THE ROLE OF INNOVATION IN ECONOMIC DEVELOPMENT

by

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ABSTRACT

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The aim of this study is to determine the role that innovation plays in economic development and how an economic environment can be created that is conducive to innovation. The urgent need for development in large parts of the world indicates the importance of the increase in innovative activities because innovation is indicated as the "engine of growth and development".

It was found that innovation takes place within an innovation system and should be studied from a system perspective. The system perspective implies that there are different participants and that these participants function individually but that they also interact (wittingly or unwittingly) with one another. The innovation system is defined as a system that includes the participants or actors and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, which determine the innovative performance of the system. A system approach is therefore necessary to study the influence of innovation on development.

The role that innovation plays in economic development has been established by means of the historical patterns of economic development and major innovations as well as an analysis of literature of empirical studies. The historical pattern indicates the importance of innovation for economic development, but literature revealed the complexity of the relationship due to the non-linear relationship among different actors or participants in an innovation system.

The main determinants of innovation was identified and a conceptual, descriptive model for an innovation system was developed, indicating the different participants, their roles, the interaction among them, and the economic environment within which the participants function. The model was applied to the Mpumalanga province in South Africa as case study. Strengths and weaknesses were identified in the Mpumalanga innovation system and recommendations were made for the improvement of the Mpumalanga innovation system which in turn should lead to an improvement in the economic development of the province.

Key terms:

Innovation; Innovation system; Economic development; Conceptual model; Innovation system model; Mpumalanga innovation system; Neo-Schumpeterian theory; Development theory; Innovation system participants; Innovation system linkages.

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ACRONYMS

BEE	Black Economic Empowerment
CBO	Community Based Organisation
CIS	Community Innovation Survey
CS	Community Survey
EU	European Union
FDI	Foreign Direct Investment
FET	Further Education and Training
FTE	Full Time Equivalent
GCI	Global Competitive Index
GDP	Gross Domestic Product
GDPR	Gross Domestic Product per Region
GDE	Gross Domestic Expenditure
GEM	Global Entrepreneurship Monitor
GGP	Gross Geographic Product
GNP	Gross National Product
GVA	Gross Value Added
HBDC	Highveldridge Business Development Centre
HDI	Human Development Index
HIV & AIDS	Human Immunodeficiency Virus & Acquired Immune Deficiency Syndrome

ICT	Information and Communications Technology
ISO	International Organisation for Standardisation
KMIA	Kruger-Mpumalanga International Airport
MEGA	Mpumalanga Economic Growth Agency
MNC	Multi-national Corporations
MNE	Multi-national Enterprises
MSI	Mpumalanga Stainless Initiative
NGOs	Non-government Organizations
NIS	National Innovation System
NSI	National Systems of Innovation
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
PPP	Purchase Power Parity
R&D	Research and Development
RIS	Regional Innovation System
RRSSI	Revealed Regional Summary Innovation Index
RSI	Regional System of Innovation
SABC	South African Broadcasting Corporation
SAMAF	African Micro Finance Apex Fund
SEDA	Small Enterprise Development Agency
SIS	Sectoral Innovation System

SMEs	Small and Medium Enterprises
SMMEs	Small, Medium & Micro Enterprises
S&T	Science and Technology
TBI	Technology Business Incubators
TEA	Total Entrepreneurial Activity
TFP	Total Factor Productivity
TNCs	Trans-national Corporations
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TSB	Transvaal Suiker Beperk, changed name in 2006 to TSB Sugar
UITT	University-Industry Technology Transfer
UK	United Kingdom
USA	United States of America
VAT	Value-added Tax
VC	Venture Capital

CHAPTER ONE

INTRODUCTION

There is a dire need for development and improvement of living conditions among the greater part of the world population. Poverty and unemployment are a reality in many countries. Innovation is seen by many economists as a driver of economic development. It is therefore important to determine what role innovation can play in development and how best innovation can be enhanced to improve economic development.

Innovative activities take place in an innovation system. There are different participants in an innovation system that function individually or interact with each another. The economic environment within which these participants function has an influence on the innovative performance of the participants and of the system as a whole. It is therefore important to understand the functioning of an innovation system if innovation is to be enhanced. In this study, a descriptive model of an innovation system will be developed, the participants and their interactions will be identified and an economic environment that is conducive for innovation will be determined.

South Africa is just one of the countries in which poverty and unemployment is of great concern and is in urgent need of improvement in economic development. South Africa has developed and less-developed economic sectors functioning side by side. Mpumalanga is one of the provinces in South Africa that shows one of the lowest levels of development and one of the highest poverty levels of the nine provinces of the country. The aim of this study is to evaluate the Mpumalanga province for the purpose of determining its strong and weak points, as well as Mpumalanga's potential for innovative performance to facilitate the economic development of the province.

1.1 Background

The majority of the world population of 6,6 billion people live in less fortunate circumstances where the conditions include little or no shelter, inadequate food supply, poor health conditions, high unemployment and poor literacy (Todaro & Smith, 2009:2). South Africa is no exception, with a high number of people that suffer under such conditions of poverty.

The number of people in the world living on less than $2,00 (2005 PPP) a day has not declined since 1981 but has remained nearly constant at 2,5 billion. The largest decrease occurred in East Asia and the Pacific, but for the remaining developing countries, the number of people living on between $1,25 (2005 PPP) and $2,00 (2005 PPP) a day nearly doubled to 1,2 billion in the period 1981 to 2005 (The World Bank, 2010c:91). The percentage of people in South Africa that lives on less than $2,00 a day (at 2005 international prices) decreased from 38,0 % in 2000 to 22,0 % in 2008 (The World Bank, 2010a). This implies that there are still more than 10 million people in South Africa suffering from extreme poverty.

The picture of poverty in South Africa is not complete without comparisons of the social factors such as literacy, life expectancy, the human development index (HDI), HIV & AIDS and access to services. The HDI (2010) is 0,597 and South Africa is ranked a low 110th amongst 169 countries worldwide (Klugman, 2010:143-146). According to The Global Competitiveness Report: 2011-2012 (Schwab, 2011:322-323), of 142 countries surveyed, South Africa is ranked as follows:

- Quality of overall infrastructure: 62;
- HIV prevalence: 139;
- Infant mortality: 111;
- Life expectancy: 130;
- Quality of educational system: 133; and

- Quality of math and science education: 138.

These are only a few indicators highlighted from the report to show South Africa's relatively low socio-economic development in comparison with that of the rest of the world. The socio-economic conditions in South Africa are far from ideal. The Mpumalanga province is one of the provinces in South Africa that performs worst as measured by the socio-economic indicators. In Table 2.2, it is shown that the percentage of people employed that earn less than R1 000 per month is 49 % in Mpumalanga, compared to 39,4 % for the whole of South Africa; the percentage of employed people earning more than R4 500 per month is 11,8 % in Mpumalanga, compared to 13,6 % for South Africa. Mpumalanga has the second lowest number of hospital beds per 1 000 people (after Limpopo) of all the provinces in South Africa (Table 7.35). Further, Mpumalanga is the province with the highest percentage of people above 20 years that have no schooling, highest percentage of people with HIV & AIDS (Table 7.33), higher infant mortality rate than that of South Africa (Table 7.34) and the second lowest percentage of people with landline phone in the dwelling (Table 2.2). Mpumalanga is also amongst the four provinces with the lowest life expectancy, lowest adult literacy rate and lowest percentage of people with tap water in the dwelling (Table 2.2). This again stresses the need for and importance of development.

Innovation has been described by many economists as the engine of economic growth and development, but innovation and entrepreneurship have been neglected by many mainstream economists in history. In the theories of the classical economists, such as those of Adam Smith and Karl Marx, technological change and economic development formed an essential part. But during the late nineteenth and early twentieth centuries, technological change and economic development were neglected by the neoclassical theorists. Neoclassical theories dominated that era (Verspagen, 2005:489). The interest in development theories only started blooming again after 1945 (Brue, 2000:494). In some of these development theories, innovation (or technical change) was neglected or totally omitted. Even in those development theories where innovation is included, it is treated as an exogenous factor (Hanusch & Pyka, 2007d:21). It was Schumpeter who constructed a development theory with innovation as the major driver, endogenous to the economy and disturbing the equilibrium (Schumpeter, 1961).

Since the 1980s, interest in the role that innovation plays in development has started to grow. Schumpeter's theory began generating more interest among economists who became known as neo-Schumpeterians (Freeman, 2008:227; Hanusch & Pyka, 2007e; Heertje 2006:119). One of the points where the neo-Schumpeterian view expands on Schumpeter's theory is in the idea that innovation takes place in a complex system (Carlsson, 2007:857-858). The need for development, and the role that innovation can play in this process, needs further investigation.

1.2 Problem statement

In order to address the dire need for economic development globally, as well as in South Africa and particularly Mpumalanga, it is important to establish how innovation can contribute to economic development.

1.3 Research questions

The research questions are as follows:

(i) What role does innovation play in economic development; and

(ii) How can an economic environment be created that is conducive to innovation?

These research questions are studied in terms of the global situation, but are focused on the unique South African situation. The Mpumalanga Province is used as the case study under review, as the low levels of economic development and high levels of poverty in the province both need to be redressed.

1.4 Significance of the study

The theoretical contribution of this study lies first in the clarification of relevant innovation concepts and the analysis of the different innovation and economic development theories that describes the relationship between innovation and economic development. Second, the study provides evidence of the positive and complex relationship between innovation and economic development. Third, the study contributes to the identification of the most relevant determinants of innovation. It reveals that human resource development is an essential determinant of innovation, and that the strength of an innovation system lies in a combination of determinants that influence the innovative activities of firms. Fourth, a conceptual model of an innovation system is developed that contributes to the theory of innovation economics. This model consists of the identification of the most relevant participants or actors, the roles these participants or actors play and the elements necessary in the economic environment within which they function, that together contribute to the improved innovative performance of the innovation system. Fifth, the practical contribution of the study is the identification of the strong and weak points in the Mpumalanga province to establish if the Mpumalanga province functions as or has the potential to function as an innovation system. The study reveals that the province is richly endowed with natural resources, but that the quality of human resource development, amongst other components, mostly restricts innovative performance. Recommendations regarding the enhancement of the Mpumalanga province's innovative potential or performance may ultimately contribute to the economic development of the province.

1.5 Methodology

The research methodology applied is qualitative in nature. A descriptive analysis is made of the concepts and of the historical background in Chapter Two and Chapter Three. Research that was undertaken in the rest of the world concerning the links between innovation and other factors, as well as research into the determinants of innovation, is used. The most relevant links and determinants are identified in Chapters Four and Five, respectively. A conceptual, descriptive model of an innovation system is then developed in Chapter Six. In Chapter Seven, the Mpumalanga province is used as a case study to be qualitatively evaluated against the model developed in Chapter Six. Data used are mostly secondary, but some of the data are from unpublished documents and statistics collected from stakeholders in the Mpumalanga Province. The statistics that are used are descriptive and no inferential statistics are used.

1.6 Layout

In Chapter Two, the concept of innovation, as well as all related concepts, are discussed and clarified. The differences between innovation and invention, the different definitions of the entrepreneur and entrepreneurship, as well as the relationships between the entrepreneur and innovation are each critically analysed. These concepts are analysed in an economic context with the focus on the welfare of society as a whole. Innovation is achieved largely by private enterprise, but there are many other participants who are also involved in innovative activities or who exert an influence on the innovative activities. These participants are seen to function within a system referred to as an innovation system. The concepts innovation system, national, or regional innovation system are also defined in Chapter Two.

The second part of Chapter Two shows, by means of a literature review, the importance of economic development in order to further motivate the importance of the study of innovation. Supportive data is presented to emphasise the dire need for economic development globally, in South Africa, and specifically, in the Mpumalanga province. The demonstrated need for development in the Mpumalanga province provides additional motivation why this province in particular was identified as a case study.

In Chapter Three, the role of innovation in economic development is placed in the theoretical and historical background of the economy by means of a further literature study. A critical discussion of the economic schools of thought is conducted to establish what role innovation played in the economic theories. The discussion compares classical economic theory and the neoclassical theory of "equilibrium in the markets" and "perfectly competitive markets", in which innovation plays no role, with the Schumpeterian theory. Schumpeter criticised the neoclassical theory for the absence of entrepreneurship from its model. Schumpeter's theory is based on innovation that disturbs equilibrium and so causes development. The neo-Schumpeterian school of thought supports Schumpeter (as opposed to the classical and neoclassical theories), but studies innovation from a system point of view. The foundations of this study of the role of innovation in economic development lie, therefore, in the Schumpeterian and the neo-Schumpeterian schools of thought.

In Chapter Four, the relationship between innovation and economic development is presented. The relationship over time between major innovations, GDP *per capita* and population growth is indicated. The difficulties in measuring innovation are discussed. Empirical studies are analysed to determine the similarities and the differences in their findings of the relationships between innovation and economic development and the process of these relationships. Included here is a discussion of the role of the entrepreneur because the entrepreneur is believed to be the innovator. The relationship between economic development, innovation, and entrepreneurship is also discussed in Chapter Four.

The important role of innovation in economic development that is established in Chapter Four necessitates a study to establish precisely what it is that determines innovation. In Chapter Five, a literature review is done in order to identify the determinants of innovation and to establish what conditions should be present to enhance innovative performance in an innovation system. These determinants are grouped in two categories, the determinants that focus on the firm specifically, and the determinants that are related to the firm's environment.

In Chapter Six the different models for an innovation system, as described in literature, are studied. Subsequently, a conceptual, descriptive model for an innovation system is developed, based on the determinants of innovation that were established in Chapter Five. The model consists of an economic environment, participants or actors and the linkages between the participants. The different participants are identified and their roles are described in Chapter Six. These participants include, *inter alia,* small, medium and large businesses, emerging entrepreneurs, the public sector, education and training bodies, and any other person or institution that may influence the environment or climate for innovation. The roles may range from any of these institutions themselves being innovative, to creating the environment within which innovation can take place. It is important to determine the effect that the different participants, the roles that they play and the interactions among them have on innovation and entrepreneurship, so that it may be determined how the different participants can contribute to create a more innovative climate. This, in turn, will improve the performance of the innovation system, the economic development and consequently, the social well-being of the people.

In Chapter Seven the Mpumalanga Province, as a case study, is evaluated against the innovation system model that was developed in Chapter Six. The determinants of innovation and the functioning of the regional system of innovation are evaluated to determine how conducive the economic climate in the province is for innovation. The availability of innovation system participants in the province, and the roles they perform, are evaluated. The aim of this evaluation of the Mpumalanga province is to determine if the province is functioning as an innovation system and, if not, whether the province has the potential to function as an innovation system and so, ultimately, to contribute to the economic development of Mpumalanga.

In the final chapter, a summary of the study is presented. Conclusions derived from the discussions and analyses of the previous chapters are provided.

CHAPTER TWO

INNOVATION AND RELATED CONCEPTS

2.1 Introduction

The research questions of this study are twofold, what role does innovation play in economic development and, how can an economic environment that is conducive to innovation be created? In order to answer these questions, Chapter Two will be used to discuss and clarify the concept of innovation, as well as the related concepts. The differences between innovation and invention, as well as the different definitions of the entrepreneur and entrepreneurship, will be critically analysed. These concepts will be viewed in an economic context with the focus on the welfare of society as a whole. Innovation will be seen as *thinking new* and will not only include new products or new technology in the business sector, but will also refer to new ways of doing, of acting, of functioning, in businesses, government and other organisations.

Innovation does not take place in isolation in one specific institution. It is a network of institutions that interact to form a system of innovation. Innovation will be studied in the context of a national or regional system of innovation. These additional terms will also be clarified in Chapter Two in order to understand better the holistic approach of the study.

The second step in this Chapter is to show, by means of a literature review, the importance of economic development, and of economic growth as a component of development. This Chapter will also be used to demonstrate the importance of being able to distinguish between the concepts, growth and development, that are often incorrectly used as synonyms. This study will focus on the role of innovation in economic development as opposed to economic growth.

The dire need for economic development globally, as well as in South Africa and Mpumalanga, will be justified in Chapter Two. Evidence of the extent of low economic development and high poverty rates will be given in order to explain the need for development. Chapter Two serves to clarify the concepts which will be used in the discussion of the role of innovation in economic development in the following Chapters.

2.2 The innovation concept

Innovation is a concept that is used very often by different disciplines in different contexts. In the different contexts, the meaning of innovation is sometimes changed or interpreted differently. Fagerberg, Mowery & Nelson (2005) describe in the preface of their publication the variation in the definitions and interpretations of innovation as "…a multifaceted phenomenon that cannot be easily squeezed into a particular branch of the social sciences or humanities" and see innovation as "…a multitude of perspectives based on – or cutting across – existing disciplines and specializations".

In the following paragraphs, the different views found in the literature of the concept will be discussed. Innovation must be distinguished, for example, from related terms such as invention and entrepreneurship. It is also necessary for the concept, innovation, to be defined in the context of economic development and in the context of this study.

2.2.1 The definition of innovation

There have been many discussions in literature seeking a definition of innovation. As yet, there is not one specific definition that is generally accepted. So for the purpose of this study, innovation will be defined as follows:

> An innovation is the successful implementation of a new or improved product (good or service), or process, a new marketing method, or a new organisational method.

This definition is partly adopted from The Oslo Manual of the Organisation for Economic Co-operation and Development (OECD & Eurostat, 2005:46) which states, "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations". This definition of the OECD & Eurostat limits the innovative activities to businesses, even though innovation does not only take place in firms, but can take place in any organisation or institution. This includes small and large firms, government and any other institution. Many authors focus on firms as the only institutions where innovation takes place, probably due to the discipline in which the study is done. If the discipline is focused on business studies, the role of participants in the economy, other than firms, is often ignored. Innovation is not only important for small and large firms, but for any other institution that needs to be innovative and must make use of entrepreneurship in order to improve and be successful. Vosloo (1994:147) agrees that the term entrepreneurship is mostly used in connection with businesses, but that it appears in small, medium and large businesses, in new ventures as well as in existing enterprises, and in government and other institutions. Drucker (1994:29) uses the term "social innovation" in contrast to "technical innovation" when he refers to the innovative activities of institutions such as schools, universities, civil services and banks. The phrase "business practices, workplace organisation or external relations" in the OECD & Eurostat definition is therefore replaced by the more general term "organisations", due to innovation taking place in many different kinds of institutions.

Most of the definitions of innovation, including the OECD & Eurostat definition, have Schumpeter's definition as basis. Schumpeter was one of the first economists who used the concept of innovation in his theories and his definition is still the one that is most widely used by innovation economists. Despite his groundbreaking work, his definition of innovation received much criticism, but has not yet been replaced by any other generally accepted definition. Schumpeter's definition of innovation is as follows:

> "This concept covers the following five cases: (1) The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position" (Schumpeter, 1961:66).

The OECD & Eurostat's definition adapted the acts that constitute innovation from Schumpeter, that is, the introduction of a "new product", "new method", "new market" and "new organisation". Schumpeter's definition of innovation actually exists of examples of actions that are carried out by business people and are not all necessarily innovation. The opening of a new market can, for example, be carried out by the marketer in his daily activities by using his old and practiced methods. It does not necessarily require any new or creative ideas or methods. The definition by the OECD & Eurostat therefore changed the wording from “opening of a new market” to “a new marketing method” and then changed “carrying out of the new organisation of an industry” to “a new organisational method”. For any idea, product, method or organisation to be called an innovation, it has to be applied; therefore, the OECD & Eurostat changed the concept “introduction” of the acts, to “implementation” of the acts. The definition neither of the OECD & Eurostat, nor that of Schumpeter, state that these acts, the “new method”, the “new market” or the use of a “new source of supply” have to be “successfully” implemented. For a new method, new product or new organisation method to be called innovation, the successful implementation of these acts is necessary. The goal of innovation is a positive change and increased productivity. A positive change is only possible if the acts of change are successfully implemented. Baregheh, Rowley & Sambrook (2009:1334) include in their definition of innovation that the aim for organisations is, “to advance, compete and differentiate themselves successfully in the marketplace”.

According to Smith (2005:149), the definition of innovation is about novelty, and the first challenge is to measure novelty. He reasons that even if novelty can be measured, a definition is needed for the term “new”. According to Smith, something may be old, but it can be new to the firm, or it can be a radically novel idea or it can be only an incremental change. The Oslo Manual (OECD & Eurostat, 2005:17-18) also uses the concept “new to the firm” when measuring innovation, even though the OECD & Eurostat agree that it forms part of diffusion by stating, “… an innovation does not need to be developed by the firm itself but can be acquired from other firms or institutions through the process of diffusion” and, “The minimum requirement for a change in a firm’s products or functions to be considered an innovation is that it is new (or significantly improved) to the firm”. Rogers (1995:132) agrees with the OECD & Eurostat and states that innovation is, “… an idea, practice or object that is perceived as new to an individual or another unit of adoption”. In such a case, the firm does not actually acquire the innovation from another firm, the firm acquires only the idea or technology. It only becomes innovation when the firm that acquired the technology or idea from another firm successfully implements that product or idea in the relevant market. Fagerberg, Srholec & Verspagen (2009:1) further clarify that innovation is not only about, "… developing brand new, advanced solutions for sophisticated, well-off customers, through exploitation of the most recent advances in knowledge", which is seen as a typical "first world" activity. Fagerberg *et al.* reason that "… even in so-called low-tech industries, there may be a lot of innovation going on, and the economic effects may be large … the term innovation may also be used for changes that are new to the local context …. Although many of the outcomes are less glamorous than celebrated breakthroughs in the high-tech world, there is no reason to believe that their cumulative social and economic impact is smaller." This kind of innovation is particularly important in the developing world.

The definition of innovation should include incremental changes, although the Oslo Manual of the Organisation for Economic Co-operation and Development (OECD & Eurostat, 2005:17) takes only, "… a significant degree of novelty…" into consideration. The purpose of the OECD & Eurostat is to measure innovation, but incremental changes are difficult to distinguish and therefore to measure. The problem is that the perceptions of the concepts "incremental" and "significant" differ among individuals. Sundbo (1998:21) defines "radical innovations" as, "… qualitatively very new and different elements which change a whole field" and "incremental innovations" as, "… small improvements which occur continually through the introduction of smaller new elements". Sundbo explains that even incremental innovation must involve a "qualitative" change including a "new element" and must not be only social or economic change. Despite these definitions, it is still not possible to determine when a change in product, process, organisation, etc. is "significant" enough to be regarded as part of innovation or not.

The term "technological change" is often used in literature when referring to innovation. Mansfield (1969:99) discussed both the terms "innovation" and "technical change", but he referred to innovation as only inventions that are applied for the first time. However, it is clarified in the next paragraph (by discussing the difference between invention and innovation) that inventions are not a prerequisite for innovation. Mansfield's definition of technological change corresponds more closely with the definition of innovation in this study. Mansfield (1969:10-11) defines technological change as follows:

> "Technological change is the advance of technology, such advance often taking the form of new methods of producing existing products, new designs which enable the production of products with important new characteristics, and new techniques of organization, marketing, and management".

The term innovation is preferred to technological change, due to innovation being the more inclusive concept. Technological change is often perceived to be restricted to manufacturing and so not applicable to services (Bloch, 2007:29).

The explanation of an act becoming an innovation only when it is successfully implemented, becomes clear when the difference between innovation and invention is considered.

2.2.2 Innovation *versus* invention

The terms innovation and invention are closely related, but although sometimes confused as synonyms, are two very different concepts. The Collins Dictionary of Economics (Pass, Lowes & Davies, 1993:277,261) explain the concepts by defining invention as, "… the creation of new production techniques and processes and new products which can be developed into usable processes and products through INNOVATION". Innovation is defined as, "… the practical refinement and development of an original INVENTION into a usable technique (process innovation) or product (product innovation)". Audretsch (2004:175) offers that invention and innovation are related, but not identical. He sums up the difference between the two concepts as follows, "The distinction is that innovation is a process that begins with an invention, proceeds with the development of the invention, and results in the introduction of a new product, process or service to the marketplace". Both of the definitions of The Collins Dictionary of Economics and that of Audretsch imply that an invention is a prerequisite for innovation to take place. Yet, this is not necessarily the case. According to Schumpeter (1961:89), "… innovations…need not necessarily be any inventions at all". Innovation is often only an improvement or modification of a product, process or system that has been used for a long period. This implies that no new invention preceded the innovation. It is equally true that all inventions do not necessarily become innovations either. Herrick & Kindleberger (1983:223) stated that some inventions cannot be developed into profitable innovations due to cost constraints, therefore inventions do not necessarily become commercially effective.

The essence of the difference between innovation and invention lies in the fact that for innovation to take place, the new or existing invention is transferred into practice. Invention is, according to Williams (1999:13-14), "… the creation or discovery of something new…" where innovation is seen as, "… the implementation of discoveries and inventions…". The view of Fagerberg (2005:4) is similar when he distinguishes between invention and innovation, writing, "Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out in practice". This is similar to Schumpeter's (1961:88) view where he stressed the importance of inventions to be "carried into practice" in order to become economically relevant. Freeman, Clark & Soete (1982:201) defined invention as, "The first idea, sketch or contrivance of a new product, process or system, which may or may not be patented" and innovation as "The first introduction of a new product, process or system into the ordinary commercial or social activity of a country". Freeman (1982:7) gives Schumpeter credit for the place that innovation has in the theory of economic development and he summarises Schumpeter's explanations of the concepts, invention and innovation, as follows:

> "An *invention* is an idea, a sketch or model for a new or improved device, product, process or system. Such inventions may often (not always) be patented but they do not necessarily lead to technical innovations. In fact, the majority do not. An *innovation* in the economic sense is accomplished only with the first *commercial* transaction involving the new product, process, system or device, although the word is used also to describe the whole process".

