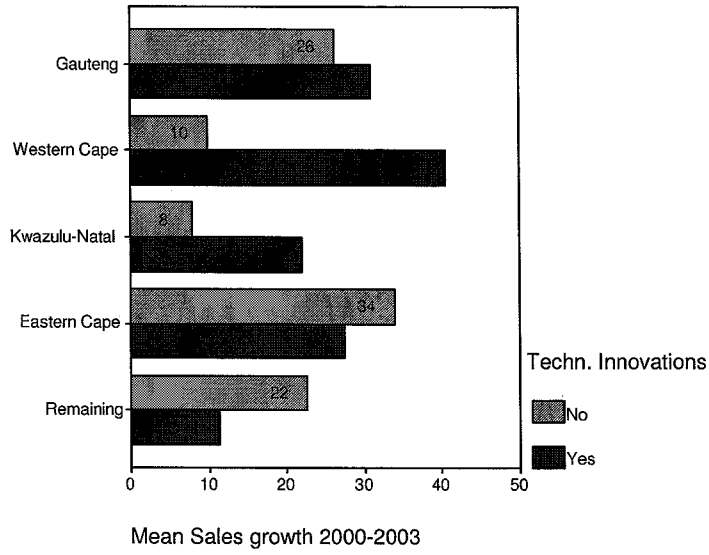


Figure 5.7 Mean total sales growth distributed by region (divided by technological innovations).

5.4. Distribution of export intensity growth

Business performance is measured by, among other things, total sales. Before the effects of innovation on business performance are examined, the distribution of innovation across different factors will be discussed in this paragraph. This will give a better understanding where innovation is concentrates. A distribution is made by firm size and region.

5.4.1. Distribution of export intensity growth across firm size

The export intensity across divided by firm size shows a positive relationship (see Figure 5.8). The smallest firms (less than 50 employees) have an export intensity of 11%, while the largest firms (more than 500 employees) has an export intensity of 22%.

The difference in export intensity may be explained by the needed resources and knowledge, which are needed for exporting. Small firms will experience some difficulties with obtaining the right amount of resources for exports compared with large firms. Large firms are therefore likely to export more than small firms.

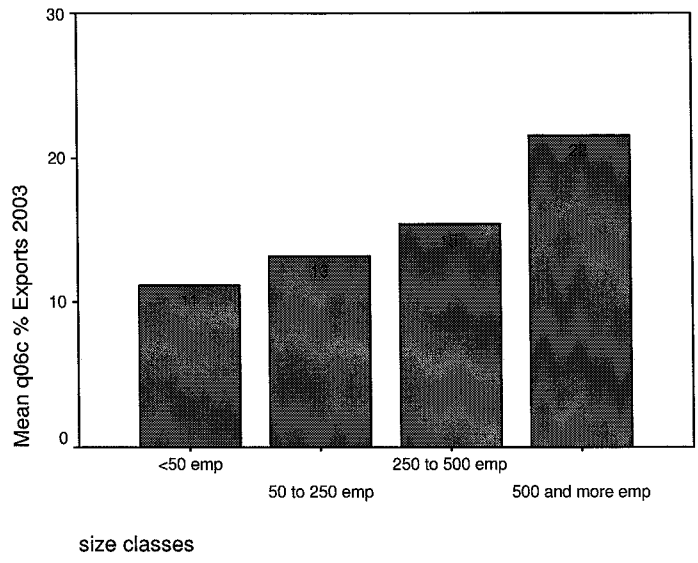


Figure 5.8 Export intensity distributed by firm size.

According to Figure 5.9 it seems that technological innovations do not have any effect on export growth. Export growth across different firm sizes show that firms with no technological innovations have a higher export growth compared with firms with technological innovations. This finding is in contradiction with literature where technological innovations have a positive effect on export growth.

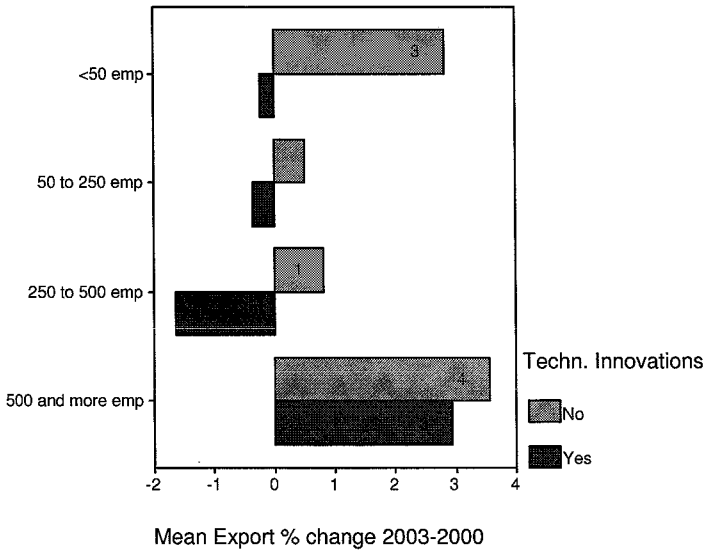


Figure 5.9 Export intensity growth distributed by firm size (divided by technological innovations).