A further difference between innovation and invention can be shown by examining the institutions or individuals who carry out the invention or innovation. Where inventions can take place, for example, at universities, innovation takes place mostly in firms (Fagerberg *et al.*, 2005:5). Schumpeter (1961:88-89) uses a similar distinction by stating that innovation and invention are two “entirely different tasks” that requires “entirely different aptitudes” and he states that it is only a coincidence if the entrepreneur (who carries out the function of innovation) and the inventor is the same person. Herrick & Kindleberger (1983:222) use the analogy of pure and applied science where the scientist performs the research and produces the invention while the managers and entrepreneurs carry out the innovation. The former is seen as performing pure science, and the latter is seen as applying the science. Rogers (1995:135) also distinguishes between technology and innovation by using the same analogy. Rogers believes that technology is the product of basic research, but to design an innovation, the scientific knowledge needs to be put into practice in order to solve a perceived need or problem. The implication, therefore, is that when the basic research is used in order to solve problems, it becomes applied research. There is, however, not a clear cut between where pure science (or the basic research) ends and where applied science (or applied research) starts, as is implied by Herrick & Kindleberger and by Rogers. Invention and innovation cannot be classified under either pure or applied science. Inventions can be the product of pure science or can be an application of already-existing science. An invention is not yet a commercial application, but can be a science application, where innovation exists when the product or process is commercialised.

In their discussion on invention and innovation, Herrick & Kindleberger (1983:223) also distinguish between inventions, purely for the pleasure of making discoveries, and deliberate efforts by teams to invent and innovate, in order to make profits. The first type, they called autonomous technological change, which is where the invention is done for “idle curiosity”. The second kind they called induced technological change where there is a strong need to convert the products, through systematic development, into something that consumers might prefer.

There can also be differences between the times that invention and innovation takes place. Time lags of different lengths can occur between the invention and its related innovation (Fagerberg *et al.*, 2005:5). Van Duijn (1983:176-179) provides a table (Table 2.1) with a list of dates of 160 inventions and the corresponding dates of innovation. This list is evidence of the different time lags between an invention and the innovation following it. The time lags ranges, for example, from one year between the invention of Freon refrigerants and their related innovation to a fifty-six years difference between the invention of the remote control and its related innovation. Mansfield (1969:103-104) provides a few possible reasons for these lags. They delays may be caused, for example, by the entrepreneur's uncertainty regarding public acceptance of the innovation, by doubts concerning the profitability of the innovation or even just maintenance problems.

It is now clear that innovation and invention are strongly linked, but are two very different concepts. There are different types of innovation that can be distinguished in the literature of innovation. These differences will be explained below.

2.2.3 Types of innovation

The literature distinguishes among different types or components of innovation. Sundbo (1998:21), focussing on Schumpeter's definition, identifies four types of innovation and four different characters. The types of innovation are:

> " 1. A new product or a new service; 2. A new production process; 3. A new organizational or management structure; 4. A new type of marketing or overall behaviour on the market, including a different relationship with the state and other official regulation systems, societal organizations or specific consumers".

Sundbo does not elaborate on the difference between the types and the characters of innovation, but the characters seem to be the different forms that the types of innovation can take on when change in products, services, processes, organisational structures, etc. takes place. The characters of innovation that Sundbo (1998:21) identifies are:

> "1.Technological (objects); 2. Intellectual, e.g. consultancy; 3. Physical movements (which are not technology), e.g. a new transport (but without a change in technology); 4. Behavioural, e.g. a new strategy for the company's market behaviour or a new organizational structure".

Innovation is often used in the literature as one, or sometimes a few, types or characters of innovation. These components of innovation can be studied separately, but none of them can be excluded from the comprehensive concept of innovation. The different types of innovation are described below:

> "A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics".

> "A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software".

> "A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing".

> "An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations" (OECD & Eurostat, 2005:48-49).

2.3 <u>Entrepreneurship</u>

The entrepreneur plays a vital role in innovation. The terms or concepts, innovation and entrepreneurship, can seldom be discussed in isolation from each other. The concepts, entrepreneur and entrepreneurship, thus need to be defined, due to the different perceptions in literature of these concepts.

For the purpose of this study, the entrepreneur is defined as follows:

> An entrepreneur is an individual who carries out innovation.

This definition is adopted from Schumpeter (1961:74). This definition implies that an entrepreneur is the agent who is responsible for the successful implementation of a new product or improved product (good or service), or process, a new marketing method, or a new organisational method in organisations. Schumpeter (1961:74&89) sees innovation as the function of the entrepreneur, and the entrepreneur is seen as the individual whose function it is to carry out new combinations. Drucker (1994:25) has a similar opinion and calls innovation, "…the specific instrument of entrepreneurship". He defines the entrepreneur as one who "always searches for change, responds to it, and exploits it as an opportunity". The words "new" and "change" are essential to these definitions, because it distinguishes these definitions of the entrepreneur from definitions where the entrepreneur is described only as manager or capitalist. Schumpeter (1961:76) agrees only partly with J.B. Say's definition of the entrepreneur (when he quoted Say as believing, "the entrepreneur's function is to combine the productive factors, to bring them together"), because Schumpeter reasons that this is only true if the combination of production factors takes place for the first time (implying the novelty concept of innovation).

An entrepreneur is not the same as a manager even though current usage has the two terms as interchangeable synonyms. Schumpeter distinguishes between the entrepreneurial function and the managerial function. Although the same person may carry out both functions, the two functions are not the same. The managerial function is about running a firm along established lines. This function must be clearly contrasted against the entrepreneurial function of carrying out innovations. Schumpeter further clarified these concepts as follows, “Nobody ever is an entrepreneur all the time, and nobody can ever be only an entrepreneur … A man who carries out a ‘new combination’ will unavoidably have to perform current nonentrepreneurial work in the course of doing so…” (Schumpeter, 1939:102-104).

The entrepreneur might be considered to carry risk, due to the uncertainty involved in innovation. Schumpeter, however, does not agree that the entrepreneur carries risk. According to Schumpeter (1939:102-104), a distinction must be made between the entrepreneur and the capitalist. Schumpeter’s view was that the entrepreneur does not bear the risk, but that the capitalist does, because it is the latter that can lose money. Schumpeter stated that the entrepreneur and capitalist may be the same person, but that bearing the risk is not part of the entrepreneurial function. Schumpeter sees risk only as the loss of money. Yet it must be argued that, if there is uncertainty, there is risk (even if it is not the loss of one’s own money). An entrepreneur does not introduce new products to the market, implement new methods of production and organisation, etc., just to satisfy his curiosity or his sense of adventure. The entrepreneur is involved in innovative activities in order to reduce costs, to increase returns on an investment or to increase any other form of economic gain, even if the investment was not made by the entrepreneur himself. Drucker (1994:23) agrees with Schumpeter’s view that there is a distinction between entrepreneurs and capitalists or investors, but Drucker contends that this does not imply that entrepreneurs do not carry risk. Drucker is of the opinion that anyone who is involved in economic activity is subjected to uncertainty and so must be willing to take risks.

Innovation and entrepreneurship does not only take place in firms, but in other institutions also. Vosloo (1994:147) summarises it as follows, “In its broadest sense an entrepreneur may be described as a person who has the ability to explore the environment, mobilize resources and implement action to maximize those opportunities.

The term thus includes a variety of innovators who, on the business side, work in small, medium or large enterprises and on the non-business side, in voluntary or government institutions". Bygrave, (1994:2), offers a narrow view of entrepreneurship by including in entrepreneurship everyone who starts a new business. Bygrave defines the entrepreneur and the entrepreneurial process as, "An entrepreneur is someone who perceives an opportunity and creates an organisation to pursue it" and, "The entrepreneurial process involves all the functions, activities, and actions associated with perceiving opportunities and creating organizations to pursue them". Although there is credibility to part of Bygrave's definition in his references to new opportunities and the creation of something new, he limits entrepreneurship to new business creation. The definitions of Schumpeter, Vosloo and Drucker imply that entrepreneurship cannot be limited to new businesses, but can take place in any kind of business at any time during the life of such a business. Vosloo, (1994:147), stated, "The term [entrepreneurship] does not refer to the size or age of an enterprise, but to a certain kind of activity." This activity refers to innovation.

It must not be thought that the entrepreneur is the only role player in innovation activities. An entrepreneur does not function in isolation. There is a system of innovation, within which the entrepreneur interacts with other participants in performing its innovative activities. This will now be further explored.

2.4 Systems of innovation

Although innovation can take place in any kind of organisation, innovation mostly takes place in firms. Many organisations or institutions have an effect on the firms and their innovative activities. These firms, organisations and institutions that play a role in the innovative activities all interact and form a system. Such a system is called an innovation system. The word "system" is sometimes interpreted as something that is planned or controlled by a certain political institution or as having been consciously designed or built. This is not at all what is meant by the concept "innovation system". The word "system" here implies that there is interaction among all the different actors or participants who contribute to innovation, and the system includes an environment within which innovation takes place. These actors or participants do not necessarily interact consciously with one another. The different participants do not necessarily have the same goal, either. The entrepreneur's main aim will most probably be profit, where the aim of the academic institutions may be research and training to enhance innovation, while the aim of government may be the creation of a macroeconomic environment within which innovation can take place. Yet, the different participants each have an impact on one another. Nelson (1996:276) explained the system concept as follows, "There is no presumption that the system was, in some sense, consciously designed, or even that the set of institutions involved works together smoothly and coherently. Rather, the 'systems' concept is that of a set of institutional actors that, together, play the major role in influencing innovative performance".

An innovation system is defined as follows:

> An innovation system consists of the participants or actors and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

This definition consists of a number of distinct components. First, an innovation system is a system that consists of many independent participants, also called actors or institutions in some publications. Secondly, there is an interaction among the participants (Nelson, 1996:276; Freeman, Lundvall & Metcalfe, as quoted by the OECD, 1997:9-10; and Paterson, Adam & Mullin, 2003:1). The flows of technology and information among people, enterprises and institutions are very important in the national systems of innovation (NSI). The different role players in the innovation system include, for example, enterprises, academic and research institutions, the public sector and other institutions. The relationships among these role players may form a complex system, but the different role players can each benefit from the interaction amongst them. The benefits can be to the advantage of individuals or individual firms, including joint research activities, diffusion of knowledge and technology, and improved firm performance. These benefits will eventually lead to an improvement in the economic and social well-being of a community (OECD, 1997). Some of the interaction among these participants may be co-operative while others may be competitive. No single participant controls the workings of the system nor the interaction among the participants, although there are participants who can exert a significant influence in or on such a system. Government can, for example, play an important role in the performance of the system as a whole (Paterson *et al.*, 2003:2). Thirdly, the participants function within a socio-economic environment. The definition of Edquist, as quoted by Fagerberg *et al.* (2005:183), adds an aspect that most other definitions do not include. Edquist's definition has, "… all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations". The "economic, social, organisational, political, institutional and other factors" form the environment within which the participants function. Finally, the participants, their interactions and the environment determine the innovative performance of the system. Nelson (1996:276) describes the outcome of the system as the, "innovative performance of national firms". The outcome should be "innovative performance", but of the whole system and not only of firms. Other definitions limit the outcome to a few specific innovative activities, which therefore exclude some of the aspects that should form part of innovative performance. For example, Freeman includes only the initiation, import, modification and diffusion of new technologies, while Lundvall includes the production, diffusion and use of new knowledge. Patel & Pavitt include the rate and direction of technological learning; and Metcalfe includes the development and diffusion of new technologies, and the creation, storage and transfer of knowledge, skills and artefacts (OECD, 1997:9).

The definition of an innovation system can be adapted for a national, regional, sectoral or other kind of innovation system by specifying the national, regional or sectoral boundaries of the participants. The innovation system concept originated with the concept of national innovation systems, but recently the regional innovation system became popular in literature. Carlsson (2007:860) distinguishes between national, regional, sectoral and technological innovation systems. According to Carlsson, national systems of innovation (NSI) refer to innovation activities within national boundaries where regional systems of innovation (RSI) refer to innovation activities within regional boundaries. Sectoral innovation systems focus on individual sectors or industries and technological innovation systems is about a particular technology or set of technologies, not bound by a specific geographical area.

2.4.1 National innovation systems

In literature, the term "national innovation system" (NIS) is used interchangeably with the term "national system of innovation" (NSI). For the purpose of this study, a national innovation system is defined as follows:

> A national innovation system consists of the participants or actors, situated within national borders, and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

To distinguish a national innovation system from any other kind of innovation system, such as regional, sectoral or international innovation systems, it must be specified that these actors or participants be situated within national borders. Lundvall's definition (as quoted by the OECD, 1997:9) states "inside the borders of a nation state", Nelson (1996:276) and Patel & Pavitt (as quoted by the OECD, 1997:9) mention "national firms" and "national institutions", respectively, and Paterson *et al.* (2003:1) uses the term "within national borders".

2.4.2 Regional innovation systems

The realisation of the importance of studying innovation systems from a regional perspective originated from the regional differences that exist within nation states (Chen & Kenney, 2007:1071; Doloreux & Parto, 2005:136). Cooke, Uranga & Etxebarria (1997:479) demonstrated that, "... some of these basic characteristics which distinguish a state can sometimes be distinctive in certain regions in comparison to other regions which belong to the same state". According to Baskaran & Muchie (2010), a regional innovation process originates because of interactions among economic and social levels between different institutions located in a particular region. The aim of the research determines which system of innovation will be focused on. From a policy perspective, it may be more useful to study the national innovation system whereas the regional innovation system studies contribute to understanding the regional differences, handicaps and potential.

A regional innovation system may be defined, similar to a national innovation system except for the boundaries, as follows:

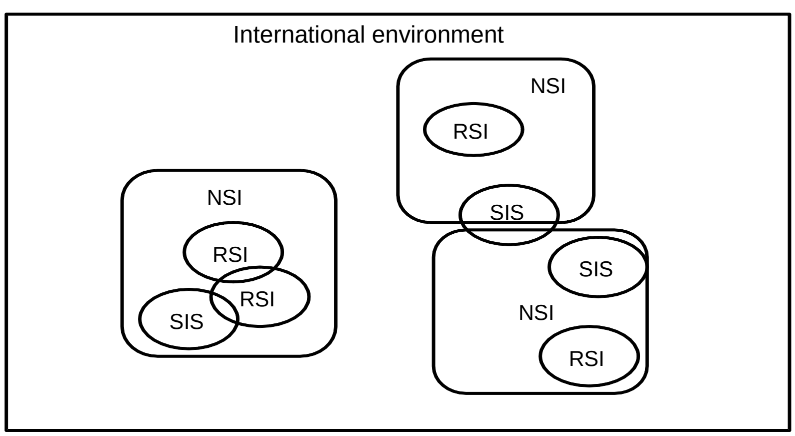
> A regional innovation system consists of the participants or actors, situated within a region, and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

The definitions of Chung (2002:487), Cooke (as cited by Capron & Cincera, 1999:11) and Doloreux & Parto (2005:134) include, just as do the definitions for national innovation systems, the different actors or participants and the interactions amongst them. Unfortunately, there is no specific reference concerning how "the region" is to be defined. The concept "national" in the term "national innovation system" is more self-evidently the national borders of a country. The term, "region", is not always as clearly demarcated. Cooke *et al.* (1997:480) supplies clear parameters by defining regions in the regional innovation system perspective as, "... territories smaller than their state possessing significant supralocal governance capacity and cohesiveness differentiating them from their state and other regions". Not all researchers agree that a region is defined by its "significant supralocal governance". Holbrook & Salazar (2003:2) agree with Cooke *et al.* in that regions are smaller than their state and Holbrook & Salazar further elaborate (by quoting Braczyk & Heidenreich) that the regions are neither autonomous nor sovereign in terms of relations with the nation-state or supranational institutions, but Holbrook & Salazar explains that regional powers vary amongst countries. Holbrook & Salazar add that, “Some regions span more than one sub-national unit of government, others are sub-sets within a distinctive regional space, others have virtually no formal or dedicated ‘governance’ at all (for example there is no politico-administrative corresponding ‘Silicon Valley’) while still others have few if any specific policy tools or levers with which to influence innovation processes”. There are two aspects implied in Holbrook & Salazar’s view of a regional innovation system, even though the region, *per se,* may not have been clearly defined. Firstly, the regional innovation system, in which the “politico-administrative authority” plays a more direct role, must be distinguished from the sectoral innovation system in which the authority has a more indirect influence. Secondly, for a region to be classified as an innovation system, innovative activities should be present and the participants should be able to have an influence on the innovative processes. Doloreux & Parto (2005:143) suggest that it might be argued that all regions, however defined, have some kind of innovation system. This may be true in the national context, but not all regions have the potential to have participants, interaction or innovative activities so that the region would need to be classified as an innovation system. Regions develop due to political, cultural or economic forces (Cooke *et al.,* 1997:480). If the region is formed by non-economic forces that can change in a relatively short period, and if the region does not manifest innovative activities nor does it have potential to develop such activities, the region should perhaps not been classified as an innovation system. Scerri (2008:3) explains that national innovation systems are better-demarcated systems as the nation state is an internationally recognised legal entity that is rarely threatened by, for example, civil war or an act of war by another nation state. Scerri stated that, “the legal basis for sub-national systems of innovation tends to be less firm and inviolate” and that, “the legal lines may be changed relatively easily through internal political processes”. Scerri’s reasoning makes it clear that a regional innovation system, in contrast to a national innovation system, is not defined by the legal, geographic boundaries of the regions. Some innovative activities have to be present for a region to be classified as an innovation system.

2.4.3 <u>The relationship between the national and regional innovation concepts</u>

In Figure 2.1, the relationship between national systems of innovation (NSI) and regional systems of innovation (RSI) is indicated. A national innovation system functions within, and is linked to, the international innovation environment. A national innovation system may also comprise many regional innovation systems. Fromhold-Eisebith (2007:224) summarises the relationship of the RSI with the NSI by stating, "… a RSI is not operating as an autonomous, self-contained unit, but as a set of elements and connections that is linked with its NSI, other RSI of its own nation and external ones, too". The relationships among the national and regional innovation systems and the international innovation environment are illustrated in Figure 2.1. Figure 2.1 illustrates that there are different national innovation systems (due to the existence of different countries). Each country has a national innovation system, whether working well or not. The NSI do not overlap due to their separation by national boundaries. These national innovation systems function in a global context and are therefore influenced by the world economy. The international environment includes, for example, a world recession or prosperity, the effect of wars in other countries on the economy, for example, that influence the national economy, even if not directly.

Figure 2.1 The relationship between NSI, RSI and SIS



A national innovation system forms links with other national innovation systems, having a more direct foreign influence on their own system, through, for example, bilateral trade, university co-operation, human resource mobility, and the like.

Figure 2.1 further illustrates that in a national innovation system, there may well be sectoral innovation systems (SIS) too. Sectoral innovation systems may either be limited by geographical boundaries, or may be defined by sectoral or industry boundaries that extend beyond geographical boundaries. According to Carlsson & Stankiewicz, as quoted by Cooke, Uranga & Etxebarria (1997:476), the technological system may be nationally or regionally bound, may be international or even global.

In Chapter Six, the participants or role players in an innovation system will be identified. The roles of the different participants in the system of innovation will also be determined, as well as the interaction among these participants.

2.5 Economic development

This study of innovation and the drive to increase innovative activities is imbedded in the need for economic development. This need for economic development globally, as well as in South Africa and Mpumalanga, will be presented in order to motivate the importance of this study of innovation.

Although the terms, economic growth and economic development have often been used as synonyms, there is, currently, a clear distinction of the two concepts in literature. Economic development is a much more complex concept, including economic growth as one of the contributing factors to development (Herrick & Kindleberger, 1983:21; Nafziger, 2006:15; Todaro & Smith, 2009:8). A shift in interest from growth to development came after World War II when governments realised that the benefits of growth often did not spread to the poorer parts of the population (Nafziger, 2006:15). According to Herrick & Kindleberger (1983), "… economic growth means more output" where "economic development implies not only more output but also different kinds of output than were previously produced, as well as changes in the technical and institutional arrangements by which output is produced and distributed". Nafziger (2006:48) describes the difference between growth and development as follows, "Economic growth is an increase in a country's per capita output. Economic development is economic growth leading to an improvement in the economic welfare of the poorest segment of the population or changes in educational level, output distribution, and economic structural change". Herrick and Kindleberger's definition focuses on output only. Nafziger's definition is more comprehensive by including the improvement of welfare, but limits it to the poorest part of the population and so neglects the improvement of any other part of the economy. Nafziger's definition limits the improvement in economic welfare to education and output distribution. For different communities, the improvement in welfare may include changes or improvements in many other areas, such as health or employment. Listing the improvement needed in certain areas within the definition of economic development restricts the improvement of welfare to those issues. The definition of economic development should rather be:

> Economic development is economic growth leading to economic structural change and an improvement in the welfare of the community.

The concept of economic development should also be distinguished from development as a whole. According to Herrick & Kindleberger (1983:94), economic development is only a subset of the whole process of development and focuses mostly on "materially oriented issues" such as output, employment, incomes and composition of production, whereas development focuses mostly on "changes in the human condition". Todaro & Smith (2009:16) supply a detailed definition of development, as follows:

> "Development must...be conceived of as a multidimensional process involving major changes in social structures, popular attitudes, and national institutions, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of poverty. Development in its essence, must represent the whole gamut of change by which an entire social system, tuned to the diverse basic needs and desires of

individuals and social groups within that system, moves away from a condition of life widely perceived as unsatisfactory toward a situation or condition of life regarded as materially and spiritually better".

This definition captures the dynamic characteristic of development, in the sense that development implies a constant improvement in living standard. This definition, though, is very wide and concepts such as "unsatisfactory conditions" and "materially and spiritually better" are differently perceived by individuals. Economic development can thus be seen as a sub-set of development, albeit an essential part of development, just as economic growth is a sub-set of economic development, even though an essential part of the larger "economic development". For example, an improvement in living standard would be the outcome of economic growth, economic development and of development as a whole.

Traditionally, the focus was on economic growth only, but it shifted to economic development due to unwanted and negative perceptions of some outcomes of growth. According to Todaro & Smith (2009:14), countries that concentrated on stimulating industrial growth often did it at the expense of agricultural and rural development. This created a false impression of an improvement of living standards due to a higher GNP (or GDP). Todaro & Smith further reasoned that industrialisation could cause structural unemployment if labour was not mobile between sectors. Industrialisation can also have a negative effect on food security if the agricultural and rural sectors of the economy are neglected. Further, if not well managed, industrialisation can have a negative effect on the environment by causing both air and water pollution. Todaro & Smith (2009:208) further indicated that the poor countries queried the concept of growth *versus* that of income distribution. By stimulating the growth in a country, the income distribution gap can be spread further, depending on who contributes to the growth – the rich or the poor. Yet, the Commission on Growth and Development (2008:14), appointed by The World Bank, contends that rising inequality does not necessarily mean that poverty is not reduced and that it often happens that poverty is reduced while inequality increases, especially in fast-growing economies. The Commission further emphasises the importance of growth by stating that redistribution is easier if there is economic growth in a country. The Commission stated that in very poor countries growth is necessary to reduce poverty because in such countries there is nobody to redistribute from and that in a country where everyone is poor, growth will reduce poverty even if income is not distributed equally.

In order to improve living standards and welfare, not only economic growth is important, but rather the encompassing concept of economic development. Yet the importance of economic growth as a component of economic development should not be underestimated. The Commission on Growth and Development (2008:14) stated the following:

> "The Commission understands that growth is not an end in itself. It is instead a means to several ends that matter profoundly to individuals and societies. Growth is, above all, the surest way to free a society from poverty. Without it, a stark lack of material resources will tend to dominate everything else, narrowing people's horizons, consuming them in a daily struggle to get by, and depriving them of the chance to fulfil their potential. Prosperity, on the other hand, frees people to make choices, and allows a more equal distribution of opportunities. Human development, understood in its broadest sense, is both an 'output' of growth and one of the most important inputs".

2.6 Summary

The first objective of Chapter Two was to clarify the concept, of innovation, as well as related concepts. The definition of innovation that will be used in this study, is largely based on the definition of the Oslo Manual (OECD & Eurostat, 2005) and on that of Schumpeter (1934 as published in 1961), and is as follows:

> An innovation is the successful implementation of a new or improved product (good or service), or process, a new marketing method or a new organisational method.

The difference between the concepts, innovation and invention, was discussed, explaining that an invention only becomes an innovation when it is commercialised.

The entrepreneur plays a significant role in innovation. Schumpeter's definition of an entrepreneur is accepted as best describing the entrepreneur in economic context. The entrepreneur is therefore defined as follows:

> An entrepreneur is an individual who carries out innovation.

The entrepreneur should be seen as distinct from the manager and the capitalist, although one person may fulfil the functions of all three. Contrary to what Schumpeter presented, the entrepreneur does carry risk of various kinds. Although the importance of the entrepreneur is accepted, the entrepreneur is not the only participant in the innovation system. Other participants include government, research institutions, suppliers, competitors, etc. The entrepreneur functions, not only in small or new businesses, but also in large businesses, existing businesses and in other institutions.