5.4.2. Distribution of export intensity growth across regions

Looking at Figure 5.10 the distribution of export intensity across regions the export intensity is at the highest in Eastern Cape (21%). This can be explained by the fact that Port Elizabeth is an important seaport. According to this explanation it should be expected that Western Cape shows high export intensity as well. This is not the case since the export intensity of Western Cape (14%) is much lower than in Eastern Cape. The export intensity of Western Cape can be even compared with Gauteng

(12%), which is situated inland, and Kwazulu-Natal (10%). The lowest export intensity is found in the remaining provinces. This can be explained by the fact that these regions have the lowest income in South Africa (Statistics South Africa, 2000: p. 11).

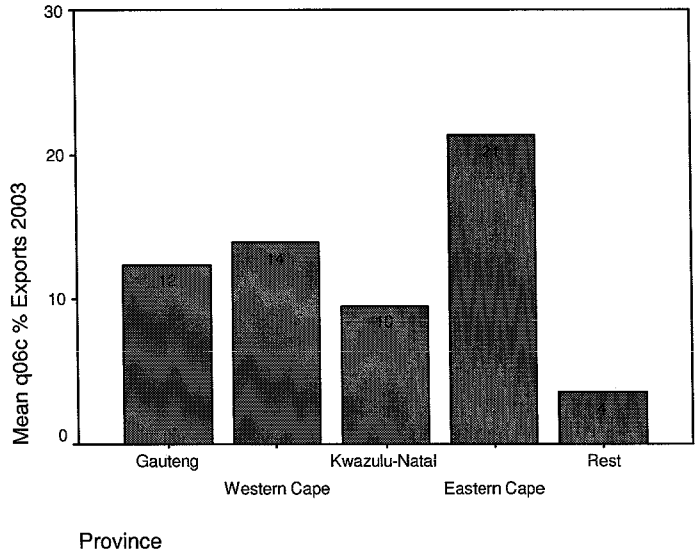


Figure 5.10 Export intensity distributed by region.

In the province Gauteng and Western Cape firms with export growth do not have technological innovations. In the other provinces/regions this is the other way around (see Figure 5.11).

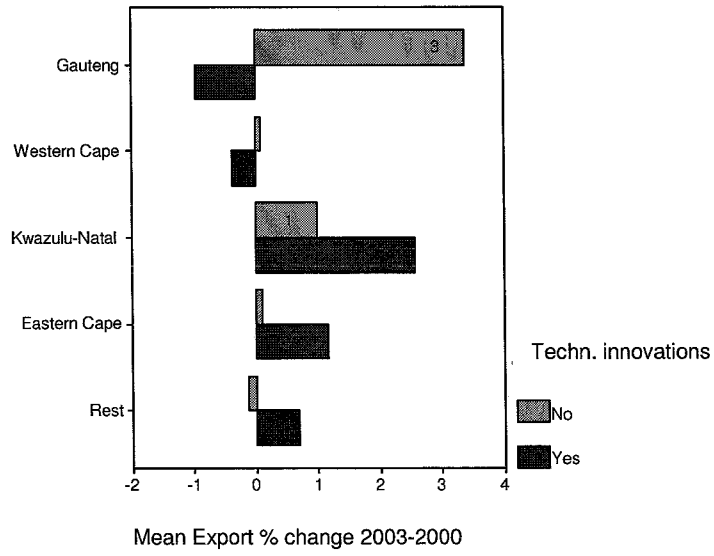


Figure 5.11 Export intensity growth distributed by region (divided by technological innovations).

6. Explanatory analyses

In the previous chapter the independent variable 'innovation' and the dependent variables 'total sales growth' and 'export growth' are described. In this chapter the hypothesis of this report are tested. For this test a multi regression model is used which analyses the effect of the independent variables on the dependent variables. The description of the model and the variables is done in the first paragraph (6.1). After the explanation of the model and the variables the hypothesis are tested (paragraph 6.2).

6.1. Two stages least square regression analysis

The statistical analysis of effects of innovation on employment is not straightforward. Innovation as such is not an exogenous variable, but is determined by the model as well. For instance firm size is known to affect the innovative output of a firm; additionally firm size may affect employment as well. Hence, innovation acts as a dependent and a independent variable as well. Normal statistical approaches such as OLS regression are not appropriate in this case since parameter estimates are inconsistent, and it is problematic to separate and identify effects of innovation and other independent variables (Pindyck & Rubinfeld, 1991). To solve these estimation problems I follow an econometric approach that was advanced by Verspagen (2004). This is a two stage least squares approach. In the first stage, probit regressions analyses with product, process and new to the market innovation as dependent variables were conducted. The estimation results were used to construct predicted innovation variables, that were subsequently used in the second stage, which was a normal OLS regression.

6.1.1. Variables

The variables described in Table 6.1 are used in the multi variate analyses for the dependent variables sales growth 2003 and export growth 2003. For each dependent variable four different regressions models are formulated. In the first two models firms who started their business in the period 1998-2000 are included. These two models are divided into one without and one with interaction effects (prcXlsiz, pdtXlsiz and marXlsiz). In the third and fourth model innovative firms who started their business in the period 1998-2000 are included. Also these two models are divided into one without and one with interaction effect (prcXlsiz, pdtXlsiz and marXlsiz).

Table 6.1 Variables used in regression models.

Variable	Description
s_lsiz	Size of the firm in number of employees logarithm
forow	Whether or not the firm is owned by a foreign firm
inpcsp	Predicted variable if a firm has introduced process innovation in the period 1998-2000
inpdtp	Predicted variable if a firm has introduced product innovation in the period 1998-2000
inmarkp	Predicted variable if a firm has introduced product innovation in the period 1998-2000 which were new to the market.
starter	Whether the firm started its business in the period 1998-2000
techno	Whether the innovative firm started its business in the period 1998-2000
marXlsiz	Interaction effect of predicted variable if a firm has introduced product innovation in the

	period 1998-2000 which were new to the market and firms size by number of employees. This variable is only used in model II for total sales and export growth 2003.
prcXlsiz	Interaction effect of predicted variable if a firm has introduced process innovation in the period 1998-2000 and firms size by number of employees. This variable is only used in model II for total sales and export growth 2003.
pdtXlsiz	Interaction effect of predicted variable if a firm has introduced product innovation in the period 1998-2000 and firm size by number of employees. This variable is only used in model II for total sales and export growth 2003.
_cons	Constant

Sectors are included in the model, but not mentioned in the table.

6.1.2. Sales growth 2003

For the effects of innovation in 1998-2000 on sales growth in 2003, four regression models are carried out. In Table 6.2 two models are shown where firms who started their business in the period 1998-2000 are included. In model I no interaction effects are included. These are included in model II.

Table 6.2 Regression models sales growth 2003 (with starters).

	Model I			**Model II**		
	Coef.	Std. Error.	p-value	Coef.	Std. Error.	p-value
_cons	0.05	0.33	0.44	0.02	0.33	0.47
s_lsiz	-0.02	0.08	0.41	0.05	0.12	0.33
forow	-0.01	0.19	0.20	-0.14	0.19	0.23
inpcsp	-0.62	0.45	0.08	-0.61	0.45	0.09
inpdtp	0.62	0.37	**0.05***	0.62	0.37	**0.05***
inmarkp	-0.40	0.24	**0.05***	-0.41	0.25	**0.05***
starter	0.37	0.16	**0.01***	0.36	0.16	**0.01***
marXlsiz				-0.13	0.14	0.18
prcXlsiz				0.15	0.14	0.14
pdtXlsiz				0.07	0.12	0.27
	Number of obs.	446		Number of obs.	446	
	R-squared	0.03		R-squared	0.04	
	Adj R-squared	-0.01		Adj R-squared	-0.01	

Sectors are included in the model, but not mentioned in the table.

**significant p<0.05, one-sided test*

In Table 6.3 model III and IV are shown where innovative firms who started their business in the period 1998-2000 are included. Model III is without, and model IV is with interaction effects.

Table 6.3 Regression models sales growth 2003 (with innovative starters).

	Model III			Model IV		
	Coef.	Std. Error.	p-value	Coef.	Std. Error.	p-value
_cons	0.13	0.33	0.47	0.09	0.34	0.39
s_lsiz	-0.02	0.08	0.40	0.05	0.12	0.33
forow	-0.14	0.19	0.23	-0.13	0.20	0.25
inpcsp	-0.59	0.45	0.10	-0.58	0.46	0.10
inpdtp	0.62	0.37	**0.05***	0.61	0.38	**0.05***
inmarkp	-0.42	0.25	**0.05***	-0.42	0.25	**0.05***
techno	0.02	0.21	0.47	0.02	0.21	0.46
marXlsiz				-0.13	0.14	0.17
prcXlsiz				0.16	0.14	0.13
pdtXlsiz				0.08	0.12	0.26
	Number of obs.	446		Number of obs.	446	
	R-squared	0.02		R-squared	0.02	
	Adj R-squared	-0.02		Adj R-squared	-0.299	

Sectors are included in the model, but not mentioned in the table.

**significiant p<0.05, one sided-test*

6.1.3. Export growth 2003

For the effects of innovation in 1998-2000 on export growth in 2003, four regression models are carried out as well. In Table 6.4 two models are shown were firms who started their business in the period 1998-2000 are included. In model I no interaction effects are included. These are included in model II.

Table 6.4 Regression model export growth 2003 (with starters).

	Model I			Model II		
	Coef.	Std. Error.	p-value	Coef.	Std. Error.	p-value
_cons	5.48	6.75	0.21	5.37	6.76	0.21
s_lsiz	3.12	1.70	**0.03***	0.27	2.51	0.46
forow	-0.24	4.00	0.48	0.61	4.02	0.44
inpcsp	-3.56	9.26	0.35	-1.55	9.31	0.43
inpdtp	4.52	7.64	0.28	2.90	7.67	0.35
inmarkp	-4.21	4.99	0.20	-3.46	5.00	0.24
starter	1.04	3.17	0.37	0.85	3.16	0.39
marXlsiz				3.70	2.86	0.10
prcXlsiz				-0.56	2.96	0.43
pdtXlsiz				-3.55	2.38	0.07
	Number of obs.	480		Number of obs.	480	
	R-squared	0.10		R-squared	0.11	
	Adj R-squared	0.07		Adj R-squared	0.07	

Sectors are included in the model, but not mentioned in the table.