Innovation activities take place within a system of innovation. The innovation system consists of different participants and the interaction amongst them. This interaction amongst the participants can be deliberate efforts to enhance innovation or it can be entirely independent actions that, knowingly or unknowingly, have an influence on the other participants or on the innovation process. There is not a generally accepted definition in literature for an innovation system. For this study, an innovation system will be defined as follows:

> An innovation system consists of the participants or actors and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

This definition of an innovation system can be adapted for a national, regional, sectoral or other kind of innovation system by specifying the national, regional or sectoral boundaries of the participants. The demarcation of the national innovation system is assumed to be the boundaries of the nation state, but the demarcation of the regional innovation system is not as easily defined. The boundaries of a regional innovation system may not have a firm legal basis. Some innovative activities have to be present if a region is to be classified as an innovation system. Innovation has to be studied within the context of the innovation system in order to determine how innovative performance can be made yet more effective. A model for a system of innovation, including the participants, their interaction and their roles in the system will be presented in Chapter Six.

The second objective in this chapter was to present the need for economic development globally, but especially for South Africa. Economic development is defined as follows:

> Economic development is economic growth leading to economic structural change and an improvement in the welfare of the community.

Economic development requires the improvement of the overall well-being of the people in a country – a mere increase in the GDP constitutes growth, but does not necessarily imply economic development. Yet, economic growth is an essential part of economic development.

The development needs in South Africa and the Mpumalanga province were presented. The Mpumalanga province was indicated as one of the provinces in South Africa with a great need for development. The Mpumalanga province will therefore be used as a case study and Mpumalanga will be evaluated (in Chapter Seven) against the model of an innovation system that will be presented in Chapter Six.

In the next chapter, the different views on the role of innovation in economic development will be presented.

CHAPTER THREE

VIEWS ON INNOVATION IN ECONOMIC THOUGHT

3.1 Introduction

In the previous chapter, the concepts, innovation and economic development, were clarified. It is now the aim of this chapter to place the role of innovation in economic development in its theoretical context through a literature study. It will also seek to provide historical background on the issue. The chapter consists of a critical discussion of the schools of economic thought to establish what role they ascribe to innovation and entrepreneurship. The discussion will include the classical economic theory and the neoclassical theory of “equilibrium in the markets” and “perfectly competitive markets”. Schumpeter’s view and theory will be discussed largely due to the important role that he played in innovation theory. The discussion will include the long wave theory and its part in the role of innovation.

According to Sundbo (1998:4), an “innovation economics” tradition developed in the 1970s and 1980s where innovation theory developed as a particular school of economic thinking. The term “neo-Schumpeterian” is used by some economists to describe this new school of thought, and the neo-Schumpeterian theory on innovation is therefore included in the discussion.

3.2 The main contributors to innovation theory

Although many economists have touched on the concept of innovation, Gabriel Tarde and Joseph Alois Schumpeter deserve to be studied in more detail, because of their respective contributions to innovation theory.

3.2.1 Gabriel Tarde's role in innovation theory

The French sociologist, Gabriel Tarde (1843-1904) has been described as the first great theorist of innovation and entrepreneurship (Barnett,1953:v-vi; Sundbo, 1998:48).

Tarde was the first theorist who used and described the two concepts, invention and innovation, as well as the postulate that innovation comes in waves. Tarde mostly used the concepts of invention and imitation. He believed that first imitators, and not the inventors, play the central role. This corresponds with the innovators in later literature. The major works of Tarde, in which he described the innovation theory, included the trilogy *Les lois de l'imitation* (1890), *Logique Sociale* (1894) and *L'Opposition Universelle* (1897), as well as his work *Psychologie Economique* (1902) (Sundbo, 1998:49-50).

Latour & Lépinay (2009:35) stated, "Fifty years before Joseph Schumpeter, eighty years before the development of economics of technical change, Tarde places innovation and the monitoring of inventions at the heart of his doctrine". Sundbo's (1998:50) view is that Tarde was first in describing the innovation concepts and that this foundation of the innovation theory lived on with Schumpeter, as Schumpeter became known as "the founder of innovation theory".

3.2.2 Schumpeter's contribution to innovation theory

Schumpeter made a crucial contribution to the study of the role of innovation in development. Schumpeter (1939:86-87) highlighted the importance of innovation when he wrote, "… innovation is the outstanding fact in the economic history of capitalist society or in what is purely economic in that history…". He stated his intention is to make the facts of innovation the basis of his model of the process of economic change. As the founder of innovation theory, it is therefore vital to pay some attention to his life and thinking.

Joseph Alois Schumpeter (1883-1950) was born in the Austrian province of Moravia. He studied law and economics at the University of Vienna and started his career by practicing law and teaching political economy. He was appointed as professor at the University of Graz (Austria) in 1911, and was an exchange professor at the Columbia University during 1913 and 1914. In 1919, he served as Minister of Finance of the Austrian Republic, after which he pursued his career in the private sector. In 1921, he became president of a private banking house in Vienna (Biedermann Bank), but when the bank went bankrupt in 1924, he accepted a professorship at the University of Bonn. In 1932, he was appointed at Harvard University and he remained at Harvard until his death. Schumpeter served as president of the American Economic Association for a period, which was unusual for a foreign-born economist. Amongst Schumpeter's best-known publications are "The theory of economic development" (1911), "Business cycles" (1939), "Capitalism, socialism, and democracy" (1942), and his encyclopaedic "History of economic analysis" (1954) (Brue, 2000:499-500; Hanusch & Pyka, 2007d:19-20; Heertje, 2006:3-4).

Schumpeter's contribution to the theory of economic development and the role of innovation therein, is remarkable. The following quotes are examples of the recognition Schumpeter received:

> "Joseph Schumpeter…was one of the most original social scientists of the twentieth century…Very early he developed an original approach, focusing on the role of innovation in economic and social change" (Fagerberg *et al.*, 2005:6).

> "More than half a century after his death, Schumpeter still remains an intriguing source of scientific debate on major economic and social issues and methodology, and empirical research on economic dynamics and technical change" (Heertje, 2006:vii).

> "Over the past thirty years a number of economists have dedicated themselves to studying technical change, or innovation more broadly, its sources, and its economic

> consequences … In all these branches of economics, as well as among scholars directly concerned with technical advance, Schumpeter is widely cited as an inspiration" (Nelson, 1996:87).

> "Schumpeter … is the exceptional economist who links innovation to the entrepreneur, maintaining that the source of private profits is successful innovation and that innovation brings about economic growth" (Nafziger, 2006:293-294).

Although Schumpeter has received the recognition that he deserves in the literature of the last twenty to thirty years, he was not recognised as a leading economist during the time that he developed and published his theories. The classical and neo-classical schools received much attention and Keynesianism was very popular after World War II when Schumpeter was most active. Van Duijn (1983:93) stated that, since the 1970's, "… resistance arose against the failure of neo-classical theory to deal with the phenomenon of innovation …". Hanusch & Pyka (2007d:25) opined that, "… it might appear astonishing that it took until the middle of the 1980s for the economics community to rediscover the ideas of Schumpeter …". The two reasons that Hanusch & Pyka (2007d:25) give for the lack of interest in Schumpeter's theory are, first, the interest in Keynes's theory concerning the removal of macroeconomic imbalances and the potential stabilising effect on the circular flow. The second reason is that Schumpeter did not present his ideas in the form of mathematical systems. The later development of such systems and subsequent attempts to formalise Schumpeter's theory, have substantially increased interest in his work.

However, what is it that makes Schumpeter's theory so significant and different to other schools of thought? In the discussion that will follow, Schumpeter's role in the innovation theory will be analysed, as will contributions of other notable economists.

3.3 The place of innovation in economic theories

There are many different views in economic theory of the role of innovation. Some theorists see innovation as one of the key elements, the basis of the theory, while others do not consider innovation as an important factor. In some theories, innovation is seen as an endogenous factor, while other theories describe innovation as exogenous to the economy. This study is embedded in the Schumpeterian and the neo-Schumpeterian theories, as will be explained in the discussions that will follow. In this section, an overview of the origin of the innovation concepts as well as the place of innovation in the historical theories will be presented.

The theory of innovation will be discussed using the following concepts as subject headings: equilibrium *versus* disequilibrium, innovation as an endogenous versus an exogenous factor of growth, the importance of the entrepreneur in innovation theory, and the concept of clusters of innovation (which will include a discussion on the "long waves" in the economy).

3.3.1 Equilibrium *versus* disequilibrium

The most fundamental difference between the neo- and classical theories and the Schumpeterian theory is the debate on an economy that tends towards an equilibrium position *versus* an economy that is continually changing and in disequilibrium. Although innovation (or technology, as some sources refers to the concept) has been recognised by some classical economists such as Marx and Adam Smith, the dominant neoclassical theory did not regard innovation or technology as a major category in its models. These models were based on economic equilibrium (Sundbo, 1998). According to Sundbo (1998), "The Neoclassical theory is based on an abstract theoretical assumption of general equilibrium in the economy, which would mean that there would normally be no change". The neoclassical theory cannot therefore be used to explain economic growth or development, because growth and development implies change. Marshall, as quoted by Nelson (1996:88), explains the lack of interest in innovation and economic development by the mainstream of economics, saying, “The Mecca of economics lies in economic biology rather than economic mechanics. But biological conceptions are more complex than those in mechanics; a volume on foundations must therefore give a relatively large place to mechanical analogies, and frequent use is made of the term equilibrium which suggests something of a static analogy”.

Schumpeter’s theory questions the traditional view of economic system’s tendency towards equilibrium and its ability to explain and predict certain phenomena:

> “… ‘static’ analysis is not only unable to predict the consequences of discontinuous changes in the traditional way of doing things; it can neither explain the occurrence of such productive revolutions nor the phenomena which accompany them. It can only investigate the new equilibrium position after the changes have occurred” (Schumpeter, 1961:62-63).

He refers here to change that is exogenous to the neoclassical model of the economic system. He believed that this traditional static view of the economic system does not explain development:

> “Development in our sense is a distinct phenomenon, entirely foreign to what may be observed in the circular flow or in the tendency towards equilibrium. It is spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing. Our theory of development is nothing but a treatment of this phenomenon and the processes incident to it” (Schumpeter, 1961:64).

Important influences on Schumpeter’s theories are Léon Walras and Karl Marx, but these influences do not imply that he agreed with their theories. The influence from Walras on Schumpeter was Walras’s emphasis of the interdependence of economic quantities in his theory. Schumpeter strongly disagreed with Marxism, but he admired Marx’s emphasis on the process of economic change. Marx’s theory coincides with

Schumpeter's on the basis that technology is continuously changing and is therefore dynamic. Marx differs mostly from Schumpeter in that Marx "passionately hated capitalism" (Brue, 2000:189-191;500). Marx, similar to Schumpeter, regarded innovation as the centre of their respective growth theories (Freeman, 2008:74). Schumpeter's theory differs from that of Walras in that Walras's theory is based on general equilibrium analysis and so his approach is static. This implies that his theory does not include an explanation of innovation as a component in economic analysis, because innovation is the one component that leads to disturbing an equilibrium situation. Nelson (1996:88-89) is of the opinion that theories like that of Walras "… might actually interfere with the ability to theorize about innovation and … might drive concern for innovation to the outlands of the discipline". Brue (2000:373) summarises Walras's theory as follows:

> "Walras's general equilibrium theory presents a framework consisting of the basic price and output interrelationships for the economy as a whole, including both commodities and factors of production. Its purpose is to demonstrate mathematically that all prices and quantities produced can adjust to mutually consistent levels. Its approach is static, because it assumes that certain basic determinants remain unchanged, such as consumer preferences, production functions, forms of competition, and factor supply schedules".

According to Hanusch & Pyka (2007d:22), the reaction of Schumpeter in 1908, the same year in which Schumpeter met Walras, was as follows:

> "Economic development and all the important sources of disturbance of equilibrium states lead away from equilibrium without showing any tendency of returning to it".

Schumpeter therefore directly opposed the very basis of Walras's theory. Schumpeter's view on the important role of innovation in disturbing the equilibrium is summarised in Brue (2000:501) as follows:

> “Without innovation, economic life would reach static equilibrium, and its circular flow would follow essentially the same channels year after year…The entrepreneur, seeking profit through innovation, transforms this static situation into the dynamic process of economic development…The resulting economic development arises from within the economic system itself, rather than being imposed from outside”.

The attention that the Keynesian school of thought received contemporaneously with Schumpeter’s theory development necessitates a look into the Keynesian theory also. Although Keynes criticised certain aspects of the neoclassical school, the Keynesian school of thought itself arose from the neoclassical school and therefore included static equilibrium economics (Brue, 2000:447). Where innovation seems to be the centre of Schumpeter’s theory, Keynes treats it as a phenomenon outside of the economic scene. Another major difference between Schumpeter’s growth theory and that of Keynes is that Schumpeter focuses mainly on the supply side, whereas Keynes’ theory is based on the demand side (Heertje, 2006:94). Schumpeter (1961:65) stated his position as follows:

> “It is, however, the producer who as a rule initiates economic change, and consumers are educated by him if necessary; they are, as it were, taught to want new things, or things which differ in some respect or other from those which they have been in the habit of using. Therefore, while it is permissible and even necessary to consider consumers’ wants as an independent and indeed the fundamental force in a theory of the circular flow, we must take a different attitude as soon as we analyse *change*.”

The role of innovation in development thus can be explained neither by the classical, neoclassical nor by the Keynesian schools of thought, due to the static basis of their analysis, as well as the neglect of innovation in their theories. It is the Schumpeterian theory, with its explanation of the role of innovation in disturbing the equilibrium situation, that is fundamental to the explanation of economic development.

3.3.2 Innovation as an exogenous or endogenous factor

In the theories of the classical economists, such as those of Adam Smith and Karl Marx, technological change and economic development formed an essential part. But during the late nineteenth and early twentieth centuries, technological change and economic development were neglected by the neoclassical theorists. Neoclassical theories dominated that era (Verspagen, 2005:489). The interest in development theories only started blooming again after 1945 (Brue, 2000:494). In some of these development theories, innovation (or technical change) was neglected or totally omitted. Even in those development theories where innovation is included, it is treated as an exogenous factor. According to Hanusch & Pyka, (2007d:21),

> "Neoclassical thinking focuses on the optimal allocation of resources and the adaptations following exogenous shocks, such as demographic change, changing preferences etc".

The revived interest in technological change and economic development was initiated during the 1950's, *inter alia*, by the Nobel Prize winner, Robert Solow. Solow received this prestigious prize for the neoclassical theory of growth (Nafziger, 2006:153). Solow treated technological change as an exogenous factor, which implies that the growth that could not be explained by the variables endogenous to the model must be a result of exogenous technical change (Fagerberg *et al.*, 2005:489). The variables that Solow treated as endogenous to growth are capital and labour. Solow used capital, labour and technological change as variables in the production function. Brue (2000:499) summarised Solow's findings of the relationship among these variables as, "He found that increases in labour and capital inputs explain less than half of economic growth. The residual…results from technological progress". Yet Solow, (2008:18), called technological change "neutral" and defined "neutral" stating, "Shifts in the production function are defined as neutral if they leave marginal rates of substitution untouched but simply increase or decrease the output attainable from given inputs". Solow's theory, in short, is founded in the neoclassical view, which states that the economy adjusts internally to achieve stable equilibrium growth. His theory is based on the contribution of capital and labour to growth, with technological changes as an exogenous factor. Although Solow highlighted the importance of technological change in growth, his theory contrasts strongly that of Schumpeter. Romer (1986) developed a model to incorporate technological change as an endogenous factor. Romer's model became part of what is referred to as the "New Growth Theory" (Fagerberg *et al.*, 2009:19; Freeman, 2002:193). Although Romer played a role in incorporating technological change as an endogenous factor in economic growth theories, Romer's model remains another equilibrium model, one similar to the neoclassical growth models.

It was Schumpeter who developed a development theory with innovation as the major driver, endogenous to the economy and disturbing the equilibrium. He was little concerned with the effect of the exogenous shocks to the economy, and he focused on the endogenous effect of innovation on the development process. Hanusch & Pyka (2007d:21) quoted Schumpeter as saying:

> "Economic development has to be considered as a process generated within the economic system …I was deeply convinced…that there must be a source of energy within the economic system which endogenously destroys every equilibrium state which might be reachable".

This "source of energy" Schumpeter refers to is innovation that functions as a catalyser for disturbing equilibrium and generating development. Schumpeter (1939:86) explicitly called innovation an "internal factor of change" by explaining:

> "It [innovation] is an *internal* factor because the turning of existing factors of production to new uses is a purely economic process and, in capitalist society, purely a matter of business behaviour. It is a *distinct* internal factor because it is not implied in, nor a mere consequence of, any other".

Schumpeter's view of the endogenous nature of innovation differs from that of the neoclassical economists in terms of the production function. Innovation does not vary the quantities of the factors of production in order to produce different quantities, as described by neoclassicism; innovation actually causes a completely new production function (Schumpeter, 1939:87). This new production function can represent the production of a totally new product, or the change of the inputs or method of production of an existing product, in order to produce something new. The entrepreneur plays an important role in Schumpeter's theory by being the creator of this new production function. It is now necessary to establish the role of the entrepreneur in the different theories.

3.3.3 <u>The entrepreneur in economic thought</u>

Entrepreneurship does not play the same role in all economic development theories. Where some theories place the entrepreneur at the heart of growth and development, others pay no attention to the role of the entrepreneur. Lombard & Vosloo (1994:10) stated, "The policy models for economic growth developed by mainstream economists – i.e. the proponents of 'neoclassical economics' in the tradition of Marshall, Keynes, Samuelson, *et al*. – do not deal explicitly with entrepreneurship as a distinct factor of production or an element in the economic growth process. In fact, explanatory models in mainstream economics (including the Keynesian tradition) hardly deal with economic growth at all". Vosloo (1994:153) stated even more strongly that,

> "… entrepreneurship is the real source of all economic and social development. It is an irony that the role of entrepreneurship in the process of economic growth is grossly neglected in mainstream macroeconomic theory".

Adam Smith, in his seminal "The Wealth of Nations", published in 1776, already mentioned the owner-manager who combines resources, land, labour and capital for the successful functioning of a business. Some theories afterwards built on Smith's ideas and later, during the middle of the nineteenth century, the French word, *entrepreneur,* became popular to describe the owner-manager of a new industrial enterprise. During the development of the neoclassical theories, the owner-manager had not been incorporated as he had been in the classical theories. The neoclassical markets that are described as perfectly competitive and in equilibrium (with Walras, in 1874, and Marshall, in 1890, as the founders of this theory), do not make provision for the entrepreneur or "supplier" who creates products different from all other products or a "supplier" who controls or sets market prices (Bygrave, 1994:411-413). The neutral role of the "supplier" (entrepreneur) in the neoclassical model is described by Bygrave (1994:413), saying, "… suppliers (owner-managers) must behave as passive, responsive participants as the market sets prices and determines demand. As prices rise, suppliers produce more; as prices fall, they produce less. So, although the perfect market provides a solid foundation for economic predictability, it achieves this sophisticated capability *by eliminating the unpredictable behaviour of entrepreneurial owner-managers* who thrive on upsetting market activities by introducing innovative products and services". Schumpeter (1961:76) criticised Walras and "… many other authors …" for the neglecting of the entrepreneur in their theories. He caustically noted, "The tendency is for the entrepreneur to make neither profit nor loss in the circular flow – that is, he has no function of a special kind there, he simply does not exist".

In the Schumpeterian theory, the entrepreneur plays a determining role. According to Schumpeter (1961:74), the entrepreneurs are the individuals who carry out innovations. It is, therefore, the entrepreneur who is the agent through which innovation and eventually development takes place. Brue (2000:501) summarised the role of the entrepreneur in Schumpeter's theory when Brue noted, "The entrepreneur, seeking profit through innovation, transforms this static situation into the dynamic process of economic development". Hébert & Link (2008:248-256) give a chronological trace of the theories that studied the entrepreneur as innovator. Schumpeter is singled out by Hébert & Link as dominant in connecting the entrepreneur with innovation. The theories, which link innovation with the entrepreneur, that preceded Schumpeter include Richard Cantillon (1680-1734), Nicholas Baudeau (1730-1792), Jeremy Bentham (1748-1832), J.H. von Thünen (1785-1850), Gustav Schmoller (1838-1917), Werner Sombart (1863-1941) and

Max Weber (1864-1920). Hébert & Link's (2008:253;255) summary of Schumpeter's theory corresponds with that of Brue and they state that, "Schumpeter is generally credited with establishing the entrepreneur as innovator …" and "Joseph Schumpeter … set out to develop a theory of economic development in which the entrepreneur plays a central role…Schumpeter's entrepreneur becomes the motive force of economic change. The entrepreneur is a key figure for Schumpeter because, quite simply, he is the *persona causa* of economic development".

The entrepreneur is responsible for what Schumpeter called "creative destruction". This implies that the entrepreneur destroys the existing economic structure in the process of creating new products and production methods. This entrepreneurial innovation, in turn, leads to economic growth and development (Brue, 2000:504-505). Schumpeter (1976:83) supplies some examples of creative destruction:

> "… the contents of the laborer's budget, say from 1760 to 1940, did not simply grow on unchanging lines but they underwent a process of qualitative change. Similarly, the history of the productive apparatus of a typical farm, from the beginnings of the rationalization of crop rotation, plowing and fattening to the mechanized thing of today – linking up with elevators and railroads – is a history of revolutions. So is the history of the productive apparatus of the iron and steel industry from the charcoal furnace to our own type of furnace, or the history of the apparatus of power production from the overshot water wheel to the modern power plant, or the history transportation from the mail-coach to the airplane. The opening up of new markets, foreign or domestic, and the organizational development from the craft shop and factory to such concerns as U.S. Steel illustrate the same process of industrial mutation…that incessantly revolutionizes the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism."

Schumpeter (1961:92) stated that the "characteristic task" of the entrepreneur "consists precisely in breaking up old, and creating new".

Innovations, according to Schumpeter (1961:223) do not appear individually, but in groups or swarms. These clusters of innovation cause the up- and down-swings in economic development. This relationship between innovation and the waves in economic activity will now be further reviewed.

3.3.4 Innovation and long waves in economic thought

Different economists developed their theories based on the existence and explanation of long waves in economic activity. The focus of this study is not on the theories of the long wave, but rather on the relevance of the long waves to innovation. To understand better the relevance of the long wave theories to innovation, some background to the origin of, and these theories themselves, together with the content of these theories, must be given. Special attention will be paid to Schumpeter's explanation of the business cycles and of the long waves of Kondratiev, because Kondratiev was a pioneer of the long wave theory, Schumpeter was the pioneer of the innovation theory, and Schumpeter built on the long wave theory of Kondratiev. Many other economists have expanded still further on the long wave theories of Schumpeter and Kondratiev and many different views now exist on the role of innovation in these long waves. An overview of these views will be included in the discussion.

Tinbergen (1984:13) explained that the wave theories originated from observation of the rising and declining movements in several statistical time series (of approximately 40 years) during the 19th and 20th centuries. During the period under review, according to Tinbergen, the fluctuations showed highest points in, approximately, 1870, 1920 and 1970, and lowest points in, approximately, 1850 and 1895. Understandably, if unfortunately, the estimation was disturbed by the influence of World Wars 1 and 2. Tinbergen contends that Van Gelderen, a Dutch economist, was the first economist who recognised these wave-like trends, but that it was the Russian economist, Kondratiev, who generally gets the credit for the initiation of long-wave theory. Delbeke (1984:2) added Parvus and De Wolff to the two former theorists, as economists who originally contributed to the awareness of the long wave theories. The dates of turning points that Delbeke offers (1815, 1849, 1873 and 1896) coincide more or less to those of Tinbergen. In literature, the term “long waves” is sometimes just referred to as “waves”, and is distinguished from the shorter cycles, like the business cycle (Tinbergen, 1984:13-14).

Schumpeter developed the theory of the business cycle with the four phases, being, prosperity, recession, depression and recovery. Schumpeter focussed on the role of innovation in long waves (Delbeke,1984:2). Freeman (1984:vi) stated, “… it was Schumpeter who gave a new twist to the whole long-wave debate in 1939, when he explained Kondratiev cycles in terms of major innovations providing at intervals the basis for the spring tides of expansion”.

Kondratiev (1935:105) used statistical methods to test his theory of the existence of long waves with an average length of approximately fifty years, in the capitalistic economy. He found that the economy did indeed move in certain, regular, long waves. The regular patterns in Kondratiev’s theory, according to Sundbo (1998:27), are due to “certain permanent evolutionary factors” that necessarily cause prosperity after a recession. Kondratiev (1935:110-111) stated in his findings that it was not possible to determine the exact turning points and that an error of five to seven years must be allowed. The following is a summary of the turning points of the waves that Kondratiev determined:

“First long wave
1. The rise lasted from the end of the 1780’s or beginning of the 1790’s until 1810-17.
2. The decline lasted from 1810-17 until 1844-51.

Second long wave
1. The rise lasted form 1844-51 until 1870-75.
2. The decline lasted from 1870-75 until 1890-96.

Third long wave
1. The rise lasted from 1890-96 until 1914-20.
2. The decline probably begins in the years 1914-20.”