**significant p<0.05, one –sided test*

In Table 6.5 model III and IV are shown where innovative firms who started their business in the period 1998-2000 are included. Model III is without, and model IV is with interaction effects.

Table 6.5 Regression model export growth 2003 (with innovative starters).

	Model III			Model IV		
	Coef.	Std. Error.	p-value	Coef.	Std. Error.	p-value
_cons	5.12	6.70	0.22	4.99	6.72	0.23
s_lsiz	3.01	1.70	**0.04***	0.16	2.51	0.47
forow	-0.53	3.99	0.45	0.31	4.02	0.47
inpcsp	-3.94	9.24	0.34	-1.96	9.29	0.42
inpdtp	4.37	7.62	0.28	2.78	7.66	0.36
inmarkp	-3.78	5.00	0.23	-3.06	5.00	0.27
techno	5.67	4.35	0.10	5.49	4.35	0.10
marXlsiz				3.71	2.85	0.10
prcXlsiz				-0.61	2.95	0.42
pdtXlsiz				-3.54	2.37	0.07
	Number of obs.	480		Number of obs.	480	
	R-squared	0.11		R-squared	0.12	
	Adj R-squared	0.07		Adj R-squared	0.07	

Sectors are included in the model, but not mentioned in the table.

**significant p<0.05, one –sided test*

6.2. Hypotheses testing

The results of the analysis are rather remarkable. Innovation seems to have a limited positive effect on business performance. The results of the tested hypotheses can be divided into total sales growth (6.2.1) export growth (6.2.2) and characteristics of innovation (6.2.3).

6.2.1. Total sales growth

Hypothesis 1 (partly confirmed)

The first hypothesis states that innovative firms have a higher sales growth than non-innovative firms in South Africa. The results of the analysis of this hypothesis are rather contradictory. This relation is significant (p=0.05) in all models (see table 6.2 and 6.3). Only product innovation seems to have a positive effect on total sales growth. However, product innovations, which are new to the market, have a negative effect on total sales growth. Process innovation seems not to have any effect on total sales growth.

Since the findings are rather contradictory the hypothesis is only partly confirmed.

Hypothesis 2 (not confirmed)

The second hypothesis states that small innovative firms have higher sales growth compared to large innovative firms in South Africa. All models do not prove this hypothesis. There is found a positive relationship with both product and process innovation on firm size but they are not significant. Therefore the model does not confirm this hypothesis.

Hypothesis 3 (not confirmed)

The third hypothesis states that new innovative entrants have a higher sales growth compared to innovative firms, which are already on the market in South Africa. New innovative entrants who are established between 1998 and 2000 don't have any effect on sales growth. However, looking to new entrants in general the relation is positive and significant in model I and II (p=0.01 and p=0.01). This hypothesis is not confirmed.

6.2.2. Export growth

Hypothesis 4 (not confirmed)

The fourth hypothesis states that innovative firms have higher export intensity growth than non-innovative firms in South Africa. The same variables as with total sales have a positive and negative influence on export growth according to the model. Product innovation will have a positive influence and process innovations and the introducing of an innovation new to the market a negative influence. Since all these variables are not significant this hypothesis is not confirmed.

Hypothesis 5 (not confirmed)

The hypothesis 5 states that small innovative firms have a higher export growth compared with large innovative firms in South Africa. Looking at the interaction variables it seems that firms, which introduced product innovations, which were new to the market, have a positive influence on export growth. However, since this variable is not significant this positive relationship is not valid. Looking at the other interaction variables, product and process innovation, only negative effects were found. These variables are not significant as well. Therefore this hypothesis is not confirmed.

6.2.3. Characteristics of innovation

Hypothesis 6 (partly confirmed)

Hypothesis 6 states that firms with product/service innovations have higher sales growth than firms with process innovations. The findings are rather contradictory. In all models inpdtp has a positive effect on sales growth and is significant (p=0.05). However, product innovations that are new to the market show a negative effect in all models (p=0.05). This contradicts with the effect of product innovation. Process innovation doesn't seem to have an effect on total sales growth. A negative effect has been found but it wasn't significant. Therefore this hypothesis is only confirmed partly.

Hypothesis 7 (not confirmed)

Hypothesis 7 states that firms with product/service innovations have higher export intensity growth than firms with process innovations. Since no effect has been found between innovation and export intensity growth this hypothesis is not confirmed.

7. Conclusions and discussions

Innovation is considered as the key driver for economic growth. In this report the questions is asked what the effects are of innovation on business performance in South African firms. The answer on this question will be given in paragraph 7.1. In the next paragraph the weaknesses and strengths are discussed (7.2). Subsequently the findings will be critically assessed (7.3). Finally recommendations for further research are given (7.4).

7.1. Conclusions

First the main question is answered in this paragraph. The effects of innovation on business performance will be discussed in more detail as well.

Effects of innovation in general

The effects of innovation on business performance on firm level in South African are somewhat unexpected. Innovation has a positive effect on business performance, but very limited. A small positive effect on total sales growth due to innovation has been found, while innovation doesn't have any effect on export intensity growth. These two unexpected findings lead to the conclusion that:

> ***Innovation in general has a positive effect on business performance in South African firms, however this positive effect is limited to product innovation.***

Only product/service innovation has a positive effect on business performance while process innovation doesn't have any effect. The effects of product/service innovation are limited to total sales growth since innovation in general doesn't have any effect on export intensity growth.

Product innovations that are new to the market

A remarkable finding is the effect of product innovations that are new to the market. Generally these kinds of innovations are characterised by the fact that their novelty is rather high. Therefore a strong positive effect on business performance is expected. However, firms with product innovations that are new to the market have a negative effect on business performance. Only total sales growth is negatively affected by this kind of innovation since innovation in general don't have any effect on export intensity growth.

Firm size

The effects of innovation on business performance differ across firm size. Therefore innovative firms are divided into different size classes and the effect on business performance was measured. According to literature small firms are more able to gain advantage from innovations compared to large firms. However, it seems that the effect of innovation on total sales growth isn't influenced by firm size in South Africa. Therefore small innovative firms don't show a higher total sales growth than large

innovative firms. Export intensity growth wasn't influenced by firm size either. Therefore innovation has the same effect on export intensity growth in small and large firms in South Africa.

New entrants

Besides a distinction in firm size, a distinction between innovative new firms (firms established in the period 1998-2000) and established innovative firms (firms established prior to 1998). It seems that innovative new entrants do not have a higher business performance compared to established innovative firms. Looking at new entrants and established firms, a positive effect of innovation on business performance is found. Only total sales growth was positively influenced. Therefore innovative new entrants don't show a higher business performance compared to innovative established firms.

7.2. Weaknesses and strengths

The reliability of these results are dependent on the quality of the research itself. Since this research is of a longitudinal design, and not of a cross sectional design, it is possible to make statements on causal relations since the same firms are included in the dataset. For a longitudinal research it is of imperative importance to gain a high response. Since no less than 97.7% of the firms responded the sample is not biased by non-response. Since this research is of a longitudinal design the dataset of the previous SAIS 2001 research was used. The dataset of SAIS2001 was weighted so it corresponds to the size distribution of South African firms (see chapter 4). The data from the SAIS2001 survey was randomly selected from the Reedbase database (sampling frame). All the mentioned aspects above have a positive influence on this research and therefore the conclusions can be generalized to South Africa.

In the 97.7 % response not all the firms are included. During the data verification it was clear that 16 firms could not be traced anymore and 13 other firms were merged and 19 went out of business between 2000 and 2003. In total 48 companies are not taken into account with the data collection and analysis. This may biased the findings of this report.

The time period between the fist (SAIS 2001) and the second measurement (SAIS 2001 revisited) plays an important role as well. According to literature the time-lag between the innovation and the effect on business performance will take at least one or two years (Diederen et al, 2002). The length of this period is dependent on several factors so the duration of it is unknown. The time-lag and the duration of the effects of innovation on business performance are important for the determination of the appropriate moment for measuring business performance. Since the measurements are done after three years the effects of innovation on business performance should be present. However, the appearance and the length of the effects of innovation on business performance are still questionable and because of this a weakness in this research exists.

Questions in the questionnaire aren't interpreted the same by all the respondents. Despite the fact that respondents receive definitions of various concepts included within the questionnaire, the questions are still open for misinterpretation. The different interpretations of questions may have influenced the dataset. However, these inaccuracies are a general problem of questionnaires.

Another strength of the survey was that the provided data from the SAIS2001 was double checked in 2003.

7.3. Discussion

According to literature, innovation in general has a positive influence on business performance. However, in this research only product innovation has a positive influence on total sales growth in South Africa. Process innovation does not seem to have any influence on total sales growth. This effect of process innovation wasn't expected. An explanation of this unexpected finding may be found in the characteristics of process innovation. First, the effects of process innovation are less visible compared with product innovation. Second, process innovation comes often accompanied with product innovation. These characteristics of process innovation might increase the difficulty of measuring the effects of process innovation on total sales growth. The limited effects of process innovation might therefore be reduced.

Also export intensity should be positively influenced by innovation. However, in South Africa no positive influence of all types of innovation on export intensity growth has been found. An explanation for this can be found in the low number of observations because only a few firms exports. This low number of observations may result in an inaccurate conclusion. The technological development of South Africa may be an explanation as well. South Africa faces strong competition since global competition is increased and the technological development of South Africa lags behind with the rest of the world. Therefore South Africa will export less technological products so export intensity growth is more dependent on other, non-technological products.

Another remarkable finding is the negative influence of product innovations that were new to the market on total sales growth. It was expected that product innovation, which are new to the market, have a strong positive effect on total sales growth. An explanation for this unexpected finding may be found in the fact that the innovation was or was not successfully introduced into the market. If many innovations were not successfully introduced onto the market, the relation between innovation and total sales growth isn't straightforward anymore.