There have been many discussions and critics of Kondratiev’s theory. There is a debate on whether long waves actually exist, another concerning which indicators must be used to describe waves and still another on the lengths of the waves. Kondratiev used a price-time series (prices of consumer and capital goods) to determine the waves. Other indicators that were used to test the long wave theory empirically were national product and national industrial production, investment figures, unemployment, and others (Sundbo, 1998:27-28). Van Duijn (1983:147-172) empirically tested whether or not the long wave pattern in growth rates existed. He concluded that it does indeed exist, and he illustrated the waves as shown in Table 3.1. He added a fourth wave to those Kondratiev himself identified and did not just indicate upswing and downswing phases, but refined the waves into recession, depression, recovery and prosperity phases. Van Duijn used industrial production and total output as indicators, and gave evidence of the empirical test by summarising the results of the development of industrial production and total output for different countries, as shown in Tables 3.2 and 3.3. Van Duijn found that the different countries tested followed the long wave tendency. Sundbo (1998:27) concluded that, “the [long wave] theory has reasonable empirical certainty” and that, “it is useful for explaining the emergence of the current potential paradigms in innovation theory”. The wavelength of fifty years that Kondratiev adduced was confirmed by the empirical testing of Van Duijn (1983:147-172). Sundbo (1998:28) confirms this wavelength (by referring to studies of Mager, Mandel, Glisman, Rodemer & Wolter and of Cleary & Hobbes) when stating that the length of the Kondratiev waves in the (cited) studies stays within an interval of 45-60 years.

The relationship between innovation and the long waves will be further explored in Chapter Four, as part of the discussion on the relationship between innovation and economic development.

3.3.5 Innovation and the neo-Schumpeterian theory

Schumpeter’s theory on innovation and economic development was not part of mainstream economic thinking during the time that Schumpeter published his theories. However, since the 1980s, interest in the role that innovation plays in development, has started to grow. Schumpeter’s theory began generating more interest among economists. Freeman (2008:227) wrote about a "Schumpeterian renaissance" in the late twentieth century and he gives proof of the neglect of interest in Schumpeter's theory in literature before the 1970s-80s.

A certain group of economists became known as "neo-Schumpeterian", due to their adherence to Schumpeter's thinking, as well as their opposition to neoclassism. Heertje (2006:119) stated that,

> "Neo-Schumpeterians have a tendency to consider themselves as a group or school, sharing common views and opposing in particular, the so-called neoclassical scheme".

Although the term "neo-Schumpeterian" has been used quite often in recent literature, the term has not been defined or described in many publications. The reason may be that there is not yet enough agreement or correspondence in the different views of neo-Schumpeterian economists. According to Heertje (2006:120), the neo-Schumpeterian economists, in their criticisms of neoclassical equilibrium, have provided "an impressive set of empirical results", but they have not developed a "consistent alternative theory". The neo-Schumpeterian economists' beliefs are based, *inter alia*, on Schumpeter's theory, but do deviate from it. According to Freeman (2008:236):

> "… the ideas of the 'neo-Schumpeterian' evolutionary economists, although departing in some respects from Schumpeter's own ideas, were nevertheless strongly influenced by the Schumpeterian renaissance".

Scerri (2005:1) does not use the term neo-Schumpeterian, but refers to the paradigm shift in economic theory towards evolutionary economics and innovation theory. He agrees that the paradigm shift is based on two main ideas, the first, the increasing importance of innovation in growth and development economics, and the second, that the static analytical framework of neoclassical economics is not suitable for analysing the economic role of innovation.

Hanusch & Pyka (2007e), together with all the contributors to the book, attempted to enclose and describe neo-Schumpeterian viewpoints in their publication, "Elgar companion to neo-Schumpeterian economics". Hanusch & Pyka (2007a:1) explain that neo-Schumpeterian economics do not only study the economy at the micro- and macro-levels, but focus mostly on the link between the two, that is, at the meso-level. The neo-Schumpeterian view corresponds with that of Schumpeter in that innovation is seen as the major force propelling economic activity. Hanusch & Pyka (2007c:1162) defined neo-Schumpeterian economics as follows:

> "*Neo-Schumpeterian economics deals with dynamic processes causing qualitative transformation of economies driven by the introduction of innovation in their various and multifaceted forms and the related co-evolutionary processes*".

This definition includes, according to Hanusch & Pyka (2007c:1162), the following three characteristic features of neo-Schumpeterian economics: "qualitative change, affecting all levels and domains of an economy", "punctuated equilibria i.e. periods of radical change followed by periods of smooth and regular development", and "pattern formation: despite the true uncertainty, the process to be observed are not completely erratic but spontaneously structuring."

This definition and features emphasise the fundamental differences with the static neoclassical views of equilibrium. Hanusch & Pyka (2007c:1160) further emphasise the importance of innovation and entrepreneurship in neo-Schumpeterian economics and the differences with the neoclassical when they state:

> "Entrepreneurship and innovation are responsible for economic development by overcoming the limiting constraints, which are considered to be a datum in neoclassical economics. With innovation, also, true uncertainty as an essential characteristic of the future orientation of development processes enters all economic

> domains, leaving far behind the possibilities of analysis within the neoclassical framework of strict rationality".

Heertje (2006:120) did not specifically define neo-Schumpeterian economics, but he offered a comprehensive description of this school of thought, writing:

> "The neo-Schumpeterians confront the equilibrium approach of the neo-classical scheme, based on maximising behaviour of producers, consumers and owners of the factors of production, with an evolutionary framework of the dynamic process as the interaction of internal movements, activities and decisions, and the environment of the firm, both being influenced and shaped by technical change, in particular. In doing so they underline the significance of discontinuous and qualitative changes, the role of restricted knowledge, information and fundamental uncertainty, increasing returns, external effects and decision making. A typical feature also is the emphasis put on the process of diffusion of technology, both in the sense of knowledge and applications and the relationship with institutional changes in society at large."

One of the points where the neo-Schumpeterian view expands on Schumpeter's theory is in the idea that innovation takes place in a complex system. According to Carlsson (2007:857-858), the idea of studying innovation occurring within an economic system is consistent with the view of Schumpeter, referring to Schumpeter's view on the internal forces that changes economic life. However, Carlsson pointed out (using Freeman as a reference) that Schumpeter neglected the multiple sources of information inputs and the importance of a national system of innovation, due to his focus on the individual entrepreneur. There are three things, according to Carlsson, (2007:859), that come out of the systems approach: it is "necessary to specify the components of the system"; "the relationship among various components must be analysed"; and "the attributes or characteristics of the components need to be specified".

From the little that could be found in literature describing the neo-Schumpeterian "school of thought", a fairly good idea can be formed of the fundamentals of this group of economists. This study is embedded in the Schumpeterian view of economics, sharing some views with the neo-Schumpeterian economics, and may contribute to certain aspects in the neo-Schumpeterian economics. This study is therefore founded, in agreement with Carlsson (2007), on the following:

(i) Innovation is seen as the most important force behind economic development, being an endogenous, dynamic influence, disturbing the economy from a static, equilibrium state.
(ii) The interaction among the micro, meso and macro levels are important to understand fully the impact of innovation on the economy.
(iii) Innovation is a complex process, consisting of interaction among numerous components. A system approach is therefore necessary to study the influence of innovation on development.

This study aims at determining, among others, the points that Carlsson mentioned as determining the components in the innovation system, finding the relationship among those components and then, lastly, establishing how these components and their relationship can be improved to enhance innovation's eventual positive impact on development.

3.4 Summary

In this chapter, an analysis of innovation in economic theories has been given to indicate where in economic theory this study can be classified. It was shown that innovation plays no significant role in the classical theories, and even less in the neoclassical theories. These theories, which emphasise equilibrium in the economy, cannot explain the role of innovation, because the effect of innovation is actually a disturbance of equilibrium. Schumpeter has shown that growth and development can only take place if the economy is constantly disturbed to an out-of-equilibrium phase. In some of the later neoclassical theories, innovation was considered as a factor that causes growth, but was treated as an exogenous factor. The "new growth theories" were developed later, including innovation as an endogenous factor, but these theories were still based on the equilibrium principle. In the Schumpeterian and neo-Schumpeterian theories, innovation is treated as endogenous to the economy.

The entrepreneur, in contrast with neoclassical theories, plays a key role in the Schumpeterian and neo-Schumpeterian theories. Schumpeter saw the entrepreneur as the one who carries out the innovation and, whether innovation is done by a small or large firm, entrepreneurship is essential for innovation to take place.

The long wave theory forms an essential part of the innovation theory. Schumpeter was the economist who coined the term "Kondratiev waves" when referring to the long waves posited in the economist Kondratiev's contribution to the long wave theory. There are many different opinions concerning in which phase of the long wave innovation takes place. In Chapter Four this relationship will be explored further.

Schumpeter had not been acknowledged as a mainstream economist during the time that he developed and first published his theory. It was not until the 1980s that economists started paying attention to his works and to the importance of innovation in development. The neo-Schumpeterian theory is, as might be expected, based on Schumpeter's theory. The difference between the Schumpeterian and the neo-Schumpeterian theories is mostly the fact that Schumpeter did not see innovation as taking place in a system. The neo-Schumpeterian thinking is about studying innovation within a system with interaction among different role players. This current study is placed in the neo-Schumpeterian school of thought and adopts the following points of view:

(i) Innovation is the most important force behind economic development, being an endogenous, dynamic influence, disturbing the economy from a static, equilibrium state.
(ii) The interaction among the micro-, meso- and macro-levels are important to understand fully the impact of innovation on the economy.

(iii) Innovation is a complex process, consisting of interaction among numerous components. A system approach is therefore necessary to study the influence of innovation on development.

This study aims at determining the components in the innovation system, finding the relationships among the components and lastly, establishing how these components and their relationship can be improved to enhance innovation eventually to have a positive impact on development.

In the next chapter, the role of innovation in economic development will be further explored by analysing literature on the relationship, and the process of the relationship, between innovation and economic development.

CHAPTER FOUR

THE RELATIONSHIP BETWEEN INNOVATION AND ECONOMIC DEVELOPMENT

4.1 Introduction

In the previous chapter, the views regarding innovation in economic thought were discussed. In this chapter, it will now be established by conducting a literature study, what the relationship between innovation and economic development entails.

The importance of studying the role of innovation is made clear when Freeman, (1982:3), states that innovation is "critical" for sustainable economic growth, for the improvement of quality of life, for the long-term conservation of resources and for the improvement of the environment. Freeman further stresses the role of innovation in the reduction of poverty by stating that the role of innovation in the reduction or elimination of mass poverty of Asia, Africa and Latin America, as well as other parts of the world, must not be overlooked. Freeman (1982:3) expands the explanation of the role of innovation in the improvement in living conditions when he adds the access to more and new types of goods and services to the improvement of overall financial well-being. Freeman explains that innovation is not only important for improved well-being and prosperity in the form of increasing production of the already-known goods, but also for the development and production of totally new goods that people have never before seen or heard of, even of products that have previously existed only in people's imaginations. These products can, according to Freeman, enable people to do things they have not done before and so contribute to the improvement in living conditions.

In order to establish the relationship between innovation and economic development, it will first be determined how innovation and economic development has been measured in different studies. Secondly, the trends of innovation in history will be established. Thereafter, different studies will be analysed in order to determine if the findings in the different studies correspond regarding the relationship between innovation and economic development, as well as the relationship between entrepreneurship, innovation and economic development.

4.2 Measurement of innovation

In Chapter Two, innovation was defined as the successful implementation of a new or improved product (good or service), or process, a new marketing method, or a new organisational method. However, when attempting to measure innovation in an empirical study, some problems are experienced. These problems will also be discussed, and then, the different ways economists found to measure innovation in their studies will be explored.

4.2.1 Different methods of measuring innovation

Although there are many difficulties in the measuring of innovation, many attempts have been made in the past to quantify innovation. Becheikh, Landry & Amara (2006) researched 108 studies on innovation and found that 24% used firm-based surveys to measure innovation, 25% used innovation count, 18% patent registrations, 6% research and development (R&D) expenditure, 15% indices, 9% other measures (sales generated by innovations, the number of trademarks, the time allocated by managers to innovation related activities, etc.) and 4% did not attempt to measure innovation. The different ways of measuring innovation seem to be dependent on the aim of the research. There are studies that measure the outcomes of innovation, and here, innovation surveys and innovation counts may be useful. Other studies focus on capabilities to innovate, and in these cases, the R&D expenditure and many of the indices (including indicators such as education, infrastructure, patents, etc.) may be more useful.

Innovation surveys:

The OECD and Eurostat worked together and published the first edition of the Oslo Manual in 1992. This became the reference for many surveys on the nature and impacts of innovation in the business sector, such as the European Community Innovation

Survey (CIS). Since 1992, the number of countries conducting innovation surveys based on the Oslo Manual has increased and now includes countries such as Canada, New Zealand, Japan and even non-OECD countries such as a number of Latin American countries, Russia and South Africa (Department of Science and Technology, 2007; Holbrook, 1997; OECD & Eurostat, 2005:11; RANNIS, 2006; Statistics New Zealand, 2010). The second, improved Oslo Manual was published in 1997, while a third edition was published in 2005 (OECD & Eurostat, 2005:3). These surveys provide information at the level of firms. Although this approach is becoming the standard method of collecting direct information on innovation, it does have some disadvantages. According to Becheikh *et al.*, (2006:650), these negatives include the dependence of the significance and representativeness of the results on the response rate, as well as the unqualified dichotomous measurement of innovation asking whether firms innovate or not (thus implying that all innovations are the same, that most firms innovate, and not qualifying the degree of newness).

Inputs to innovation:

One of the methods traditionally used as a measurement of innovation in empirical studies is R&D expenditure by firms. This method is popular due to the comparability over time and across countries as it is measured in monetary values and so the R&D can be expressed as a ratio to GDP without the need for exchange rate adjustments when both R&D and GDP are expressed in national currencies (Archibugi & Coco, 2005:183). The R&D expenditure by firms gives an indication of the involvement of a firm in innovating activities. However, it does not measure the innovative output of the firms. Some of the disadvantages of using R&D expenditure for the measurement of innovation that have been identified include that not all R&D expenditure will lead to innovation. This causes R&D to be a measure that overestimates innovation (Audretsch, 2004:175; Becheikh *et al.*, 2006:649; Greenhalgh & Rogers, 2010:59). On the other hand, not all innovations are a result of R&D expenditure. For instance, some innovations can just be a sudden, clever idea of the innovator. Further, there may be a time lag between the R&D expenditure and the innovation (Greenhalgh & Rogers, 2010:59), and adequate recording and tracking of R&D expenditure is not always available in all countries (LeBel, 2008:338). Research and development expenditure as the measurement standard favours large firms over small and medium enterprises (SMEs) as the latter two may not be using formal R&D structures (Becheikh *et al.*, 2006:649).

Outputs from innovation:

Popular output measure of innovation are patent statistics. Although patents are used in many studies as a measure of innovation output, they should rather be seen as an input measure, or as an "intermediate output", as Audretsch (2004:175) calls it. This is because patent registration measures inventions - not innovations. Not all inventions become innovations (resulting in an overestimation of innovation). It should be noted also that not all inventions are patented (Audretsch, 2004:175; Becheikh *et al.*, 2006:649-650; Fagerberg, Srholec & Verspagen, 2009:21; Greenhalgh & Rogers, 2010:61; and LeBel, 2008:338). The quality and quantity of patents registered varies across countries, perhaps due to cost restraints, as well as the different procedures for patent registrations in different countries (Archibugi & Coco, 2005:183). There may also be differing time lags between an invention and its resulting innovation (LeBel, 2008:338). Hasan & Tucci (2010) conducted research on innovation using patent registration as the measurement for innovation. They acknowledge the disadvantages mentioned above, but indicated their reasons for using patent data as being: (1) usually, inventions are commercialised; (2) detailed statistics of patent registrations are available for many years; (3) the cost involved to obtain and defend the patent implies that a financial return is mostly present or possible.

Another output measure that overcomes the problems of using patent data is innovation count. This includes data such as new product/process announcements, specialised journals, databases, and the like (Becheikh *et al.*, 2006:650). There are countries that keep records of innovative output. Two examples of such records are the United States Small Business Administration's Innovation Data Base and Germany's Mannheim Innovation Data Base (Audretsch, 2004:175-176), but not all countries keep such records. The innovation count method of measuring innovation also has some disadvantages. Becheikh *et al.*, (2006:650), reason that innovation count favours radical innovations over incremental ones, and product innovations over process innovations. In the case of scientific publications, the quality can vary widely between countries. It must be noted also that English-speaking countries are likely to be over-represented because the majority of journals monitored by the Institute for Scientific Information are published in English (Archibugi & Coco, 2005:183). Royalties and licence fees as a measure have the disadvantage that it is not clear when the fees are an indication of the creation of technology or due to the acquisition of the technology (Archibugi & Coco, 2005:183).

Composite variables:

To overcome the problems associated with input and output measures of innovation, such as R&D expenditure and patent registrations, as well as to find a more comprehensive measure of innovation, some economists have developed innovation indices. These indices combine a number of indicators in a single figure, and attach weights to the relative importance of the indicators (Greenhalgh & Rogers, 2010:62). Examples of such indices follow.

The Revealed Regional Summary Innovation Index (RRSII) is an index that is based on the European Innovation Scoreboard. It consists of seven indicators: (i) population with tertiary education; (ii) participation in life-long learning; (iii) employment in medium-high and high-tech manufacturing; (iv) employment in high-tech services; (v) public R&D expenditures; (vi) business expenditure on R&D and (vii) high-tech patent application (Fraas, 2003:1-2; Howells, 2005:1222). Archibugi & Coco (2004) developed an index called the ArCo technology index. The ArCo measure was constructed as the average of eight different indicators reflecting various aspects of technological capability, (i) patents, (ii) scientific articles, (iii) internet penetration, (iv) telephone penetration, (v) electricity consumption, (vi) tertiary, science and engineering enrolment, (vii) mean years of schooling and (viii) literacy rate. The World Economic Forum (Porter & Schwab, 2008:6;41), in the development of a Global Competitiveness Index, indicates innovation as one of the twelve pillars of the index. The pillar in itself is an index that consists of the following indicators: (i) capacity to innovate, (ii) quality of scientific research institutions, (iii) company spending on R&D, (iv) university-industry research collaboration, (v) government procurement of advanced technology products, (vi) availability of scientists and engineers, (vii) utility patents and (viii) intellectual property protection. The index is a weighted average of the responses to survey questions and hard data. LeBel (2008) developed an innovation index considering only *per capita* scientific citations and *per capita* net royalty ratio, each of these two indicators carrying equal weights. Although LeBel (2008:338) admits that the index may not capture all dimensions of innovation, he reasons that the index eliminates problems associated with using patent registrations and R&D expenditure as measurements, such as those previously discussed.

A method that was used to combine different measurements and that overcomes the problem of assigning weights to indicators (as is experienced with indices) was used by Fagerberg & Srholec (2008) and is called "factor analysis". Fagerberg & Srholec used factor analysis on data for 25 indicators of development and 115 countries between 1992 and 2004. According to Fagerberg & Srholec, (2008:1421), "This method is based on the very simple idea that indicators referring to the same dimension are likely to be strongly correlated, and that we may use this insight to reduce the complexity of a large set (consisting of many indicators) into a small number of composite variables, each reflecting a specific dimension of variance in the data". In a factor analysis applied to innovation, indicators such as the following were included: (i) patenting, (ii) scientific publications, (iii) information and communications technology (ICT) infrastructure, (iv) International Organisation for Standardisation (ISO) 9000 certifications, (v) access to finance and (vi) education (Fagerberg & Srholec, 2008; Fagerberg *et al.,* 2009:26).

4.2.2 Difficulties in measuring innovation and measuring the impact of innovation on economic development

Unfortunately, there is no single, generally accepted definition for innovation (as discussed in Chapter Two) and this makes the identification of an innovation particularly difficult. It seems that the identification of product innovation is easier than is that of process innovation. It also is apparent that examples of marketing and organisation innovation have little prominence in historical literature on innovation. There is also conflict in literature concerning the inclusion of incremental changes or significant changes in innovation. Van Duijn (1983:173) agreed that it is not easy to either list or date major innovations. The problems that Van Duijn experienced in identifying innovations include the following: First, he stated, “innovations are heterogeneous in character”. He went on to explain that there are product innovations and process innovations; innovations in old industries and innovations that have established new industries; and this results in trying to compare apples with pears. Second, Van Duijn stated, “innovations are heterogeneous in area of application” in the sense that product innovations may be consumer goods, or producer goods, or sometimes both. He gave the following example and said, “Consumers may consider the innovation of the vacuum cleaner as very basic, but have no notion of the significance of the innovation of the gyro-compass”. Third, Van Duijn mooted, “innovation is heterogeneous in impact”, implying that the extent of the innovation can differ. The example he offered was that a major innovation like the motor car and a small innovation like the zip fastener may have different sizes of impact, but they each count as just one innovation. Fourth, Van Duijn questioned whether only seminal innovations or subsequent improvements should be mentioned, for example, “Should only Bessemer steel – the beginning of the modern steel industry – be listed or also subsequent improvements in the steel industry?”

Secondly, the identification of inventions is not necessarily helpful in identifying innovations. Inventions are not an indication that an innovation will take place nor yet of when it will take place and is therefore not useful in tracking innovations. Ray (1980:12) used the example of electricity and noted, “the ‘basic’ invention may have been that of Faraday (1831) who could not ... have presented his theories in 1831 without the outstanding achievements of scientists like Benjamin Franklin (1749), Galvani (1791), Volta (1800), Ampère (1822) and others. It was a long way from Faraday’s work to the large scale electricity industry that ‘created new social benefits, new markets and new jobs!’”

Ray thus implies that there may be a long chain of other inventions that eventually lead to or help a specific invention to take place and that it may take decades for an innovation to follow that invention. The time lapse between invention and innovation has already been discussed in Chapter Two and Schumpeter's (1961:89) view was that, "…innovations … need not necessarily be any inventions at all". Van Duijn (1983:174) mentioned that the name and time of inventions are often known, but that the name of the innovator and the time of the innovation have not been as regularly recorded by history. Often, assumptions have to be made regarding innovations.

Thirdly, more than just the identification of the kind of innovation is needed, in order to measure the impact of innovation. According to Ray, (1980:12), the diffusion of innovation across the economy as well as the speed of this diffusion is important when measuring the impact on the economy. The diffusion of innovation is a very complex process, where a new product or process can trigger the innovation of another new product or process or replace the existing ones. Van Duijn, (1983:175), agrees that not only the moment of innovation is important, but also the diffusion of an innovation.

The fourth problem is that the longevity or life-span of an innovation must also be considered when measuring the impact of innovation. Different and new innovations may have different lifetimes before they are replaced by other new innovations. Some innovations last an indefinite time.

Fifthly, in the Oslo Manual (OECD & Eurostat, 2005:15), it is stated that it is difficult to measure innovation because innovation is a continuous process. Ray (1980:12) expanded this view by stating that diffusion is a continuous process and that large-scale diffusion is a gradual process. A constantly changing situation makes an impact study more difficult to carry out. Van Duijn (1983:174) explained that that the success of an innovation can only be assessed after some time (at least a decade) has passed, but, "… this implies that the lists necessarily get thinner towards the date of compilation", and that, "Drop-offs in numbers of basic innovations thus do not necessarily mean reduced innovativeness". Van Duijn further pointed out that, "In retrospect, some of the older innovations may not seem as important as they once were" and that, "… our current perspective could well lead to an under-representation of innovations before …".

The sixth problem is that the classification of innovations must also be considered. According to Ray, (1980:9), an innovation that is, for example, classified as “industrial” in the first instance, may be applied in other sectors and may even have its major impact elsewhere. He used an example of the technique of delaying the clotting of blood (used in medical science) that was being applied to the Malayan rubber plantations where the techniques are applied to increase the flow of rubber from the trees. To trace an innovation in such different applications enormously complicates the tracking process.

In the seventh place, it must be considered that some of the impact of innovation cannot be measured in quantifiable terms such as growth in production or profit. Measuring the impacts of medication and of vaccine innovation on development mandates the inclusion of the improvement in living standards of people. Many other innovations improve living standards, for example, innovations such as access to communication via telephone, cell phones, television, internet, the availability of electricity and transport, and many other innovations that are now taken for granted. The benefit, according to Ray (1980:9), is also different for different people or different industries.

Lastly, some innovation may result in labour saving processes, which may in turn lead to a downswing in economic performance. This is contrary to what is expected of innovation and results in a negative impact of innovation.

4.3 Measurement of economic development and improvement in economic performance

Economic development was defined in Chapter Two as economic growth leading to an improvement in the welfare of the community. Economic development has traditionally been measured by the increase in the real gross national product (GNP), or real gross domestic product (GDP), *per capita* (Todaro & Smith, 2009:14). The measurement of the complex concept of economic development has changed to using the GNP *per capita*, as well as other factors such as life expectancy, adult literacy and the human development index (HDI) as indicators of economic development (Archibugi & Coco, 2005:176; Pomfret, 1997:4-6; and The World Bank, 2010c).

Although the focus has changed to economic development, many studies measuring the effect of innovation still measure it as an effect on growth and not on development (Hasan & Tucci, 2010; Howells, 2005; LeBel, 2008; Tang & Koveos, 2004; and Thurik & Wennekers, 2004). Even when the study concerns the "effect of innovation on economic development", many studies use the GDP *per capita* as the measurement for economic development (Fagerberg & Srholec, 2008; Van Stel, Carree & Thurik, 2005). This may be due to the important role that economic growth plays in economic development, as was discussed in Chapter Two, paragraph 2.5.1. Wennekers, Van Stel, Thurik & Reynolds (2005:297) use gross national income *per capita* as the measurement for economic development and write, "The most important manifestation of economic development is increasing per capita income". In Chapter Two, the debate on economic growth that does not necessarily lead to economic development due to a skewed income distribution is portrayed in the inclusion of income distribution as an indicator in the measurement of living standard. Measures for income distribution include, firstly, the income share by quintiles (which is the lowest 20% of income earners, then the next lowest 20% and so on up to the highest 20%) and, secondly, the Gini Coefficient (which is a measure of the deviation of the actual income distribution from perfect income equality) (Herrick & Kindleberger, 1983:138-142; Pomfret, 1997:12-13). Another alternative measurement that is used as indicator of economic development or an improvement in living standard is the level of employment (Audretsch, 2004:181; Audretsch & Thurik, 2001:29; Herrick & Kindleberger, 1983:117).