The effect of innovation on total sales growth isn't influenced by firm size. In literature there is evidence that small firms are better able to take advantage of innovations compared to large firms. This is, among other things, because small firms are more able to adopt in a changing market. It seems that in South Africa innovative small firms do not have a higher total sales growth than innovative large firms. It may be possible that innovative small firms mainly develop innovations that involve limited

risks, which is based on extending existing technologies. Large firms have less, but more complicated and risk full innovations. Small firms that develop innovations that involve limited risks may results in a diminished higher total sales growth than the complicated and risk full innovations of large firms. With this explanation, the assumption is made that the innovations are successfully introduced into the market.

According to literature new entrants benefit more from innovation compared to firms, which are already on the market. The findings were unexpected since no differences were found between new entrants and incumbents. Looking to new entrants in general, a positive effect of innovation on total sales growth was found. This surprising finding can be explained by the low amount of observations, which is too low for finding reliable results.

7.4. Further research

In this report several unexpected results were found. To get more knowledge about these unexpected findings further research is needed. Below several recommendations are given.

The effect of innovation on business performance in measured three years after the first measurement. Because of the unknown time-lag and the length of the effects of innovation on business performance, the effects of innovation on business performance should be measured more often. This extra data will give the opportunity to examine the effects of innovation business performance more accurate.

Process innovation seems not to have any influence on total sales growth. To effects of process innovation are difficult to measure since it is often a result of product innovation. Therefore it is recommended to isolate process innovation from product innovation.

Export intensity growth seems not to be dependent of innovation. The small amount of observations may have influenced the findings. In further research more observations are needed to examine the effect of innovation on export intensity growth. Export intensity growth may also be dependent on other non-technological products. Therefore more information is needed about the exported products to examine if innovation only has the biggest impact on export intensity growth.

The introduction of a product innovation has a negative effect on total sales growth. To understand this unexpected finding it should be asked if the product innovations were launched successfully into the market. This information should give information about the reason for the negative effect of product innovation on total sales growth.

The effect of innovation on business performance doesn't differ in small and large firms. The characteristics of innovation in firms may explain why total sales growth in

small and large firms are the same. In future research the characteristics of innovations in small and large firms should be taken into account.

Because of the low amount of observations it isn't possible to examine whether sales growth differ between innovative new firms and established firms. In further research more observations are needed to examine the differences between new firms and established firms.

References

Acs, Z.J. and D.B. Audretsch (1988). Innovation in large and small firms: an empirical analysis, *American Economic Review*, vol. 78, pp. 678-690.

Acs, Z.J. and D.B. Audretsch (1993). Analysing innovation output indicators: the US experience. In: Kleinknecht, A., and D. Bain (Eds.), New concepts in Innovation Output Measurement, the MacMillan Press Ltd, London.

Alali, S. (1995). Developing countries and technology transfer. *International Technology Management,* 10 (7-8), pp. 704-713.

Archibugi, D. and J. Michie (1997). Technological globalization or national systems of innovation?, *Elsevier Science*, 29 (2), pp. 121-137.

Baumol, William J. (2002). *The free-market innovation machine: analyzing the growth micracle of capitalism.* Princeton: Princeton University Press.

Breakwell, G.M. and S. Hammond and C. Fife-Shaw (2000). *Research methods in psychology, 2nd edition.* London: SAGE Publications ltd.

Brouwer, M. and L. van der Does de Willebois (1990). *Innoveren en concurreren.* Amsterdam: Meeuwis.

Buys, A. (2004). *Characterisation of the South African National System of Innovation. Working paper*, Department of Engineering and Technology Management, University of Pretoria.

Case, Karl E. and Ray C. Fair (1999). *Principles of Economics – 5th edition.* New Jersey: Prentice Hall

Christenson, C.M. and R.S. Rosenbloom (1995). Explaining the attackers advantage, *Organisation Science*, 4, pp. 301-324.

Clerx, R. (2005). Business networks and innovation in South Africa: An Exploratory study on innovative partnerships of South African firms. In possession of R. Clerx.

Cooper, R.G. and E.J. Kleinschmidt (1985). The Impact of Export Strategy on Export Sales Performance, *Journal of International Business Studies*, 16 (1), pp. 37-55.

DACST (1990). Technology base of the South African Business Sector, Marketing international and MTA Consulting. www.sacst

De Wet, G. (2001). *Emerging from the technology colony: A review from the South.* Pretoria: Department of Engineering and Technology Management, University of Pretoria.

Del Monte and Papagni (2003). R&D and the growth of firms: empirical analysis of a panel of Italian firms, *Research Policy 32*, pp. 1003-1014.

Diederen, P., H. van Meijl and A. Wolters (2002). Innovation and farm performance: the case of Dutch Agriculture, in: Kleinknecht and Mohnen (eds), pp. 73-85.

Doms, M., T. Dunne and M.J. Roberts (1995). The role of technology use in the survival and growth of manufacturing plants. *International Journal of Industrial Organization*, 13, pp. 523-542.

Dosi, G. (1988). Sources, procedures, and microeconomic effects of innovation, *Journal of Economic Literature*, 25, pp. 1120-1171.

Favre, F., S. Negassi and E. Pfister (2002). The effects of spillovers and gorvenment subsidies on R&D, international R&D cooperation and profits, in: Kleinknecht and Mohnen (2002) (eds.), pp. 201-224.

Freel, Mark S. (2000). Do small innovating firms outperform non-innovators?, *Small Business Economics* 14, pp. 195-210.