Some of the studies on the role of innovation are done at the level of firms. The measurement of economic performance is then not on the economic development, but rather on the increase in production of the firm. The growth rate of the output per worker, sales per employee and the total factor productivity are often used as measurements, but these measurements are usually used when making use of a neo-classical model of analysis such as in the studies by Cameron (1996), Crespi & Zuñiga (2010) and Hulten & Isaksson (2007).

4.4 The relationship between innovation and economic development

In order to determine the relationship between innovation and economic development, the long term trends in both innovation and economic development will first be explored. Thereafter, empirical studies on the relationship between innovation and economic development will be studied to establish if there is correspondence for the findings.

According to Ray (1980:16), "… economic history provides sufficient evidence for underlying the economic importance – in long cycles or otherwise – of innovation, of its role as a driving force as well as the consequences of its relative neglect". A historical overview of the innovations that were implemented in the past is therefore important. It is not possible to keep track of every little innovation, but there are some major innovations that are worth mentioning due to their significance in history. The aim here is only to give some examples of major innovations in history in order to provide exemplars of the importance of innovation in development.

4.4.1 Historical trends in innovation and economic development

The relationship among innovation, population growth and economic growth is portrayed in Figures 4.1 and 4.2. Figure 4.1 indicates the world population growth and major events in technological history from 9 000BC until the present and Figure 4.2 indicates the world population growth and the world GDP *per capita* for the past 2 000 years.

The importance of innovation for the increase in *per capita* income, population growth and improvement in welfare is clear from the data over the millennia. The GDP growth *per capita* and the population growth were very low during the years between 1 and 1 400 AD, but between 1400 and 1500 the world population and GDP *per capita* started increasing. Innovations in, *inter alia,* the following areas resulted in these changes:

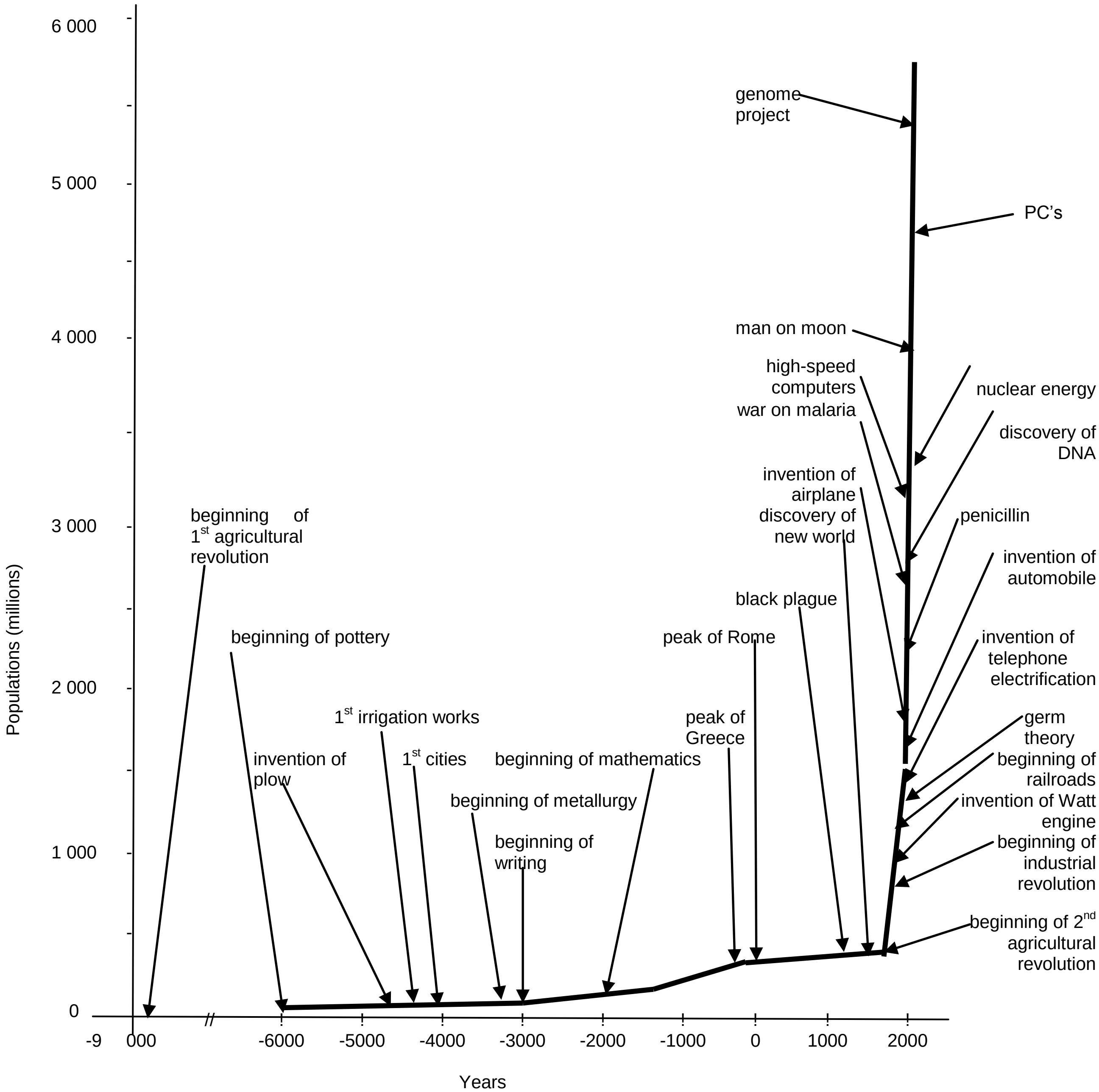
better hygiene, more efficient ways to harness wind and water power to improve and increase human and animal energy, improvement in agricultural techniques such as irrigation, improved seeds and multiple cropping, improvements in shipbuilding and navigation technology led to increased trade, expanding markets and specialization. Again, since the 1800s, the GDP *per capita* growth, as well as the population growth, started increasing suddenly and exponentially.

These increases again can be linked to innovations, this time to such developments as the invention of the steam engine that led to the use of fossil fuel energy for productive tasks and thereafter to the Industrial Revolution (The World Bank, 2010b:32-34).

These are merely a few examples of the innovations that led to rapid increase in population and economic growth. Yet it is clear that the number of innovations has also increased exponentially since the 1800s, just as the economic development increased. A more comprehensive list of inventions and innovations in the 19th and 20th centuries is offered in Table 2.1.

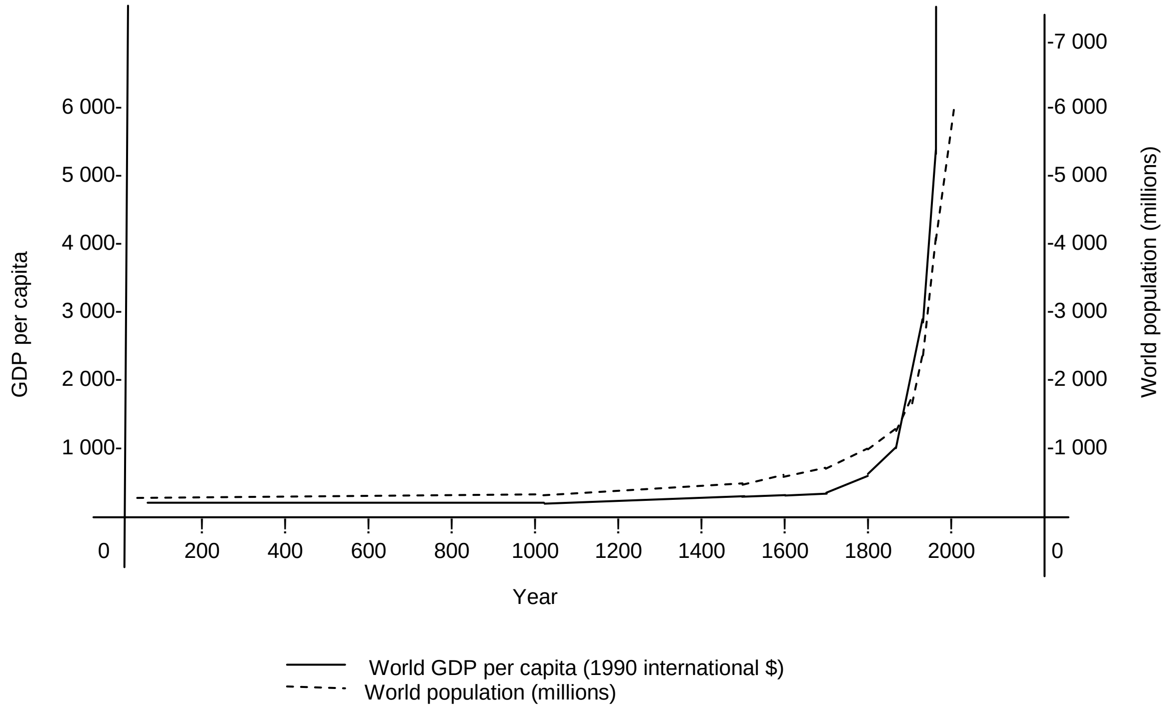
Figure 4.1 The growth of world population and some major events in the history of technology -9 000 B.C. to present

Growth of incomes was accompanied by unprecedented increases in population and exponential increases in the rate of scientific discoveries.



Taken from: Fogel, 1999:2

Figure 4.2 Growth in population and GDP *per capita* in the past 2 000 years



Source: Maddison, 2001:241&261

4.4.2 Evidence of the relationship of innovations to long waves

Kondratiev (1935:111) empirically established certain long wave relationships, but did not imply that the results explained the trend of the long waves. One of the relationships is that of discoveries or inventions with long waves. Kondratiev stated,

> "During the recession of the long waves, an especially large number of important discoveries and inventions in the technique of production and communication are made, which, however, are usually applied on a large scale only at the beginning of the next long upswing".

Kondratiev (1935:112) qualified the “discoveries and inventions” that is presumed as “changes in technique of production” by calling it “relevant scientific-technical discoveries and inventions”. This application of the invention or discovery, which takes place during the upswing, is most likely to refer to innovation. Kondratiev (1935:112) was of the opinion that, although “changes in technique” are very important for “capitalistic development”, inventions alone will not achieve development. He believed that the economic conditions must first be favourable for the application of the invention to take place. This implies that Kondratiev shared Schumpeter’s view on the importance of innovation, not invention, in the theory of long waves. However, they differ in their opinion of the relationship between the phase of the wave and innovation.

Schumpeter (1961:223) starts his theory on the business cycle with the conviction that innovations are discontinuous and clustered. Schumpeter asked two questions and then provided answers to them:

(i) Why does economic development fluctuate and in an unevenly manner? Because new combinations appear discontinuously in groups or swarms.
(ii) Why do entrepreneurs appear in clusters? Because new entrepreneurs facilitate the appearance of other entrepreneurs (Schumpeter, 1961:228).

According to Van Duijn (1983:99), this view of Schumpeter is the link between innovation and cyclical fluctuations, in that, “cycles arise because innovations appear in bunches”.

Schumpeter (1961:228-230) gives reasons for, and explains the stimulation of the economy reflected in the above-mentioned statements, as follows:

(i) The carrying out of new combinations is a difficult task, only accessible to people with certain qualities. Only a few people can succeed in this direction if the economy is not in a boom phase. But after one or a few have achieved success, many of the difficulties disappear. The success of some firms makes it easier for more people to follow until, finally, the innovation becomes familiar and its acceptance becomes a matter of free choice.

(ii) Since the entrepreneurial qualifications are something which is distributed in an ethnically homogeneous group according to the "law of error", the number of individuals who satisfy progressively diminishing standards in this respect continually increases. The successful appearance of an entrepreneur is followed by the appearance of ever increasing numbers, though they may be progressively less qualified.

(iii) Every boom starts in one or a few branches of industry (railway building, electrical and chemical industries, and so forth), and it derives its character from innovations in the industry where it begins. Pioneers remove the obstacles for others, not only in the branch of production in which they first appear but, owing to the nature of these obstacles, *ipso facto* also in other branches.

(iv) The more the process of development becomes familiar and a mere matter of calculation to all concerned, and the weaker the obstacles become over the course of time, the less the 'leadership' that will be needed to call forth innovations. The swarm-like appearance of entrepreneurs will become less pronounced and the cyclical movement will become milder.

(v) The swarm-like appearance of innovations or, as Schumpeter called it, "new combinations", easily and necessarily explains the fundamental features of periods of boom. It explains why increasing capital investment is the very first symptom of an approaching boom, and why industries producing the means of production are the first to show super-normal stimulation.

This stimulation of the economy, resulting in a boom, will eventually end. Schumpeter (1961:232-236) explained the reasons for this as follow:

(i) The new entrepreneur's demand for means of production drives up their prices.

(ii) The new products come on the market after a few years and compete with the old. At the beginning of the boom costs, therefore, rise in the old business; subsequently their receipts are reduced: first in those businesses with which the innovation competes, but then in all old businesses, insofar as consumers' demand changes in favour of the innovation. The average time which elapses before the new products appear fundamentally explains the length of the boom. This appearance of new products causes the fall in prices, which in its turn terminates the boom, *may* lead to a crises, *must* lead to a depression and starts all the rest.

(iii) The appearance of the results of the new enterprise leads to a credit deflation, because entrepreneurs are now in a position to pay off their debts. As no other borrowers step into their place, this leads to the disappearance of the recently created purchasing power - just when its complement in goods emerges.

If the boom has ended, it leads to a depression, which again starts the process of stimulation, in other words, the process of the business cycle. In Schumpeter's (1961:236) own words:

> "… the boom … creates out of itself an objective situation, which … makes an end of the boom, leads easily to a crisis, necessarily to a depression, and hence to a temporary position of relative steadiness and absence of development."

Schumpeter had the 7-10 year business cycle in mind when he started developing his theory, but Schumpeter subsequently restated and expanded his theory with the 1939 "Business Cycles" publication. Schumpeter applied the relation between innovations and cyclical fluctuations to different cycles, and especially to the Kondratiev cycle. Up to that time only two phases had been identified, those of prosperity and depression. It was Schumpeter who recognised the now-familiar four phases of prosperity, recession, depression and recovery (Van Duijn, 1983:101).

Schumpeter (1939:166-167) also believed that there is not only one single cycle but also that cycles of different length exist simultaneously:

> "… if innovations are at the root of cyclical fluctuations, these cannot be expected to form a single wavelike movement, because the periods of gestation and of

absorption of effects by the economic system will not, in general, be equal for all the innovations that are undertaken at any time. There will be innovations of relatively long span, and along with them others will be undertaken which run their course, on the back of the wave created by the former, in shorter periods. This at once suggests both multiplicity of fluctuations and the kind of interference between them which we are to expect."

Schumpeter's view is that innovation takes place in all periods, but that there are many more innovations in the recovery periods. Nevertheless, there are economists who differ from Schumpeter's view. Mensch believes that innovation takes place mostly during the depression period and the recovery period, while Schmookler believes that innovation takes place mainly during the prosperity period (Sundbo, 1998:40-42). Van Duijn (1983:174-179) has found, in his analysis of Mensch and Schmookler, that these two studies differ largely due to the type of innovation under consideration. Mensch focused mainly on product innovation in new sectors, which takes place during the prosperity phase, and process innovation in old sectors, which takes place mainly at the end of the depression phase. Schmookler, again, focused on product innovation in old sectors. Anderson (2006) studied opinions on Schumpeter's Business Cycles theory and raised questions about the basic assumptions of Schumpeter's wave theory. Schumpeter treated the role of institutions as exogenous and he excluded exogenous factors from his analysis of economic fluctuations. Anderson found that there are economists such as Kingston and Kuznet that is of the opinion that changes in institutions influenced the Kondratiev waves.

Ray (1980:13-16) used historical data to prove that there is a relationship between these major innovations and the development in the different countries. Ray (1980:13) noted,

"… the country that implements any of these truly major, epoch-shaping innovations on a large scale, speedily disseminating it and creating the conditions – within its natural endowments – favourable to the cascading of investment stemming from it, can be reasonably supposed to do better and advance faster than another country which is later or slow in this process".

Van Duijn (1983:174-179) concluded, with empirical support, that innovation mostly rises at the end of the depression period and during the recovery phase, and then declines during the prosperity phase (Van Duijn, 1983). Freeman, Clark and Soete came to the same conclusion with their empirical analysis (Sundbo, 1998:42).

4.4.3 Innovation paradigms and long waves

The contribution of innovation to economic development is proved by some studies through the relationship of innovation paradigms to long waves. Sundbo (1998) explained the innovation theory in terms of three different paradigms in the innovation theory. Sundbo (1998:9-10) explains the paradigm concept as follows:

(i) a paradigm is "a particular basic theory that has prevailed by becoming the normal perception";
(ii) it "does not consist of random, scattered contributions";
(iii) but is "a shared perception, over an extended period, in at least the major part of the scientific world".

The three paradigms in innovation, which he identified, are
(i) the basic entrepreneur theory;
(ii) the basic technology-economics theory; and
(iii) the basic strategic theory.

Sundbo (1998:189) believes that there is enough evidence to accept that the first two paradigms were correctly identified, but that the basic strategic theory still needs more empirical clarification to be accepted as a paradigm.

Sundbo (1998:46-104) linked his study of innovation paradigms with the Kondratiev waves. He found that each Kondratiev wave is "very probably linked to its own innovation system". The third Kondratiev wave was based on entrepreneurs who started new businesses, while the fourth Kondratiev wave was founded on the development of new technology and the fifth Kondratiev wave was underpinned by strategic behaviour that includes innovation development based on the interpretation of market need. Table 4.1 gives an overview of the link between the innovation theory paradigms and Kondratiev waves, as established by Sundbo (1998:159).

Sundbo's theory concerning innovation paradigms correspond with Schumpeter's view in the sense that Schumpeter also believed that the entrepreneur plays the key role in the creating the Kondratiev waves. In Schumpeter's later works, he found that the entrepreneur, and especially the starting of new businesses (as Sundbo also sees the entrepreneur in the third Kondratiev wave), featured less. Large corporate businesses, where management and not entrepreneurship takes priority, became the norm of the day. Schumpeter wrote about the obsolescence of the entrepreneur, that innovation was being reduced to routine and that entrepreneurs had become like managers (Brue, 2000:502). Sundbo (1998:191) saw this connection between his innovation paradigms and Schumpeter's view on the obsolescence of the entrepreneur as follows:

> "This identification of the rise in innovations is also the answer to the issue that Schumpeter raised in Capitalism, Socialism and Democracy (1943): the renewal of the socioeconomic dynamic when the entrepreneur has outplayed his role, as Schumpeter thought was observable around 1940. New dynamics arise in the form of new innovation systems".

Therefore, Sundbo believed that the observation by Schumpeter applied during the same period that the innovation paradigm shifted from entrepreneurs creating new businesses to innovation taking place by developing new technology.

The paradigms set out by Sunbo (1998) seem only to identify the part of Schumpeter's definition of innovation that would be more applicable during a certain period. The first paradigm (of entrepreneurs starting new business) corresponds with Schumpeter's definition regarding a new product, new method of production, new market or new organisation structures. The second paradigm (of developing new technology) focuses mainly on the method of production. The third paradigm (of strategic behaviour) is mainly based on the creation of a new market in Schumpeter's definition. The role of the entrepreneur should not be seen as redundant in paradigms two and three, because the function of the entrepreneur is not only the creation of new business. All the other aspects of Schumpeter's definition, as well as the innovation taking place in different paradigms, are carried out by the entrepreneur. Sundbo (1998:192), as indicated in Table 4.1, sees the agent of innovation in the second paradigm as the technician, and in the third paradigm, the manager. The problem might be that Sundbo sees the function of the entrepreneur only as the creation of new business. During these paradigms, the entrepreneur therefore only shifts his function from starting new businesses to developing new products, new methods of production, new markets or new organisation structures. Schumpeter possibly made the same mistake when he talked about the entrepreneur becoming obsolete, even though his definition of the entrepreneur implies that innovation by the entrepreneur can be carried out in any size or phase of a business. Schumpeter actually had two models: Schumpeter I and Schumpeter II. The main difference between the two models is the change from small-firm innovations to innovations by larger firms, as reflected in Schumpeter's different publications, "Theory of economic development" of 1911 and in 1942's, "Capitalism, socialism and democracy" (Schumpeter, 1961; 1976). This difference, almost certainly, resulted from Schumpeter's observations changing due to changes in the real economy over time.

Freeman & Perez (2008:38-73), in agreement with Sundbo, stated that history cannot only be characterised by different "clusters of innovation" or "technology systems", but showed that the changes can be described as different "techno-economic paradigms". These paradigms of innovation are, according to Freeman & Perez (2008:49), "… a radical transformation of the prevailing engineering and managerial *common sense* for best productivity and most profitable practice, which is applicable in almost any industry …". Freeman & Perez (2008:50-62) provided a table (adopted in this study as Table 4.2) in which they identify the different paradigms and show the relationships of the paradigms with the Kondratieff waves and previous paradigms. The waves and their links to innovations are as follows:

The first wave

Freeman & Perez (2008:50-62) indicate the period 1770s-1780s (upswing) to 1830s-1840s (downswing) as the first long wave. Freeman & Perez (2008:50) ascribe it to early mechanisation and to the textile, and iron industries. Ray (1980:13-16) explained that during the "industrial revolution" which started in Britain in the first half of the 19th century, Britain dominated the world's economy and produced two thirds of the world's coal, half the iron, more than half the steel, half the commercially produced cotton cloth, and 40% of all hardware. The innovations in Britain in the mentioned industries coincide with the first Kondratiev wave. According to Ray, Britain had no competition, seeing that the United States was (then) too young, France had been set back by the Napoleonic wars, Germany and Italy were not even geographical entities and the other countries in Europe were agricultural communities.

The second wave

The second wave lasted from the 1830s-1840s (upswing) to the 1880s-1890s (downswing) due to the dissemination of steam power and railways (Freeman & Perez, 2008:50-62; Ray 1980:10). According to Ray (1980:12), Britain was again the leader in the second Kondratiev wave with the railway boom. British industrial production rose again, faster than any other country, during the upswing of the wave, until about 1860. During the 1860s and 1870s, the British growth rate started to lag behind those of Germany, Italy, Sweden, Switzerland and Belgium, but Britain was still in the lead in certain respects, such as coal, iron, steel and cotton cloth production. After the turn of the century, Britain fell behind in the production of these products as well. The USA too had reached maturity and Germany's steel production became twice that of Britain.

The third wave

The period of the third wave was from the 1880s-1890s (upswing) to 1930s-1940s (downswing) and was caused largely by electrical and heavy engineering (Freeman & Perez, 2008:50). According to Ray (1980:12-16), it was largely steel that led to the third Kondratiev wave, and not only electricity and the motor car, as had been identified by Schumpeter. This increase in steel production by Germany was the result of two important innovations: the open hearth of Siemens (1866) and the Thomas process (1878). During the latter part of the 19th century and the first part of the 20th century, metalworking industries and chemical industries grew rapidly, still with Germany taking the lead. Electricity became an important contributor. Again, Germany led Britain in the field of electricity. Although the USA was not as strong as Britain in total industrial output, Britain only produced 20% of the electricity that the USA produced and was much slower in the adoption of electricity in industry. Other innovations that played a significant role in the upswing of the third wave include power tools, telephones, office machinery, the motor vessel and others. Germany and the USA dominated the electrical engineering industry as well as the automobile industry. Henry Ford produced more cars in the early 20th century than the outputs of the next two largest firms taken together (Ray, 1980:12-16).

The fourth wave

Ray (1980:16-18) speculated about the future after the third wave, but Freeman & Perez (2008:38-73) continued with the identification of a fourth wave. Freeman & Perez saw the fourth Kondratiev wave as the period between the 1930-40s and the 1980-90s. This wave was caused by what they called “Fordist” mass production. The innovations that disseminated during this wave were identified as automobiles, trucks, tractors, tanks, armaments for motorised warfare, aircraft, consumer durables, process plant, synthetic materials, petro-chemicals, highways, airports, airlines, energy (especially oil), computers, radar, drugs, nuclear weapons and missiles, nuclear power, micro-electronics, and software.

The fifth wave

Freeman & Perez (2008:38-73) added a fifth Kondratiev wave, starting in the 1980s-90s and continuing to an as-yet unknown future date. This period they called the communication and information era, and their prediction is that the following innovations are at the core of this era: computers, electronic capital goods, software, telecommunications equipment, optical fibres, robotics, FMS ceramics, data banks, information services, digital telecommunications network, satellites, 'chips' (micro-electronics), 'third generation' biotechnology products and processes, space activities, and fine chemicals.

Although it can be concluded that all kinds of innovation takes place at all times, some kinds may suit a certain economic and social climate better than others will as economic and social climates change constantly. It may be useful to know which paradigm, or kind of innovation, best suits the existing economic and social climate, in order to stimulate the kind of innovation needed to create development at that point in the cycle.

The studies of major innovations in history have provided proof of the contribution of innovations to the end of depression periods, thus leading to prosperity phases. Innovation played an important role in economic history, in economic growth and especially in economic development, considering the improvement in living standards that these innovations birthed.

4.4.4 Empirical studies on the relationship between innovation and economic development

It is important to explore some empirical studies to verify the relationship between innovation and economic development. The empirical studies on the relationship between innovation and economic development vary according to the different schools of thought, as was discussed in Chapter Three, within which the original discussion is based.

There are many studies that still make use of the neoclassical models and new growth models, despite their shortcomings in explaining the process of innovation. These can be typified by studies comparing countries and those at firm level:

(i) LeBel (2008) built onto the endogenous growth model of Romer (1986) and added an innovation index as an endogenous factor. LeBel tested his model empirically by using a panel regression model on a sample of 103 countries for the 1980-2005 period. LeBel found that there is a positive role of creative innovation in economic growth. He described innovation as a "major determinant of *per capita* income" (LeBel, 2008:334;338). Cameron's (1996) conclusion of his survey of empirical studies corresponds with the findings of LeBel. Cameron (1996:10) believed that innovation makes a significant contribution to growth. The study of Ahmed & Suardi (2007) is also based on an endogenous growth model, using a Cobb-Douglas production function and the Solow model as baseline. Ahmed & Suardi tested 28 sub-Saharan African countries and found, *inter alia*, that the differences in *per capita* growth rates across these countries can possibly arise from differences in the technological growth rates.

Hulten & Isaksson (2007) also followed the endogenous growth theory to determine the reasons for the *per capita* income differentials among countries. They studied 112 countries over the period 1970-2000 and found that the share of total factor productivity (TFP) growth is always greater than that of capital deepening for all countries tested across income classifications. The World Bank (2010b:43) concluded from the study of Hulten & Isaksson that the TFP is the residual for the growth in output that is not explained by the growth inputs, that innovation is roughly proxied by TFP and that innovation is the major contributor to the differences in development across countries.

(ii) Crespi & Zuñiga (2010) conducted research at firm level testing the relationship between innovation and productivity empirically. Their study was conducted across 6 Latin American countries, using micro data from innovation surveys. They treated innovation as an endogenous factor, together with labour, capital and knowledge, in a Cobb-Douglas function. Productivity was measured as “sales per employee” and they found, “a very strong association between innovation and productivity” (Crespi & Zuñiga, 2010:3;31). A similar study to the work of Crespi & Zuñiga is that of Lööf & Heshmati (2002), who sought to determine the relationship between innovation and performance at firm level, but also compared the outcomes for manufacturing and service firms, as well as for “new to the firm” and “new to the market” categories. The data for their study was collected as an experiment enlargement of the second European Community Innovation Survey conducted by Statistics Sweden. The data collection was carried out in 1999 and covers the period 1996 to 1998. Lööf & Heshmati (2002:19) confirmed the positive relationship between innovation and productivity growth for service firms, but stated that this positive relationship exist for manufacturing firms only if innovation is new to the market.

The neoclassical and new growth theories were dominant in the twentieth century. The popularity of these theories may be due to their analytical abilities and mechanistic design making the approach convincing. However, in the analysis of dynamic phenomena and complex systems, these theories are inadequate (Hanusch & Pyka, 2007b:275). The diversity and unpredictability of innovations makes them even more difficult to be dealt with in these theories. According to Baumol, (2002:2), “Economic theorists have always found it difficult to deal mathematically with heterogeneous products … [I]nnovation is perhaps the product that attains the ultimate lack of uniformity. If two products or processes are very similar they will not both be considered innovative. Innovative activity, by definition, is the attempt to introduce something that did not exist before …”. Verspagen, (1992:649), added, “If technological expectations are not rational, and the consequences of technological events cannot be calculated in advance, the equilibrium growth path predicted by the new growth models … is much less likely to occur”.

The neo-Schumpeterian theories treat innovation as a much more complex system that cannot be reduced or simplified such as takes place in the neoclassical models of growth. According to Hanusch & Pyka, (2007b:278), simple systems are "decomposable" where complex systems are "irreducible", explaining, "neglecting a single part has severe consequences for their understanding". Some economists try to use the neoclassical models for explaining the complexity of innovation systems, but Nelson (1996:15) states, "While it is simple to extend the neoclassical model to include many sectors, the basic logic of that model is committed to continuing equilibrium, not resource reallocation driven by prevailing disequilibrium". Hanusch & Pyka (2007b:278) further indicate that simple systems can be predicted whereas complex systems are fundamentally unpredictable due to the non-linearities caused by interactions and feedbacks.

The systems approach of studying innovation is still in its infancy with its origin mostly during the 1980s and 1990s. It follows, therefore, that there is currently no agreement in literature on how innovation systems should be studied empirically. Fagerberg *et al.*, (2009:18), explain that, "Some researchers in this area emphasise a need for developing a common methodology, based on the functions and activities of the system, to guide empirical work … while others advocate the advantage of keeping the approach open and flexible …". Some of the studies that attempts to link innovation input or output with economic development make use of or develop an index to represent the complexity of the innovation system. The following may be cited as examples: Howells' (2005:1222) empirical study of a correlation between the Revealed Regional Summary Innovation Index (RRSII) and the relative *per capita* GDP (for selected regions across the European Union) indicated a clear correlation between innovation and economic activity and performance. Archibugi & Coco (2004) developed the ArCo index, as explained in paragraph 4.2.2, and empirically tested the correlation between the ArCo index and the GDP *per capita* of 162 countries over the period 1990-2000. They conclude that there is a very strong association between *per capita* technological capabilities and GDP. Fagerberg & Srholec's (2008) factor analysis, also explained in paragraph 4.2.2, combined several indicators of innovation capability into a factor that they called "innovation system". Fagerberg & Srholec found that there is a very close correlation between the factor score on "innovation system" and the GDP *per capita* of the 115 countries tested in the period between 1992 and 2004. The Global Competitive Index (GCI) that is used in the Global Competitiveness Report 2008-2009 (Sala-i-Martin, Blanke, Hanouz, Geiger, Mia & Paua, 2008:3-6) consists of twelve pillars: institutions, infrastructure, macroeconomic stability, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market sophistication, technological readiness, market size, business sophistication, and innovation. This report states the relative importance of innovation to the other pillars and states that, "In the long run, standards of living can be expanded only with technological innovation".

Although the studies since the 1980s-90s in the different schools of thought are mostly in agreement about innovation being important for economic development, they differ in the degree of importance of innovation. The most important difference amongst these schools of thought regarding the role of innovation in economic development lies in the process. Their disagreements can be analysed as follows:

(i) how innovation contributes to economic development;
(ii) the neoclassical view of treating innovation as an exogenous variable;
(iii) the new growth theories of incorporating innovation as an endogenous variable but still in an equilibrium model;
(iv) the Schumpeterian view of innovation as an endogenous variable disturbing equilibrium; and
(v) the neo-Schumpeterian view of innovation as a non-linear relationship among many determinants in an innovation system.

In Chapter Three, the acceptance of the Schumpeterian view due to the disturbing effect of innovation on equilibrium and the neo-Schumpeterian view of the complexity of the innovation concepts was laid out. The development of indices to represent innovation is an attempt to reduce innovative activities in the innovation system into a single number. There are economists that find it useful to make use of or to develop an index as was mentioned in the previous paragraph. Although Archibugi & Coco, (2005:176), admit that, "… there is no single number that can provide comprehensive information of the whole technological capabilities of a country", they find that "synthetic indicators" can, "…,despite the limitations, and if taken with due caution, … help to understand the reality of certain situations, and can assist in devising strategic decisions". Archibugi & Coco (2005) compared four different technological capability indices for 49 countries (countries that are included in all four indices) and found that, despite significant differences in the case of some individual countries, there is a high correlation between each pair of indices. Yet they admit that there is still a need to improve these indicators to show more similarity and to make them more reliable.

Another group of economists agrees with Hanusch & Pyka, (2007b:278), that, as was discussed previously, complex systems are irreducible. They emphasise the importance of qualitative change, and not only quantitative change, in the analysis of the innovation system. Hasan & Tucci (2010) used global patent data to investigate empirically the importance of both the quantity and quality of innovation on economic growth under various economic structures and stages of economic development. A sample of 58 countries for the period 1980-2003 was used by them and the results from a correlation matrix and regression analysis indicated that countries hosting firms with "higher quality" patents have higher economic growth and that those countries that "increase the level" of patenting also witness a concomitant increase in economic growth. Hasan & Tucci (2010:1273) concluded that quantity and quality of innovation are both associated with economic growth. The use of patent data as a measure of innovation has already been discussed in paragraph 4.2.2.

Although there is evidence from empirical studies that innovation contributes to economic development, it is important to note that not all innovation leads to development. There are exceptions such as inappropriate technology, that may lead to economic growth, but that may have a negative effect on development. This is especially the case in developing countries where importation of advanced technology that leads to large-scale capital intensive industries can create a dual economy (a prosperous modern sector and an impoverished traditional sector) (Akube, 2000).

4.5 The relationship between entrepreneurship, innovation and economic development

Although the importance of innovation in economic development has been established, there remains debate on the contribution of entrepreneurship to development. The role of the entrepreneur in economic schools of thought was explored in Chapter Three, and it was demonstrated that in the neoclassical theories the entrepreneur did not have a role to play. In the Schumpeterian and neo-Schumpeterian theories, the entrepreneur, in contrast with the neoclassical theories, plays this key role. Schumpeter saw the entrepreneur as the one who carries out the innovation and, whether innovation is done by a small or large firm, entrepreneurship is seen as essential if innovation is to take place. To confirm Schumpeter's theory, Wong, Ho & Autio (2005) indicate the positive relationship between entrepreneurship and economic growth through the entrepreneur's contribution to innovation by describing entrepreneurship as that which, "… contributes to economic growth through introducing innovations, creating change, creating competition and enhancing rivalry". Van Stel, Carree & Thurik (2005) further confirm this role of the entrepreneur in contributing to economic development through innovation by listing a few ways in which entrepreneurship may influence economic development. Thurik *et al.* (2005) believed that:

(i) entrepreneurs may introduce important innovations by entering markets with new products or production processes;
(ii) entrepreneurs are important in the early evolution of industries;
(iii) entrepreneurs may increase productivity by increasing competition;
(iv) they may enhance knowledge of what is technically viable; and
(v) they may be inclined to work longer hours and more efficiently.

Audretsch & Thurik (2001) also tested empirically whether there is a link between entrepreneurship and growth (as a component of development). They used two different measures of entrepreneurship:

(i) the relative share of economic activity accounted for by small firms, and
(ii) the self-employment rate.

They used different samples, from OECD countries over different periods, and their results were consistent. They found that increases in entrepreneurial activity tend to result in higher growth rates. Audretsch (2004) stated that the role of entrepreneurship had changed in recent years and that it had become the, "… engine of economic and social development throughout the world". Audretsch implies that entrepreneurship takes place in small businesses and he found that the role of the entrepreneur becomes more important in carrying new knowledge that has been created by larger organisations into successful commercialised innovations, that is, into knowledge spillovers.

Although it seems that most literature agrees on the positive impact that entrepreneurship can have on economic development, certain empirical tests query this relationship. In testing the findings of literature empirically, Wong *et al.* (2005) found that only high growth potential entrepreneurship has a significant impact on economic development. They conclude that, not new firms, but fast growing new firms, account for most new job creation by small and medium enterprises in advanced countries. They further conclude that a higher degree of entrepreneurship or new business creation does not guarantee better economic performance and higher economic growth and that only a very small portion of entrepreneurs engage in true, technological innovation. Wennekers, Van Stel, Thurik & Reynolds (2005) have found that there is a U-shaped relationship between economic development (measured by *per capita* income or innovative capacity index) and nascent entrepreneurship. They conclude that entrepreneurship plays a different role at different stages of economic development. The problem with their study is that nascent entrepreneurship measures only new ventures (which, of itself, is a narrow definition of entrepreneurship).

Another study, that of Tang & Koveos (2004), shows that "venture entrepreneurship" is positively related to the GDP growth rate but that "innovation entrepreneurship" is negatively related to the GDP growth rate in high-income countries. "Venture entrepreneurship", according to Tang & Koveos, is concerned with new venture creation while "innovation entrepreneurship" refers to innovations within existing enterprises.

They link the explanation with the business cycle, concluding that the positive correlation between “venture entrepreneurship” and economic growth is a pro-cyclical phenomenon, while the negative correlation between “innovation entrepreneurship” and economic growth is counter-cyclical. The correlation does not show the direction of causation. Therefore there is no proof that the new businesses cause economic growth, because the new businesses may be the result of an economic growth phase in the economy. On the other hand, the decreasing economic growth in a downward phase of the economy may be the incentive needed for innovative activities to increase. For the results to be meaningful, other factors/variables should be controlled for by, for example, multiple regressions.

Most of the differences of opinion in these discussions originate from different definitions or measurements of entrepreneurship. Some literature defines or measures entrepreneurship as new businesses or new business start-ups, while others define or measure entrepreneurship as small and medium enterprises (SMEs). The Global Entrepreneurship Monitor (GEM) uses the Total Entrepreneurial Activity (TEA) index to measure entrepreneurship. The TEA index, according to the GEM (Von Broembsen, Wood & Herrington, 2005:56), “measures the proportion of people aged 18 to 64 years who are starting or managing new firms less than three and a half years old that they will either partly or wholly own”. If entrepreneurship is measured as new businesses only, then the full extent of entrepreneurship, as defined in paragraph 2.3 as “individuals whose function it is to carry out new combinations”, is not measured. In Chapter Three, the two models of Schumpeter, Schumpeter I and Schumpeter II, indicated Schumpeter’s shift in his theory from small-firm innovations to innovations by larger firms, as reflected in Schumpeter’s different publications, “Theory of economic development” of 1911 and “Capitalism, socialism and democracy” of 1942 (Schumpeter, 1961; 1976). Schumpeter argued that monopolistic firms can more readily perform R&D and he further stated that large firms are better or more eager to undertake R&D. Arrow (1959) put forward a counterargument, namely that a competitive environment is more conducive to innovation and that a monopolist has a lower incentive to innovate. He argued that monopolies have relatively few units of output over which to spread the fixed cost because they raise prices and reduce output to maximise profits. These arguments are based on costs and benefits of both small and large firms to be innovative. Innovation is not limited to small or large businesses. Entrepreneurship can even take place in organisations other than firms. The activity and contribution of entrepreneurship to economic development cannot only be measured by new businesses (of which some do not become successful) in order to contribute to development, because the extent and effectiveness of the entrepreneur is not measured by the number of new businesses. Therefore, entrepreneurship cannot be measured by new SMEs only. Such studies on the contribution of entrepreneurship to economic development actually measure the "role of the small or medium firm as opposed to the role of the larger firm in economic development" instead of "the role of entrepreneurship in economic development". Entrepreneurship takes place in small, medium and large firms, and different sizes of firms play different roles, but they all contribute to economic development. Vosloo (1994:153) concludes that entrepreneurs are the "heroes of economic life", and he states the following regarding the role of the entrepreneur in economic development:

> "But one consistent theme recurs in the wealth creation process. It points to a special class of individuals who have been the initiators of economic growth and social development: the entrepreneurs. Entrepreneurship is now widely regarded as an integral part of a successful formula for achieving economic growth".

Innovation has been indicated as essential for economic development and the entrepreneur was defined in Chapter Two as the individual who carries out innovation. This implies that the entrepreneur plays an essential role in economic development.

4.6 Summary

In this chapter, different empirical studies were analysed to determine the relationship between innovation and economic development. The different ways in which innovation and economic development are measured has been discussed together with the difficulties that are experienced in the measuring of these concepts.

The relationship between innovation and economic development was first indicated by the major innovations in history and the economic development components *per capita* GDP growth and population growth. It was shown that since the 1800s, the GDP *per capita* growth, as well as the population growth, started increasing suddenly and exponentially. These increases are linked to innovations such as the development of the steam engine which led to the use of fossil fuel energy for productive tasks and thereafter, to the Industrial Revolution. Different examples of major innovations in history, the time of the invention, the time of the related invention, the innovator, as well as the country involved, are supplied. This historical overview of major innovations provided proof of the economy's dependence on innovation for development.

The relationship between innovation and economic growth was proved with the long wave and innovation paradigm views. Schumpeter's theory, with the support of other economists, proved that innovation takes place in all periods, but that there are more innovations in the recovery period.

The empirical evidence from different studies indicated that the studies that have the later neoclassical models or the new growth models as their basis do indeed show a positive relationship between innovation and economic growth. Even so, these studies are based on simple systems of equilibrium models. Equilibrium models, as has been established by the Schumpeterian models clarified in Chapter Three, cannot explain innovation's role in economic development due to innovation being the essential factor that, through disturbing equilibrium, leads to economic development. Where the neoclassical models have innovation as an exogenous factor, the new growth models incorporated innovation as an endogenous factor, but still in an equilibrium model.

The complexity of the relationship between innovation and economic growth has been described by the neo-Schumpeterian views, indicating the desirability of innovation being studied from a system perspective. The neo-Schumpeterian economists study innovation as a complex non-linear relationship among different actors or role players. In some empirical studies, innovation has been reduced to an index of different determinants. Evidence has been given of empirical studies indicating a positive relationship between innovation and economic development. There are neo-Schumpeterian economists who reason that innovation capabilities cannot be reduced to a single number and that there are quantitative as well as the qualitative differences in innovation systems.

In this chapter, the empirical studies on the relationship between entrepreneurship, innovation and economic development are finally discussed, placing the entrepreneur as the agent of innovation and so fulfilling a central role in economic development.

Although there is consensus on the importance of innovation to economic development, the process still needs further investigation. In the following chapter, what determines innovation will be studied, and thereafter, the innovation system will be examined.

CHAPTER FIVE

THE DETERMINANTS OF INNOVATION

5.1 Introduction

In previous chapters, the importance of innovation for economic development has been established. It was found to be imperative to increase innovative activities if economic development is to improve. The aim of this chapter is to establish, using a literature review, what it is that determines innovation and what conditions should be present to enhance the innovative performance of an innovation system.

Innovation takes place mostly in firms, but Fagerberg *et al.* (2005:20) conclude from different studies that, "…a firm does not innovate in isolation, but depends on extensive interaction with its environment". This environment can either be conducive to innovative performance or not. There is no set of criteria that is generally accepted as prerequisites for innovation to take place. Indeed, researchers differ widely in what they regard as important criteria. Most publications focus on how to measure innovation or innovativeness, each one following its own determinants, but the criteria for an environment conducive for innovation is still under debate.

The literature on the determinants of innovation can be grouped into two categories. The first category focuses on the determinants specific to the firm and the second on those that are related to the firm's environment (Becheikh, Landry & Amara, 2006 and Vega-Jurado, Gutiérrez-Gracia, Fernández-de-Lucio & Manjarrés-Henríquez, 2008). There are a small number of studies that incorporate both internal and environmental factors. The aim of a study and the discipline in which it resides often determine how the study's perspective and focus differ from that of other studies. The studies that focus on the internal determinants are often done from a business management or micro-economic perspective. This study, which focuses on the innovation system, follows a macro-economic perspective. The environment or contextual determinants of innovation are examined from the perspective of the innovative performance of the innovation system as a whole. Yet, in the view of the important role that the firm plays in the innovation system, the internal determinants of innovation are also included. Although some of the determinants can be distinguished as internal to the firm, most internal determinants of innovative performance are linked to the environmental determinants. According to Vega-Jurado *et al.,* (2008:617), the methodological difficulty of integrating different theoretical perspectives led to separate analysis of the internal and external determinants of innovation that in turn caused the neglect of the analysis of the links between the two groups of determinants. Vega-Jurado *et al.* focus attention on the joint effect that the external and internal factors have on the performance of the innovation system.

5.2 Internal (firm) determinants of innovation

Although it is sometimes difficult to distinguish between the internal determinants and the external determinants, the internal determinants that have been identified by empirical studies as having a significant relationship with innovative performance include the technological capabilities of the firm such as their research and development intensity, absorptive capacity of technology and qualified labour force. Other internal determinants that were found to have an effect on innovative performance are characteristics of the firm, finances and the cost of innovation and global engagement.

5.2.1 Technological capabilities

Technological capabilities of a firm are mainly determined by the research and development (R&D) activities, the capacity to absorb technology and the employment of qualified labour (Therrien, 2000:12).

R&D by the firm is the determinant that is often (incorrectly) seen as synonymous with innovation. The relationship is sometimes regarded as self-evident, and R&D spending is even used in many studies as a measurement for innovation (as was discussed in

Chapter Four, paragraph 4.2.1). Becheikh *et al.* (2006:655) found that in their analysis of 108 studies on the determinants of innovation, more than half of these studies regarded R&D as a determinant of innovation and that nearly 80% of them found a significant positive relationship between “in-house” R&D and innovation. Becheikh *et al.* concluded that in-house R&D, “... is largely admitted to be a crucial determinant of innovation”. The findings of Therrien (2000) confirm the importance of R&D expenditure as a determinant of innovation. Therrien used the data from the 1999 Innovation Survey in Canada into 6000 enterprises in manufacturing industries and 800 enterprises in natural resources industries. Of the firms surveyed, almost 60% of innovating firms indicated that performing R&D is important for firm success, and more than 75% of innovating firms indicated that R&D activities are linked to innovation (Therrien, 2000:32&34). Shefer & Frenkel (2005:31) found, from their survey of 209 firms in the northern district of Israel, that the magnitude of the mean values of investment in R&D between the innovative and non-innovative firms was large and highly statistically significant.

Although the importance of R&D activities in a firm should not be overlooked, R&D expenditure by itself is not sufficient to ensure innovation. According to Therrien (2000:2), the Canadian Innovation Survey indicated that 65% of firms performed R&D, but only half of them brought new products or new processes to the market. On the other hand, R&D is not always a prerequisite for innovation. Some innovation takes place without R&D. Guellec & Pattinson (2006:94) confirms that innovation can take place without R&D as prerequisite and agree that R&D is not the only determinant of innovation, stating, “Innovation goes beyond research and development (R&D). Much technological innovation does not result from R&D, although it has large impacts on the economy. This is true especially for the service industries”. Radosevic (2006:201) follows similar reasoning and has that, “For a long time, innovation has been practically identified with R&D activities. It has been assumed that no innovation can take place without R&D activities. It is now recognised that innovation is a mixture of different activities, which can take place without the involvement of R&D.” What must be considered though is that perhaps Guellec & Pattinson, and Rodosevic too, overlook the basic research and knowledge creation by public research institutes and universities (discussed in paragraph 5.3.2) that have been accepted as general knowledge and not recognised as R&D, which preceded innovative thoughts and ideas. They almost certainly imply intentional R&D expenditure by the firm or other institutions aiming to develop new products or processes. R&D, although not always a prerequisite for all innovations, nevertheless remains important for the general improvement of innovation.

The technological capability or competency of a firm is not only influenced by the R&D activities of the firm, but also by the external sources of technological opportunity and the capacity of the firm to exploit these opportunities and knowledge for innovation. The technological capacity includes the "extent to which firms can assimilate and exploit external knowledge" (Vega-Jurado *et al.*, 2008:617&620). R&D, apart from having a direct influence on innovation, further enhances the absorptive capacity of technology and knowledge (Vega-Jurado *et al.*, 2008:630). Therrien (2000:12) agrees with this statement by contending that, "Besides the principal task to support the future development of new products or new processes, performing R&D also permits a firm to use more efficiently embodied technology acquired externally (acquisition of machinery, equipment or other technology)". Therrien (2000:11&34) concludes from the analysis of the Canadian 1999 Innovation Survey that firms primarily acquire embodied technology with new machinery and equipment, and demonstrates that more than 80% of successful innovating firms indicated that they link the acquisition of machinery and equipment to innovation. Becheikh *et al.* (2006:656) found in their empirical study that acquiring sophisticated equipment and production technologies has a significant positive effect on innovation. Vega-Jurado *et al.* (2008:627-629) give further proof of the direct, positive effect of technological competencies (both R&D activities and external factors) on innovation output in their empirical analysis of the "2000 Technological Innovation in Companies Survey" of 6 094 manufacturing firms in Spain.

R&D activities and technology absorption can only be made useful by suitably qualified labour. It is not only the specific knowledge transferred, but also the attitude and abilities of the personnel to detect and adopt new technology that determines the innovative ability of a firm. Therrien (2000:34-36) shows in his analysis of the Canadian survey that more than 80% of innovating firms indicate that training is linked to innovation. Therrien further shows that a "lack of skilled personnel" is one of the main factors indicated by firms as hampering innovation. Becheikh *et al.* (2006:656) confirm from their review of 108 empirical studies that a "highly educated, technically qualified and experienced personnel" is an important determinant of innovation. Lehtoranta (2005:29) confirms this from an empirical study of Finnish firms, and states that the, "share and inflow of highly qualified personnel" affects the innovation activities of a firm.

The development of human resources is one of the most important criteria if innovation is to take place. Innovation is carried out by people and the better this specific resource is developed, the higher the chance that innovation will take place. The Ministry of Economic Development of New Zealand (2005:9) states:

> "Highly skilled and educated people are critical to innovation because they create new knowledge and ideas through research and development and other creative activities such as design, and because they help to facilitate the absorption of ideas from overseas and the transfer of ideas …".

The ability of a firm to locate and employ suitably qualified personnel is dependent on the development and quality of human resources in the environment. In paragraph 5.3.2, human development is further discussed as an external determinant.

5.2.2 Characteristics of the firm

The characteristics of the firm that have been discussed in literature as determinants of innovative performance of the firm include the size and the age of the firm, as well as the structure, culture and management of the firm.