Freeman, C. (1982). *The Economics of Industrial Innovation (2nd edition)*, London: Pinter.

Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation (3rd edition)*, London and New York: Pinter.

Geroski, P. and S. Machin (1992). Do innovating firms outperform non-innovators?, *Business strategy review, summer*, pp. 79-90.

Glass, J.G. and K. Saggi (1998). International Technology Transfer and the Technology Gap, *Journal of Development Economics*, 55, pp. 369-398.

Government of the Republic of South Africa, The (2002). South Africa's National Research and Development Strategy. Pretoria.

Julien, P.A. (1993). Small business as a research subject: some reflections on knowledge of small businesses and its effects on economic theory, *Small Business Economic* 5, pp. 157-166.

Hagedoorn J, and R. Narula (1999). Innovating through strategic partnerships: Moving towards international partnerships and contractual agreements, *Technovation*, 19, pp. 283-294.

Hall, B.H. (1987). The relationship between firm size and firm growth in US manufacturing sector, *The Journal of Industrial Economics*, vol. 35, pp. 583-606.

Heunks, F. (1998). Innovation, creativity and success, *Small Business Economics* 10, pp. 263-272.

Kaplan, D. (2004). Technology and the growth of manufactured exports: assessing South Africa's performance and policy, DRUID Summer Conference on Industrial Dynamics, innovation and development. Elsinore: Denmark.

Katz, J.M. (1987). *Technology Generation in Latin American Manufacturing Industries*, Hong Kong: MacMillan Press Ltd.

Keeble, D., C. Lawson, H. Lawton-Smith, B. Moore, and F. Wilkinson (1998). 'Internationalisation Process, Networking and local embeddedness in technology-intensive small firms.' Small Business Economics, 11, pp. 327-342.

Kim, L. (1997). *Imitation to Innovation: The Dynamics of Korea's Technological Learning,* Harvard Business School Press.

Kleinknecht, A. and P. Mohnen (eds.), *Innovation and firm performance. Econometric explorations of survey data*, Basingstoke, UK: Palgrave.

Kleinknecht, A. and R. Oostendorp (2002). R&D and export performance: Taking account of simultaneity, in: Kleinknecht, A., and P. Mohnen (eds.), Innovation and firm performance. Econometric explorations of survey data. Basingstoke: Palgrave, pp. 310-320.

Lefebvre, E., L. Lefebvre and M. Bourgault (1998). R&D-related capabilities as determinants of export performance, *Small business economics 10*, pp. 365-377.

Lefebvre, E., and L.A. Lefebvre (2002). Innovative capabilities as determinants of export performance and behaviour: A longitudinal study of manufacturing SMEs, in Kleinknecht, A., and P. Mohnen (eds). Innovation and firm performance. Econometric explorations of survey data, Basingstoke: Palgrave, pp. 281-309.

Moini, A.H. (1995). An inquiry into successful exporting: an empirical investigation using a three-stage model, *Journal of Small Business Management*, 33 (3), pp. 9-25.

Mowery, D.C. and J.E. Oxley, (1995). Inward technology transfer and competitiveness; the role of national innovation systems, *Cambridge Journal of Economics*, 19 (1), pp. 67-94, table 7.

Mueller, D.C. and J.E. Tilton (1969). R&D Cost as a barrier to entry, *Canadian journal of economics*, 2, pp. 570-579.

Oerlemans, L.A.G., M.W. Pretorius, A.J. Buys and G. Rooks (2003). Industrial innovation in South Africa 1998-2000 – Report on the South African innovation survey for the period 1998-2000.

Organisation for Economic Co-operation and Development (1997). *Oslo Manual, 2nd edition.*

Pavitt, K. (1984). Sectorial Patterns of Technical Change: Towards a Taxonomy and a Theory, *Research Policy* 13, pp. 343-373.

Pindyck, Robert S., and Daniel L. Rubinfeld. 1991. Econometric models and economic forecasts. New York: McGraw-Hill.

Porter, M.E. (1990). *The competitive advantage of nations.* New York: MacMillan Press.

Rooks, G. and L. Oerlemans (2005). South Africa: A Rising Star? Assessing the X-effectiveness of National System of Innovations. An empirical Analyses of Institutional Flows into South African Industry. Forthcoming "European planning studies".

Roper, S. (1997). Product innovation and small business growth: a comparison of the strategies of German, UK and Irish Companies, *Small Business Economics 9 (6)*, pp. 523-537.

Ross, R and H. van Cuijlburg (2001). Zuid-Afrika: een geschiedenis. Amsterdam: Arbeiderspers.

Schumpeter, J. (1939). *Business Cycles: A Theoretical, Historical, and statistical analysis of the capitalist Process.* New York: McGraw-Hill.

Schumpeter, J. (1942). *Capitalism, socialism and democracy.* New York: Harper & Row.

Schumpeter, J. (1959). *The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle.* Harvard: Harvard University Press

Seale, C. (2004). *Researching society and culture, 2nd edition.* London: SAGE Publications ltd.

Shefer, D. and A. Frenkel (2005). R&D, firm size and innovation, *Technovation*, 25, pp. 25-32.

StatSa, Statistics South Africa (2000). *Measuring poverty in South Africa.* Pretoria: Statistics South Africa

Storey, D. (1994). *Understanding the Small Business Sector*, London: Routledge.

Tödlinger, F. (1994). Regional networks of high technology firms- the case of the greater Boston region. *Marketing Management*, 14 (5), pp. 323-337.

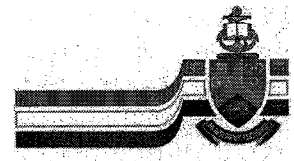
Utterback, James M. and William J. Abernathy (1975). A dynamic model of product and process innovation, *Omega*, 3 (6), pp. 639-656.

Utterback, James M., and F. Suarez (1993). Innovation, competition and industry structure, *Research Policy,* 22, pp. 1-22.

Verspagen, B., 2004, "Innovation and jobs: a micro and macro perspective" Eindhoven Centre for Innovation Studies, mimeo

Westerhuis, R. (2005). Innovation and employment growth in South Africa. In possession of R. Westerhuis.

Appendix A Covering letter



**Faculty of Engineering,
The Built Environment and
Information Technology**

**Department of Engineering
and Technology Management**

7 September 2004

Dear Sir/Madam,

The Department of Engineering and Technology Management at the University of Pretoria conducted a national survey on innovation in the manufacturing and services section in South Africa. Your company contributed to the success of this survey in 2001. The full survey report was handed over to the Minister of Science and Technology in the beginning of 2004 and is also available at www.sais2001.up.ac.za.

We are currently conducting a short follow-up on the SAIS 2001 survey. Our purpose is to discover to what extent innovation has contributed to economic development and employment growth in South Africa over the last few years.

For this reason we have developed a short questionnaire to gather imperative, longitudinal information on innovative performance, survival, sales and exports. Because of your cooperation a few years ago, your response is exceptionally valuable. We kindly ask you to complete this questionnaire. It will only take five minutes of your time. We would really appreciate your time to help us with this important matter.

Regards,

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Appendix B Survey

survey number

Faculty of Engineering, The Built Environment and Information Technology

Department of Engineering And Technology Management

Head of department: Professor M.W. Pretorius

South African Innovation Survey: SAIS2004

The purpose of this survey is to measure innovative performance, employment, sales and exports of South African firms. The data collected will be compared with data from the SAIS 2001 survey, which was handed to Dr. Ben Ngubane, who was the Minister of Science and Technology at the time
With these data we want to measure the influence of innovation on employment, survival and alliances.

The ten questions should only take a few minutes of your time. All information will be handled confidentially!

Instructions:

Please fill out Yes/No questions as follows:

Yes ☐
No ☒

Questions that require a figure can be indicated as follows:

25%

After completion, please return the Questionnaire to:

Contact person: Anthea van Zyl
Fax: (012) 362 5092
E-mail: SAIS2004@up.ac.za
Tel. No.: (012) 420 3843

General information:

Name of company : .....

Name respondent : .....

Physical Address : .....

Telephone number : .....

E-mail address : .....

Employment:
Q1a: "What were the number of employees in your firm in 2003?"

Employees 2003: .....

Q1b: "Has there been an increase or decrease of employment in the last 3 years?"

No, unchanged ☐ → Please, go to Q2
Yes ☐ → Increase ☐
Decrease ☐

Q1c: "Did this employment change occur at all education levels in your firm? (Please distinguish between lower education, medium education and higher education-level jobs?)"

Yes ☐
No ☐ → mainly at: Lower education/Operator level ☐
Medium education/Supervisory level ☐
Higher education/Management ☐

Comments? .....

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Innovative product/services:
Q2a: "Did your firm introduce any technologically new or improved products or services during 2003?"

Yes ☐
No ☐ → Please, go to Q3

Q2b: "Were these "step-by-step" changes or "drastic changes" in your product or services?"

Step-by-step changes ☐
Drastic changes ☐

Q2c: "What sales percentage were contributed by these step-by-step and drastically changes products or services during 2003?"

Sales percentage from step-by-step product/services: ..... %

Sales percentage from drastically products/services: ..... %

Q2d: "Were these products new to the market or was it a modification of an already existing idea?"

New to the market ☐
Existing idea ☐

Comments? .....

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Innovation processes:
Q3: "Did your firm introduce any technologically new or improved production processes in 2003?"

Yes ☐
No ☐

Comments? .....

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Sales:
Q4: "What were the total sales in 2003?"

Total sales 2003: ..... Rand

"If you don't have the figures off-hand, would you say there was an increase or a decrease in sales in comparison with the year 2000? Could you indicate this as a percentage?"

No, unchanged ☐

Increase ☐ Percentage: .....%

Decrease ☐ Percentage: .....%

Comments? .....

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Exports:
Q5: "What were the exports as a percentage of total sales in 2003?"

Export as a % total sales 2003: ..... %

"If you don't have the figures off-hand would, you say there was an increase or decrease in exports in comparison with the year 2000? Could you indicate this as an percentage?"

No, unchanged ☐

Increase ☐ Percentage: ..... %

Decrease ☐ Percentage: ..... %

Comments? .....

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Any other general comments you would like to make?

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Thank you for your cooperation!

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