Size

The size of the firm as a determinant of innovation has been the topic of many innovation studies. It can be inferred from various studies that the size of the firm has a positive relationship with innovation (Becheikh *et al.,* 2006; De Mel, McKenzie & Woodruff, 2009; Du, Love & Roper, 2007; and Lee, 2004). In Chapter Four (paragraph 4.5), it was indicated that the debate on the size of the firm dates back to Schumpeter's two models, Schumpeter I and Schumpeter II together with the Schumpeter-Arrow debate. Schumpeter, in his first publications, regarded the entrepreneur as the founder of a small new business, but in his later publications he recognized that entrepreneurs, responsible for innovation, function in all sizes of firms. Schumpeter indicated that the large firms outperformed the smaller firms in the innovation and appropriation process through a strong positive feedback loop from innovation to increased R&D activities (Freeman, 1982:213-214; Thurik & Wennekers, 2004:140-141; Wennekers *et al.*, 2005:296; Van Stel *et al.*, 2005:313; and Wong *et al.*, 2005:336). Schumpeter's argument was based on innovation under monopolistic conditions while Arrow focused again on the incentive to invent under competitive conditions (Arrow, 1959; Schumpeter, 1961; 1976).

Becheikh *et al.* (2006:652) confirms the positive relationship of firm size with innovation in their analysis of empirical studies. Becheikh *et al.* show that of the 108 empirical innovation studies analysed, 59 study the relationship between the size of the firm and innovation. Of the 59 studies, 36 show a positive relationship, 4 show a negative one, 11 demonstrate no significant relationship, 5 reported a bell-shaped relationship and 3, a U-shaped relationship. The positive relationship stems mostly from the benefits available to large companies as they have greater resources to support innovation and the economies of scale in R&D.

The positive relationship between firm size and innovation does not imply that small firms are not important in an innovation system, nor that an innovation system should consist of large firms only if the performance of the innovation system, in general, is to be improved. Many, if not all, large firms started small, therefore, without small firms many large firms would not subsequently exist (Greenhalgh & Rogers, 2010:88). Another possible reason for the studies showing that large firms innovate more is the indicator that is used to measure innovation. The problems with measurement of innovation were set out in Chapter Four, paragraph 4.2. R&D in small firms are often less "formal" than in larger firms and smaller firms often do not register patents, as was explained in Chapter Four. Incremental innovation has been indicated as not necessarily being measured by these studies. By using R&D expenditure, patents or only major changes in studies of innovation, the results may be distorted due to the exclusion of many innovations.

Age

Although the age of a firm may, in certain instances, have an effect on the innovative activities of a firm, it has not been established with certainty what that relationship is and it seems that age is not a significant determinant for innovation. Lee's (2004:8) empirical study, using the National Survey of Innovation 2000-2001 data from Malaysian manufacturing companies, indicated that younger firms are more likely to innovate than older firms are, but that the age of a firm is not a significant explanatory variable at the 5% level. Becheikh *et al.* (2006:652) have found that, of the 108 empirical studies analysed, 9 studied "age of the firm" as a determinant of innovation, 3 found the relationship positive, 2 found it negative, 3, not significant and 1, bell-shaped. The arguments for the two opposite relationships are that, for the positive relationship, older companies have accumulated experience and knowledge necessary to innovate, and for the negative relationship, companies have developed established procedures and routines and that creates resistance and barriers to the integration of new ideas and innovation (Becheikh *et al.,* 2006:652 and Damanpour & Wischnevsky, 2006: 279). It seems therefore that there is no general trend, and that age affects the innovative activities of individual firms differently or not significantly. This then emphasises that entrepreneurship, or the carrying out of innovative activities, cannot be measured by the number of new firms only, as was previously discussed in paragraph 4.5.

Willingness to change

It can be argued that the differences in innovation by firms lie in the culture of the firm and firm organisation. The firm with greater willingness to accept and create change (new methods, processes, organisation, etc.), is the more innovating firm. According to Loasby, (2007:295), "... heterogeneity across firms is an important principle of neo-Schumpeterian economics. It is to be found in the organization of individual minds and in the organization of firms". Fagerberg (2005:11) agrees with the importance of the organisation of firms and stated, "Research in this area, among other things, pointed to the need for innovative firms to allow groups of people within the organization sufficient freedom in experimenting with new solutions…and establishing patterns of interaction within the firm that allow it to mobilize its entire knowledge base when confronting new challenges …". Aspects such as a decentralised structure, the presence of organisational resources, the belief that innovation is important, the willingness to take risks and the willingness to exchange ideas have all been found to be conducive to innovation in firms, according to Wan, Ong & Lee (2005), in their empirical study of 71 firms in Singapore. De Mel *et al.,* (2009:1-3), added the characteristics of the owner as determinants of innovation by the firm in their empirical study of 2800 firms in Sri Lanka. They found that, "Owner ability, personality traits, and ethnicity are found to have a significant and substantial impact on the likelihood of a firm to innovate …" and, "We find very strong evidence that the characteristics of the owner do matter for innovation. More educated individuals, those with higher digit span recalls, and those scoring higher on a raven test are more likely to innovate".

5.2.3 Funds, finances and the cost of innovation

Funds and finances seem to be an important determinant of innovation and access to financing seem to be positively correlated with innovation (De Mel *et al.*, 2009:3). "Financial autonomy" (the amount of equity compared to debt), "a good financial performance" and "available funds and budgeting for innovation-related activities" all seem to have a positive, significant relationship with innovation, according to an analysis of different empirical studies by Becheikh *et al.* (2006:656). Although not many empirical studies focussed on the relationship between the firm's finances and innovative performance, it is interesting to note that, in many studies that establish the "hampering factors of innovation" (Bogliacino, Perani, Pianta & Supino, 2009; ESCWA, 2003; and Therrien, 2000), lack of financing (internal and external) is indicated as one of the highest factors on the list. Balzat (2006:107) stated, "A combination of the high risks and costs that are associated with innovation together with lacking financial resources constitutes the most important barrier to the conduct of innovative action in private business firms." Bogliacino *et al.* (2009:13) indicate the "cost of innovation", the "lack of internal resources" and the "lack of external financing" as the dominant barriers to innovation in their surveys of developing and emerging countries in Europe, Asia, Africa and Latin America. Therrien (2000:36) confirmed the "high cost of developing innovation" and the "lack of financing" amongst the factors mostly indicated by firms as hampering innovation in their Canadian survey. External financial support is further discussed as part of the environment determinants of innovation in paragraph 5.3.3.

5.2.4 Global engagement

The effects of globalisation on innovation include that firms having greater access to information and markets, are more easily able to undertake joint projects with firms in other countries. Globalisation also increases national and international competition, which makes innovation vital for firms in all industries (Archibugi & Iammarino, 1999:322 and Bloch, 2007:25). Other advantages of globalisation include economies of scale, learning from international best practice, developing mutually beneficial relationships with overseas business and improving access to skilled people, ideas, knowledge, technology and capital (Ministry of Economic Development of New Zealand, 2005:13).

Criscuolo, Haskel & Slaughter (2010) proved, with their empirical study on UK firm data from the EU-wide Community Innovations Survey, that globally-engaged firms innovate more. Their findings are as follows:

> "First, globally engaged firms do generate more innovation outputs: more patents, more self-reported innovations and a higher fraction of sales due to innovations. Second, globally engaged firms do use more inputs to knowledge production. They use more researchers. But they also use more knowledge inputs. Not only do they use more knowledge flows from outside the firm, but also they use more flows within the firm, particularly from enterprises within the enterprise group (twice as much as multi-enterprise domestic firms for example)".

Long, Raff & Stähler (2011:155) mention the complementarity between innovation and exporting in their model. They found that firms are more likely to export if the firms innovate and the firms are more likely to innovate when they see promising export opportunities. The positive relationship between global engagement and innovation is confirmed by De Mel *et al.* (2009:3) as well as by Becheikh *et al.*'s (2006:653) analysis of empirical studies who indicates that 13 out of the 14 empirical studies show a positive relationship, and the remaining study shows no significant relationship. Pamukcu (2003:1444) has similar findings from his innovation survey amongst Turkish manufacturing firms over the period 1989-93, "... firms that export as well as those using imported goods are more likely to innovate than nonexporters and firms that do not use imported equipment".

5.3 Environmental determinants

Although the determinants have been distinguished as internal (to the firm) and environmental determinants for discussion purposes, there are often strong links among these determinants. A qualified labour force, for example, does not depend only on internal training by the firm, but is strongly influenced by the environmental influences such as the quality of education and training facilities outside the firm. R&D by the firm has previously been indicated as an important internal determinant, but the importance of R&D spending outside of the firm by, for example, universities, must be explored. These, and other, environmental determinants that have been established in literature as being important for innovation are as follows:

5.3.1 Human development

Human capital is one of the essential factors in a national innovation system. Soete (2006:210) refers to it as the cement that holds the knowledge and innovation systems together. Urriago, Modrego, Barge-Gil & Paraskevopoulou (2010:4) imply that human development is an indispensable or essential condition for, or ingredient of, innovation by stating, "… the supply of physical and human infrastructure is a *sine qua non* condition for innovation …". The importance of human development is confirmed by a publication of The World Bank (2010b:165) that offers:

> "... a good educational and training system is fundamental to building a population receptive to innovation, able to tap into and absorb the sources of global knowledge, and creative in terms of technology and entrepreneurship".

A qualified labour force determines innovation internally for the firm (as discussed in paragraph 5.2.1), but in order to improve the innovative activities in an innovation system, well developed human resources should form part of the environment (Morck & Yeung, 2002:395). An empirical study was done by Suri, Boozer, Ranis & Stewart (2011), using World Development Indicators, developed by The World Bank, of 79 countries, to establish the relationship between human development and economic growth. Unsurprisingly, the findings of Suri *et al.* (2011:14) show that human development plays an essential role in determining growth trajectories. They show that not only does human development contribute to economic growth, but also that economic growth supports human development. Suri *et al.* (2011:3), subsequently, have indicated economic growth, as taking place because of innovative activities. The process is described as follows: human development influences labour, entrepreneurship and managerial abilities, which in turn affects the choices of imported technology, adaption, domestic R&D and innovation. This leads to the composition of output and exports that eventually increases the GDP or economic growth. The increase in economic growth and income, on the other hand, leads to an improvement in human development through an increase in household and government social expenditure. Fedderke (2005:37) confirms the importance of human capital, and especially quality rather than quantity of human capital, for economic growth. The findings of Fedderke are based on an empirical study of the manufacturing sector in South Africa, using panel data of observations between 1970 and 1997.

The development and quality of human resources has many different aspects that should be studied. It starts with the quality of primary and secondary education and thereafter continues to the availability and quality of tertiary education, as well as on-the-job training. In a publication by The World Bank (2010b:173), the quality and reach of the primary and secondary education and the competence of the teachers is most accurately called the, “spine of any educational system in the innovation-driven economy ...”. Porter & Stern (2001:5) add the higher levels of education to the list, for they believe, “The foundation of a nation’s common innovation infrastructure is its pool of scientists and engineers available to contribute to innovation throughout the economy”. The World Bank publication mentions basic mathematical and literacy skills, the quantity of schooling, and the quality of education and the relevance of education as the challenges to be overcome if well-developed human capital is to be available. The OECD & Eurostat (2005:43) confirm the importance of the development of human resources and list aspects that need attention, both internally, by the firm, and externally, by the role players in the environment:

> “Much knowledge is embodied in people and their skills, and appropriate skills are needed to make intelligent use of external sources or codified knowledge. The role of human capital in innovation is important at both the firm and the aggregate level. Some issues of interest here are the quality of the education system and how well it matches the needs of the innovative firms and other organisations; what efforts firms make to invest in human capital of their employees; whether innovation activity is hampered by shortages of qualified personnel; whether there are sufficient opportunities for worker training; and how adaptive the workforce is in terms of the structure of the labour market and mobility across regions and sectors”.

Education-related issues such as primary- secondary- and tertiary enrolment and the quality of the whole education system arguably head the list of the complex human development concept. The quality of math and science education, quality of management schools, internet access in schools, availability of research and training services and extent of staff training each need to be addressed. Then too, other innovation-related issues such as the quality of scientific research institutions and the availability of scientists and engineers are all related to the human development scenario (Schwab, 2011:323). The education system (primary, secondary and tertiary) must be adequate to equip people with the foundational knowledge sets that are needed for people to become entrepreneurs or productive workers. Industry too must play its part and become involved in on-the job training and further development of staff. The alignment of the education system with the needs of an innovative industry is crucial. The retention of the qualified and experienced workforce too can be just as important as the recruitment and maintenance of human capital, particularly in the light of the cost of the so-called “brain drain”.

Human resources can be divided into two components: the workforce and the entrepreneurs. Entrepreneurs are the people who carry out the innovation and must therefore be developed to fulfil this function. Yet, entrepreneurs may develop out of the workforce and one does not know beforehand which workers or learners will become entrepreneurs. Therefore, the development of the workforce becomes even more important, not only to have productive workers, but also to develop entrepreneurs. Orford, Herrington & Wood (2004:34) are of the opinion that not only is quality education needed to enhance innovation, but that entrepreneurship teaching must be done at primary and secondary school level. Orford *et al.* maintain that the education system plays an important role in “developing entrepreneurial skills and shaping attitudes”. Nafziger (2006:406) agrees that most studies indicate that there is a direct relationship between education and an entrepreneur’s success. However, he notes that the contrary can also be true due to the time and money spent on formal education, as opposed to entrepreneurial activities, or due to other occupational choices that obviate the need to become entrepreneurs. Entrepreneurship training is not the only aspect that prepares develops potential entrepreneurs, for example, the quality of mathematics and science education at school can also be regarded as contributing to an improvement of entrepreneurial activity (Orford *et al.,* 2004:52).

There is sometimes a perception that people cannot be taught to become entrepreneurs. Thomas (1994:375) reaches the following conclusions about the, "… nurturing of … entrepreneurs" in his study of entrepreneurship:

(i) With very few exceptions, entrepreneurs are not "born", but evolve through a lengthy process of education, training, learning-by-doing, experience transfer, capturing opportunities and through trial-and-error practice;

(ii) Parental background, childhood experiences, the nature of school and post-school education and the broader business and economic environment that shape any person, can all play a significant role in the acquisition of entrepreneurial abilities and business disciplines;

(iii) The "apprenticeship model" best describes the process of intensive experience transfer that usually constitutes the skill basis of any effective entrepreneur. Such apprenticeship need not be formalised in a conventional sense, but demand aspects like technical skill transfer, observational and practice learning, acquisition of a work ethic, self-discipline, self-respect and pride in the vocation, a grasp of the broader environment in which the "business" is situated, and a strong sense of responsibility;

(iv) Effective and lasting entrepreneurship creation takes time; and

(v) Many of the aspects usually linked to successful business leadership – like effectively communicating with clients, colleagues or business contacts, establishing and utilising networks, assessing risks, planning new ventures, tapping experience from knowledgeable persons, etc. – are, as a matter of routine, instilled in the mind of entrepreneurial trainees during those years of "apprenticeship".

These conclusions of Thomas emphasise the importance of an effective education and training system, with well-qualified teachers and trainers, and in an environment with role models whose examples are worth following. Vosloo (1994:156) confirms the importance of the development of entrepreneurs. He states, "It is no exaggeration to say that the overall health of our economy depends largely on dynamic entrepreneurial activity …. It is therefore vital that the development of an entrepreneurial society, through appropriate educational and training programmes and with a high degree of youth involvement, become a key component in any new order for the future of South Africa".

Although it is important for an education system to be aimed at improving and increasing entrepreneurial capabilities in people, not every person has the aptitude to become an entrepreneur. Creativity and a willingness to take risks are skills that some people may have, that some people may be able to learn and that some people may not be able to learn. Teachers are usually not entrepreneurs themselves, which creates some doubt if the entrepreneurial skills can be effectively enhanced by the education system. An education system should therefore focus on overcoming these obstacles. Nafziger (2006:409-410) mentions some other factors that were identified by different studies that may have an influence on entrepreneurship, especially from a less developed country perspective. Here are examples of what Nafziger describes and which indicate that there are many different factors that should be considered for the development of entrepreneurs:

(i) Generally, entrepreneurs come from a much higher socioeconomic background than the general public;
(ii) Societies where children are raised democratically, so that they are encouraged to take initiative and be self-reliant, are more likely to produce entrepreneurs; and
(iii) Cultural norms in less-developed countries, defining how women should behave at work, limit female entrepreneurial activity.

Human development is a long complex process that does not only depend on the education and training provided by the state. The *milieu* within which a person grows up has an impact on the development of the person. The home environment in which a person grows up plays an important role. Scerri (2009:6) stated, "While the specifics of the location of human capital formation is often contingent on cultural, political and economic factors, it is generally the family unit, however that is defined, that is the main formative context for human capital". Fedderke (2005:1;37) emphasises the important influence that human capital has on the institutions of society that determine the long-run productivity of all factors of production, and confirms that human capital is in turn influenced by these institutions. The society or community shapes the values honoured in family units. It might be important to determine whether the society or community tolerates change. This is probably related to the main religion observed, as well as other sources of values.

Human development is a complex concept that includes a plethora of different aspects. The aspects include, *inter alia*, health-related issues such as life expectancy, infant mortality and the incidence of illnesses such as malaria, tuberculosis and HIV & AIDS. Scerri (2009:6) confirms the complexity of providing adequate human capital and also includes health as a contributing element. Scerri adds secure basic needs provision and a secure base of social capital. To promote more innovation in an economy, it therefore seems important to create a healthy environment where diseases such as malaria, tuberculosis and HIV & AIDS do not affect the workforce and entrepreneurs.

5.3.2 <u>Research and development outside the firm</u>

The importance of R&D by firms (as discussed in paragraph 5.2.1) is supported by the public sector, as well as the private sector. The research done by the public sector often takes place at universities or research institutes. The importance of R&D for the environment of the innovation system is emphasised by Porter & Schwab (2008:6) when stating that in order to create "an environment that is conducive to innovative activity", the following are required, "… sufficient investment in research and development (R&D) especially by the private sector, the presence of high-quality scientific research institutions, extensive collaboration in research between universities and industry, and the protection of intellectual property".

Bilbao-Osorio & Rodrígues-Pose (2004:452) studied the impact of R&D investment of the private, public and higher education sectors on innovation (measured in terms of patent applications) in 9 European Union (EU) countries and found that R&D investment, as a whole, and higher education R&D investment in peripheral regions of the EU, in particular, have positive relationships with innovation. Public R&D expenditure did not prove to be specifically contributing to innovation. Bilbao-Osorio & Rodrígues-Pose reasoned that this might be due to public R&D largely being basic research and thus not having a direct link with the number of patent applications. Vega-Jurado *et al.* (2008:629) agree with the importance of “in-house” R&D as a determinant of innovation, but found from their empirical study of 6 094 manufacturing firms in Spain that, apart from firm R&D, “... the technological opportunities derived from scientific institutions, such as universities or public research organisations, constitute a key element in the development of products with a high degree of novelty ...”.

The public sector research plays a number of different roles. The most important of these are that it creates knowledge through basic research; it equips scientists to undertake research in public as well as the private sector; it develops innovations, which are used by industry; and it collaborates with industry in formal and in less formal research projects. The OECD (1997:9) describes the importance of R&D for innovation, as well as the links between the public sector and private sector research, as follows:

> “The quality of the public research infrastructure and its links to industry may be one of the most important national assets for supporting innovation. Government-supported research institutes and universities are main performers of generic research and produce not only a body of basic knowledge for industry, but are also sources of new methods, instrumentation and valuable skills. Increasingly, the research conducted at these institutions is being supported by enterprises who are collaborating with the public sector in joint technology projects, contracting specific research or financing staff and researchers. In addition to such R&D collaboration, the public research sector serves as an overall repository of scientific and technical knowledge in specific fields. The general ability of industry to access that knowledge is important. This can be through patent data, published information about new scientific discoveries, knowledge embedded in new instruments and methodologies, access to scientific networks and spin-off firms nurtured in technology incubators”.

5.3.3 External financial support

The lack of funds within the enterprise (discussed in paragraph 5.2.3), as well as the lack of finance from sources outside the enterprise are just two of the factors that hamper innovative activities (Piatier, as cited by Hadjimanolis, 2003:561 and OECD & Eurostat, 2005:113). A few examples that can lead to a lack of access to finances include the reluctance of lenders to share due to the high risk of innovation projects, information asymmetry between lenders and borrowers, the difficulty that outside capital providers have in the financial assessment of innovative projects, innovators frequently being unable to provide collateral for loans and a lack of venture capital for innovative start-ups (Hadjimanolis, 2003:561). Becheikh *et al.* (2006:658) concluded from their analysis of empirical studies that "... the financial support granted by governments, professional organisms and industry-orientated financial institutions encourage firms to innovate more ... This financial support can take the form of subsidies, grants awards or loans". Empirical evidence from the study of 104 Korean firms shows that financial support from government in the early stage of R&D, and from downstream firms in general, improves the success rate of innovative activities (Lee & Park, 2006:1045). However, external financing by government does not always contribute positively to innovation. Morck & Yeung (2002:401) stated, "The private sector has a track record of funding successful innovations..... In contrast, governments seem poor at allocating money for innovation". Morck & Yeung are of the opinion that state subsidy programs aimed at encouraging innovation does not work and that governments should rather use tax incentives to subsidise "winners" as opposed to "losers". Yet, this still does not ensure an effective allocation of funding as "winners" and "losers" cannot be distinguished "before the race is run".

Benfratello, Schiantarelli & Sembenelli (2008) found, in their study of a large number of Italian firms during the 1990s, that banking development has a positive and significant effect on the probability of introducing a process or product innovation.

Apart from the importance of the financial sector, foreign direct investment (FDI) also plays a role in providing the funds needed in the innovation process. Access to FDI is linked to the globalisation determinant that was discussed in paragraph 5.2.4. Without good foreign relationships, FDI will be negatively affected and the benefits of multinational and transnational corporations will be forfeited. But there is still a debate on whether FDI contributes positively to economic growth. Fortanier (2007) concludes from a panel data analysis of 71 countries that received FDI for the period 1989-2002, that growth from FDI varies between countries, depending on their characteristics.

Venture capital is also an important part of financing innovative activities. Venture capital (VC) is described by Callahan & Muegge (2003:641-642) as, "… a specialized form of financing, available to a minority of entrepreneurs in attractive industries" and characterised by "… high-risk equity investments in new entrepreneurial ventures". The role of venture capital in innovation and economic development is summarised by a quote from Gompers & Lerner in Callahan & Muegge (2003:642):

> "No matter how we look at the numbers, venture capital clearly serves as an important source for economic development, wealth and job creation, and innovation. This unique form of investing brightens entrepreneurial companies' prospects by relieving all-too-common capital constraints. Venture-backed firms grow more quickly and create far more value than nonventure-backed firms. Similarly, venture capital generates a tremendous number of jobs and boosts corporate profits, earnings, and workforce quality. Finally, venture capital exerts a powerful effect on innovation".

The high risk that discourages financing of innovative activities lies, not unexpectedly, in the high failure rate of new start-ups. The high failure rate of new start-ups is a particular problem in developing countries. The ratio of start-ups to new firms (firms that have survived between 3 months and 3½ years) ranges from 0,4:1, in Japan, to 3:1, in France, in a study of 32 countries (Orford *et al.*, 2004:13). Von Broembsen *et al.* (2005:20) conclude in their study, the chances of a business surviving beyond 3½ years in a developing country are generally lower than in a developed country".

The risk involved in new start-ups is described by Audretsch & Thurik (2001:13) as follows:

> "… when a new firm is launched, its prospects are shrouded in uncertainty. If the new firm is built around a new idea, i.e. potential innovation, it is uncertain whether there is sufficient demand for the new idea or if some competitor will have the same or even a superior idea….an additional layer of uncertainty pervades a new enterprise. It is not known how competent the new firm really is, in terms of management, organisation, and workforce."

A well-developed financial market is, therefore, not sufficient to ensure access to finances for firms. The success rate of new firms needs to improve for financial institutions to gain more confidence in firms. Governments can play a role in, for example, financial management support or training and any other support necessary to decrease the failure rate of new start-ups.

5.3.4 Market size

Although the Schumpeterian view focuses on supply rather than demand in the innovation processes (as is discussed in Chapter Three, paragraph 3.3.1), it must not be read to imply that demand is not important. Schumpeter (1961:65) stated the following:

> "It is, however, the producer who as a rule initiates economic change, and consumers are educated by him if necessary; they are, as it were, taught to want new things, or things which differ in some respect or other from those which they have been in the habit of using. Therefore, while it is permissible and even necessary to consider consumers' wants as an independent and indeed the

> fundamental force in a theory of the circular flow, we must take a different attitude as soon as we analyse *change*."

The studies that show a positive relationship between market size and innovation (Acemoglu & Linn, 2004; Desmet & Parente, 2010; and Guerzoni, 2007) do not necessarily contradict Schumpeter. Schumpeter emphasises that change is due to the producer's ideas and actions, but if there is no, or low, buying power in a community, there is also no market. That may perhaps not stop innovators, but it might force them to innovate for markets in other communities or for the export market. Larger existing markets may perhaps make it easier for the innovator, but this does not function as an incentive to innovate or to create a new market. This lack of sufficient markets emphasises the importance of the development of high quality entrepreneurship in countries with slow growing economies in order for these entrepreneurs to be able to compete in the global market.

5.3.5 Protection of intellectual property rights

There is a variety of intellectual property rights such as patents, trademarks, designs and copyright that can each lead to opportunities for profits for innovative firms. The purpose of protecting intellectual property rights is to stimulate invention, innovation, creativity and R&D (Greenhalgh & Rogers, 2010:54). Many studies agree on intellectual property rights as a determinant of innovation, and find intellectual property rights to reflect positively on innovative activities. Of the 15 studies on protection of intellectual property rights analysed by Becheikh *et al.* (2006:653-654), 11 indicated a positive relationship with innovation and 4 found the relationship not significant. The findings of Dutta & Sharma (2008) confirm this positive relationship in their study of panel data of Indian firms during the period 1989 to 2005. Dutta & Sharma found that since the strengthening of the intellectual property rights in 1994 (by the signing of the TRIPs Agreement), R&D by firms increased significantly. They concluded that stronger intellectual property rights generated incentives for domestic firms to invest in innovative activities.

Although intellectual property rights mostly influence innovation positively in developed countries, this may not necessarily be the case in developing countries. Schneider (2005:543) agrees with the positive relationship between intellectual property rights and innovation, but found in the empirical analysis of panel data of 47 developed and developing countries (over the period 1970 to 1990) that intellectual property rights have a stronger effect on domestic innovation for developed countries and that the effect might even be negative for developing countries. The conclusions drawn were that most innovation in developing countries may be imitative or adaptive in nature, and that the intellectual property rights may actually protect foreign firms at the expense of local firms.

5.4 Relative importance of determinants

The relative importance of the determinants must now be determined. Although each of these factors has been indicated to have positive relations with innovation, the question can be asked: without which of these determinants can innovation not take place? Human development (which is determined by education and training, health conditions, and many other factors) stands out as the only determinant that is essential for innovation. The entrepreneur, the agent who carries out innovation, is a person and his innovative abilities depend largely on his level of development, as indicated in paragraph 5.3.1. Other determinants of innovation such as R&D, absorptive capacity, a qualified labour force and culture and management of the firm are all based on human development. While the other determinants, apart from human development, can contribute to innovation, innovation can take place in their absence. Some innovation takes place without preceding R&D; some innovations do not require high financial expenses; in the absence of a large enough domestic market, export markets can be created; in the absence of international trade, local markets can be explored; and so on, but without the requisite human resource, none of the foregoing would eventuate.

However, it is important is to note that, although human development is essential for innovation to take place, the other determinants can each positively influence the innovative performance in an innovation system. The strength of an innovation system lies in a combination of determinants that influences the innovative activities of the firms. However, there is no fixed combination of determinants that ensure successful innovation. The heterogeneity of the firms is the very basis of innovation. Communities and innovation systems also vary and the determinants of innovation will therefore be different in the different innovation systems. The determinants and combinations of determinants will again differ in developed and in developing economies.

It is important to note that even if innovation by firms takes place rapidly, the success of the innovation system depends on the effectiveness of the social and institutional systems. Perez & Soete (1988:477) indicates that technological systems are dependent on the history of development, as well as social, cultural and political factors.

5.5 Summary

The determinants of innovation that have been identified include:

(i) the internal (to the firm) determinants: and

(ii) the external (the environment of the firm) determinants.

The internal determinants include:

(i) technological capabilities (R&D intensity, absorptive capacity of technology and a qualified labour force);

(ii) characteristics of the firm (the size of the firm and the structure, culture and management of the firm);

(iii) funds, finances and the cost of innovation; and

(iv) global engagement.

The environmental determinants include:

(i) R&D (by organizations other than the firm);

(ii) human development;

(iii) external financial support;

(iv) market size; and

(v) protection of intellectual property rights.

The list is certainly not exhaustive, but the determinants regarded in literature as being the more important have been analysed. Human development is the only essential determinant of innovation. Yet the performance of the innovation system does not only depend on human development, but on a combination of all determinants that was indicated to have a positive effect on innovation.

In order to improve the innovative activities of the firms, innovation determinants should be seen from a system perspective. In the next chapter, the innovation system will be discussed. The role players or actors in the innovation system will be identified. The roles of, as well as the relationships among, the actors will be established with a view of improving the innovative performance of an innovation system. An innovation system model will then be developed by focussing on the determinants of innovation that have been established in this chapter.

CHAPTER SIX

THE INNOVATION SYSTEM MODEL

6.1 Introduction

In Chapter Two, by defining innovation systems, in Chapter Three by studying the place of innovation in the theoretical milieu, and in Chapter Four in establishing the role of innovation in economic development, it became clear that innovation has to be studied in a system context. In Chapter Five, the importance of studying innovation in a system perspective was confirmed when it was indicated that the interaction or networking that firms have with other actors or participants in the innovation system has a significant positive relationship with innovation. Many economists refer to the concept “innovation system”, and more generally to “national innovation systems”, but very few have attempted to explain the functioning of such a system. Therefore, the need arose to develop a model for an innovation system against which specific innovation systems could be compared and evaluated. Such an evaluation may contribute to the improvement of an innovation system, which in turn can lead to an increase in innovative activity and eventually to economic development. This process was established in Chapter Four.

An innovation system consists of participants or actors, the linkages among these participants or actors and an environment within which the participants and the linkages among them will function (Balzat, 2006:19). In Chapter Two, the innovation systems concept was defined and it was concluded that the definition to be accepted in this study would be the following:

> An innovation system consists of the participants or actors and their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

In this chapter, a descriptive model will now be developed in order to give a conceptual framework of an innovation system. The participants will be identified, the roles of the different participants and the interaction and linkages among the different participants will be determined. A conceptual model is defined as “a type of diagram which shows a set of relationships between factors that are believed to impact or lead to a target condition; a diagram that defines theoretical entities, objects or conditions of a system and the relationships between them” (Dictionary.com, 2010). The model of an innovation system that is developed in this study is, therefore, conceptual in that it describes a system, the elements, objects or entities (in this case, the participants or actors), their relationships (or linkages) and a diagram of the system will be presented.

The innovation system will be studied largely from a macro-economic perspective, but will include the contribution of the firm. Porter & Stern (2001:2) explain the importance of both perspectives as follows:

> “On the one hand, firms and the private sector are the ultimate engines of innovation. On the other hand, the innovative activities of firms within a country are strongly influenced by national policy and the presence and vitality of public institutions. In other words, innovation intensity depends on an interaction between private sector strategies and public sector policies and institutions. Competitiveness advances when the public and private sectors together promote a favourable environment for innovation”.

Earl & Gault (2006:3) agree that firms are the centre of innovation, and that there are many actors that exert an influence on the success of innovative activities and note:

> "It was also clear that innovation was not an isolated activity as actors, usually the firms…, engaged in innovation and they were influenced by clients and suppliers, by market conditions and by the economic and cultural environment in which the firms functioned."

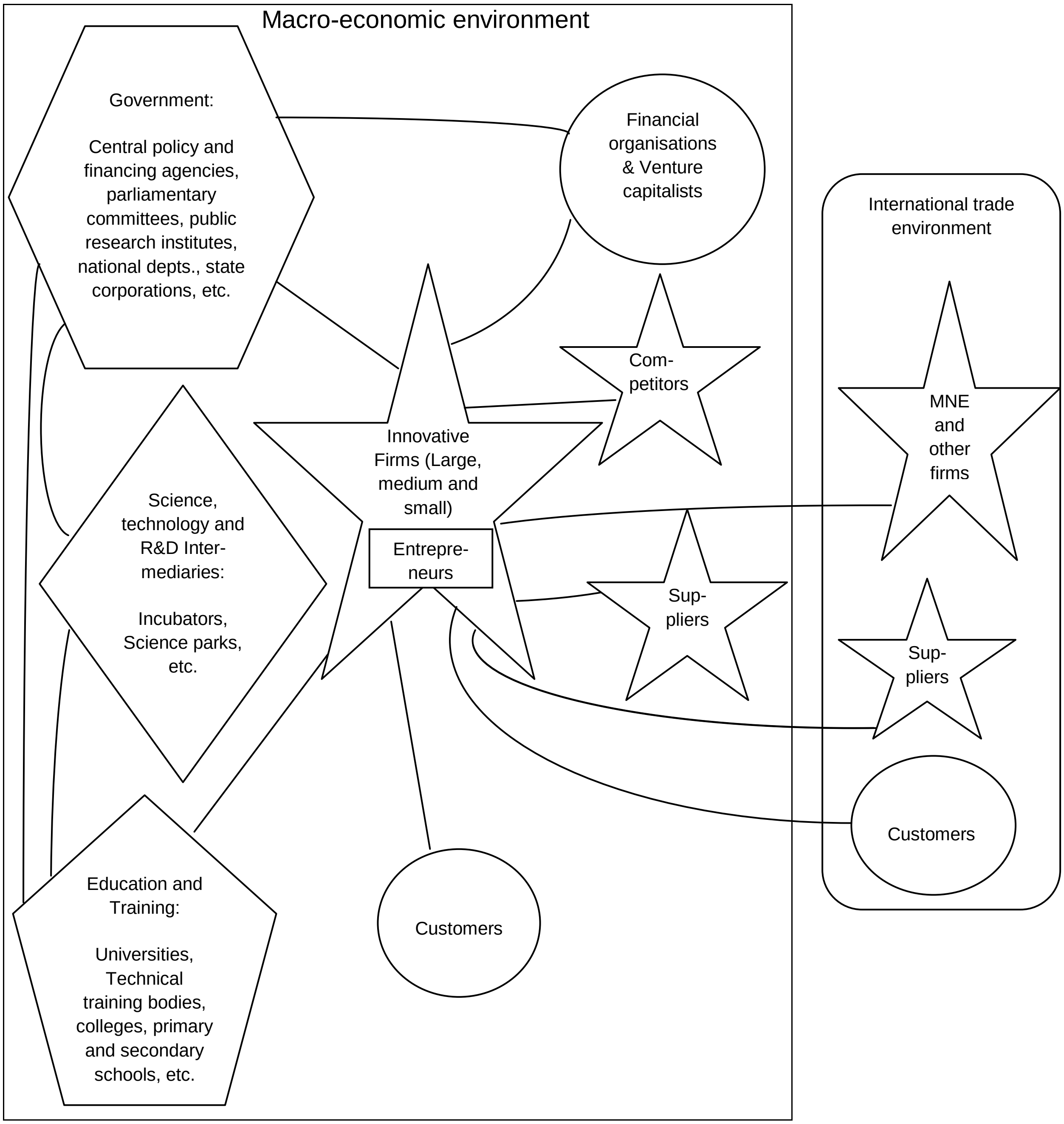
6.2 The innovation system model

The innovation system model is presented in a diagram (Figure 6.1), indicating first, the participants or actors, secondly, the linkages among the participants and then the economic environment within which these participants function.

The environment is not just a "given" or fixed, but is rather created or influenced to a great extent by the participants in the innovation system itself. Although there are many different activities and actors in an innovation system, only those that are considered to influence the goal of the innovation system (to influence the innovative performance of the system, as specified in the definition of an innovation system) have been included here. This model indicates that the innovative firms are the centre of the innovation system due to the importance of their contribution to innovative activities.

These firms include large, medium and small enterprises. Other participants that have been identified include suppliers and competitors, financial organisations and venture capitalists, customers, education and training bodies, government, science, technology and R&D intermediaries, and international participants. In paragraph 6.3.1, the roles of the different participants in the innovation system will be discussed.

Figure 6.1 Diagram of a conceptual model of a national innovation system



There are many different kinds of links that can be distinguished among the participants in an innovation system. The kinds and strengths of linkages and the interdependence of the participants in the innovation system rest on the presence of the kinds, numbers and quality of the participants in the particular innovation system. The linkages can be formal or informal, intentional or incidental and formed among different kinds of participants, as is to be discussed in paragraph 6.3.2. Both financial and knowledge flows take place through these linkages (paragraph 6.3.3). Each innovation system is unique and has its own characteristics due to the differences in quantity and quality of participants and linkages and to the characteristics of the environment influencing the participants and their linkages. Carlsson, Jacobsson, Holmén & Rickne (2002:234) are in agreement with this view:

> "Because of this interdependence, the components cannot be divided into independent subsets; the system is more than its parts...if a component is removed from a system or if its characteristics change, the other artefacts in the system will alter characteristics accordingly...and the relationships among them may also change – provided that the system is robust. A non-robust system would simply collapse if an essential component were removed".

Fromhold-Eisebith (2007:219) believes that:

> "… each nation, less or highly developed, has some kind of NSI, no matter if working well or not".

An ideal innovation system does not exist. Some innovation systems have more small and fewer large firms while others have the opposite situation. In some innovation systems, the government plays a larger role whereas in other systems the government plays a less dominant role. In some innovation systems, the international interaction is more prominent than in others. There is yet no proof which of the mentioned innovation systems is the more ideal, due to the complexity of interaction among participants. Balzat (2006:29) states:

"It is presumed that there exists no optimal set-up or functioning of an NIS …".

Fromhold-Eisebith (2007:220) further confirms this statement and offers:

> "… vast differences between the NSI structures and strategies of various economically successful countries indicate that there is no universal 'best practice' recipe".

Most research regarding innovation systems is done by highly developed countries, based on their own given situations. There are, however, in some publications, reference to the different circumstances within which developing countries function. Van Stel, Carree & Thurik (2005:313) make it clear that the role and importance of entrepreneurial ventures may differ from one stage of economic development to another. Further, they offer that the rates of entrepreneurial activity may differ also in countries that are in similar stages of economic development. However, the mere fact that there is no optimal innovation system does not imply that a descriptive model of an innovation system cannot be developed. The model that will be developed includes a description of the possible participants, their potential linkages and an environment that may be conducive to innovative activities. It will be noted that the availability and quality of the different participants and the strength of the linkages among them that will be indicated in the model are all potential components that can positively contribute to the performance of the innovation system.

6.2.1 Participants or actors and their roles in the innovation system

What must be kept in mind throughout this discussion is that the innovation system consists of many independent participants who can be either co-operative or competitive. No single participant controls the workings of the system or the interaction among the participants, but there are, nevertheless, participants who can exert a significant influence in or on such a system as, for example, government (explained in Chapter Two by citing Paterson *et al.,* 2003:2).

Most models of innovation systems are developed in the national context, due to the governing of countries on national level and their economies functioning in a national context. Yet the participants in an innovation system, whether national or regional, do not differ substantially. Some participants may play a stronger role in one innovation system than in another, but the participants that are identified are usually present in all innovation systems. The absence of one or more of these participants will have an effect on the performance of an innovation system. The identification of the participants can be derived from the determinants that have been established in the previous chapter. Firms have been indicated in Chapter Five as the participants or actors in which most innovation takes place and therefore play an essential role in the innovation system. Research and development (R&D) activities and human capital development have been established as having significant positive relationships with innovation and globalisation and the existence or creation of markets were also indicated as having effects on innovation. Further, access to finances for firms was indicated as an important determinant (or a hampering factor, in the absence of finances) of innovation. The participants can be grouped in five main categories derived from the determinants of innovation, as follow:

(i) actors involved in (R&D) activities (firms, public research organisations, universities and intermediaries or bridging organisations);
(ii) actors involved in human capital development (primary and secondary education, universities and firms);
(iii) industry (small, medium and large firms, suppliers, competitors and financial organisations);
(iv) government (different levels and departments) (Chung, 2002:486; Cooke, Uranga & Etxebarria, 1997:478; Edquist, 2005:182; Fromhold-Eisebith, 2007:219; Greenhalgh & Rogers, 2010:88; OECD, 1997:9; Rooks & Oerlemans, 2005:1206-1208); and
(v) customers (Bloch, 2007:26-27; Bogliacino *et al.*, 2009:12).

According to Chung (2002:486):

> "… the ultimate goal of NIS is to enhance firms' innovation capabilities. These … groups should not only generate innovations, but also innovate themselves in order to survive and prosper in the rapidly changing environment".

Foreign organisations do not form part of a national innovation system due to the geographical boundaries. However, the interaction and linkages with foreign participants or actors (multinational enterprises, foreign suppliers, competitors and customers) can influence the performance of a national innovation system, depending on the global involvement of participants in the innovation system. Therefore, these international considerations too will be included in the model. According to Narula & Zanfei (2005:337):

> "The interdependence of markets and the cross-fertilization of technologies … means that few countries have truly 'national' systems…some systems are more 'national' than others …".

The different participants and their roles in the innovation system are as follow:

6.2.1.1 Entrepreneurs

The entrepreneur plays a fundamental role in the innovation system by being the individual who carries out innovation, as defined in Chapter Two. In the Schumpeterian theory (as was discussed in Chapter Two, paragraph 2.3, Chapter Three, paragraph 3.3.3 and Chapter Four, paragraph 4.5), the entrepreneur, who operates mostly in firms, played a central role in economic development through the carrying out of innovative activities. Even though Schumpeter has been criticised for the negligence in his study of innovation in system perspective, he initiated the awareness of innovation and the role of the entrepreneur in innovation. Wong *et al.,* (2005:337), explain the role of the entrepreneur as innovator as follows:

> "… literature suggests that entrepreneurship contributes to economic performance by introducing innovations, creating change, creating competition and enhancing rivalry …. From the viewpoint of evolutionary economics, entrepreneurs serve as agents of change, bring new ideas to markets and stimulate growth through a process of competitive selection".

The role of the entrepreneur has been discussed extensively in Chapters Three and Four. In this chapter, the need only remains to indicate how the entrepreneur fits into the innovation system model.

Entrepreneurship has, unfortunately, been limited by many authors (Audretsch & Thurik, 2001; Bygrave, 1994; Rocha, 2004; Van Stel *et al.*, 2005; Wennekers *et al.*, 2005; and Wong *et al.*, 2005) in their definitions as being "new start-ups" and/or "small firms". Entrepreneurship and small business are not synonymous concepts and, according to Thurick & Wennekers (2004:140), entrepreneurship behaviour "… can happen in both small and large businesses but also elsewhere".

Innovation and entrepreneurship takes place not only by market entry of new firms, but also in established firms that enter new markets (Kirzner, as cited by Wong *et al.,* 2005:337). The entrepreneur plays a role in any or all of the other actors or participants of the innovation system, but is indicated in the diagram as functioning in the firm, because innovation takes place mainly in firms.

6.2.1.2 <u>Innovative firms</u>

Schumpeter (1961) placed firms as the essential actors regarding innovation in his 1911 publication by describing the firms as the instruments used by entrepreneurs in the carrying out of innovations. Schumpeter's view, however, changed from his first publications to the later publications, as was discussed in Chapters Three and Five, in the sense that he came to believe that innovation takes place in any size or age of firm and not only in new enterprises, as initially stated. Although it was indicated in Chapter

Five that there is a positive relationship between size of the firm and innovation, this did not imply that innovation takes place in large firms alone. Firms that are involved in innovative activities can include, for example, large local corporations, local subsidiaries of trans-national corporations (TNCs), small and medium enterprises (SMEs) in the formal sector, business associations and micro-enterprises in the formal sector or subsistence sectors (Paterson *et al.,* 2003:9-10). The form of firm ownership is also not determinative of the innovative activities of the firm, but rather of their abilities and incentives to be innovative (Lazonick, 2005:50).

In the model of an innovation system, the firms are to be the centre of the innovation system due to their role in innovation (Edquist, 2005:192 and Nelson, 1996:278). Most theories of innovation have the firm as the starting point of the theory, but firms do not normally innovate in isolation - they act in collaboration and interdependence with other organisations (Audretsch, 2004:171 and Edquist, 2005:182). The OECD (1997:12) describes the interdependence of the firms with other participants as follows:

> "Innovation is thus the result of a complex interaction between various actors and institutions. Technical change does not occur in a perfectly linear sequence, but through feedback loops within this system. In the centre of this system are the firms, the way they organize (sic) production and innovation and the channels by which they gain access to external sources of knowledge. These sources might be other firms, public and private research institutes, universities or transfer institutions – either regional, national or international. Here, the innovative firm is seen as operating within complex network of co-operating and competing firms and other institutions, building on a range of joint ventures and close linkages with suppliers and customers".

Although firms form part of the participants in an innovation system, they do not deliberately work towards the increase in innovative activities of the system as a whole. Yet they contribute to the performance of the innovation system as a whole in the process of achieving their own goals. According to Reynders (1975:7), the firm strives in a capitalistic order to the largest possible profitability, but that leads eventually to the improvement of the well-being of the country. The OECD & Eurostat (2005:29) state that it is crucial to know why firms innovate and they gave the reason for firms' motivation as follows: "The ultimate reason is to improve firm performance…".

The support by some other participants such as the government, universities and research institutions should therefore be such that it creates the environment within which firms can achieve their goal, because such achievement will imply an increase in innovative performance of the system and, eventually, economic development.

The roles of the firms can thus be summarised as follows:

(i) The firm, as the centre of the innovation system, mainly carries out the innovative activities (Edquist, 2005:192 and OECD, 1997:12). For firms to contribute to the innovative performance of the innovation system, they should be evolutionary, focus on change and be innovative by means of new products, processes, markets and organisation, as was previously described in Chapter Two.

(ii) Apart from the role of the firm as the participant in which innovative activities are carried out largely, the firm also plays a role, just as all other actors or participants in the system do, in creating the environment more conducive for innovation (according to the determinants of innovation that was established in Chapter Five).

The firm can play a shared role with other participants in the following:

(i) Firms play a role in improving human resources. The importance of qualified human resources for a firm's innovative performance has previously been established in Chapter Five. Although most development of human resources takes place through primary and secondary education bodies as well as universities (to be discussed in paragraph 6.3.1.5), the firm can play a role through on-the job training and other involvement in education and training of personnel (Edquist, 2005:192).

(ii) Firms play a crucial role in contributing to the R&D (Edquist, 2005:192) by either financing R&D or by doing the research or development themselves in order to become more competitive. According to the European Commission (2003:104), the business sector had been the major source of financing for total R&D (Gross Domestic Expenditure on R&D) in the late 1990s in developed countries such as the European Union, the United States and Japan. The World Bank (2010b:140-141) confirms the importance of R&D spending by the private sector, stating that in the OECD countries the business sector finances on average 63% of R&D and that the performance of R&D is similar. According to The World Bank (2010b), the situation is different in most developing countries, where the government is found as the main financier and main performer of R&D due to the private sector being less developed and consisting mainly of smaller firms.

(iii) Firms play a role in contributing to the financing resource, using their own financial resources (Lazonick, 2005:50). Schumpeter, in his first publications, focused on the role of credit creation in the facilitation of innovation, but in his later publications, he emphasised self-financing of innovative investment by firms (O'Sullivan, 2005:242). Private sector also plays a role, together with the monetary authorities, in the development of a financial system as private financial intermediaries are also firms in the innovation systems. This will be discussed further in paragraph 6.3.1.3.

(iv) Although the government plays the major role in creating sound relations with international trading partner countries, the private sector can also contribute by creating trustworthy and reliable trade relationships with firms internationally.

The role of the firms in the innovation system is therefore, primarily, as the vessels of entrepreneurs in carrying out innovations, causing the firms to be the centre of the innovation system. Yet the firms, through their interaction with other participants, can exert an influence on many other aspects in the innovation system.

6.2.1.3 Suppliers and competitors

The other firms, with which the innovating firms interact, include suppliers and competitors (Baskaran & Muchie, 2010; Earl & Gault, 2006:3-4; Edquist, 2005:182; OECD & Eurostat, 2005:76; OECD, 1997:12; Oerlemans, Buys, & Pretorius, 2006:233;

and Rooks & Oerlemans, 2005:1208). In Chapter Five, it was shown that interaction of the firm with both suppliers and competitors has a positive effect on innovation.

It should be kept in mind that each of these suppliers or competitors is an innovating firm in its own right, and is surrounded by its own suppliers, competitors and clients. The role that suppliers play in the innovation system includes the supplying of technologically improved inputs to the innovating firm and therefore the suppliers contribute to the innovative abilities of the firm. Competitors play the role of motivating or supplying the incentives for the innovating firm to become more innovative (Edquist, 2005:196).

A very important role that the suppliers and competitors play in the innovation system is that of technology and knowledge transfer. Whether the linkages are formal or informal (as will be discussed in paragraph 6.2.2), the contacts among these firms whereby knowledge and expertise are transferred, serve as both a source for, and stimulus to, innovation (OECD, 1997:7). Transactions take place among these participants and through these transactions, the technology that is part and parcel of the product or service, together with the knowledge that lead to that technology, is transferred in that transaction. Edquist (2005:196) notes:

> "Transaction … is a process by which goods and services, including technology-embodied and tacit-knowledge, are traded between economic actors".

Earl & Gault (2006:13) show proof of the importance of suppliers in the transfer of knowledge in their study. According to Earl & Gault, the Community Innovation Survey (CIS), done by Eurostat in 2004, reveals that interactions with suppliers are the most important sources of information for innovation in European firms (apart from internal sources, that is), followed by fairs/exhibitions, competitors, and conferences/journals. The importance of contact with universities and research institutes was indicated as being much less important. The findings of Earl & Gault are confirmed by Bogliacino *et al.* (2009:12) in similar surveys for the EU and a group of developing countries.

It is not only through transactions that knowledge is transferred among firms, but also through the movement of human resources among firms (OECD, 1997:3;7). This personnel mobility and resultant knowledge transfer contributes to enhancing the innovative capacity of firms. The OECD (1997:18) calls the movement of people and the knowledge they carry with them "tacit knowledge" and they stated the importance of this as follows:

> "Personal interactions, whether on a formal or informal basis, are an important channel of knowledge transfer within industry …".

The kind of linkages that can be formed amongst firms, suppliers and competitors will be discussed in paragraph 6.2.2.

6.2.1.4 Financial organisations and venture capitalists

In Chapter Five, it was clarified that access to finances is important for innovation and that innovation is hampered by the lack of financial sources. Financial organisations and venture capitalists play an important role in the innovation system of providing the financial inputs needed by the innovating firm (Ahlbäck, 2005; Baskaran & Muchie, 2010; and Holbrook, 1997).

An efficient financial system is of strategic importance for an innovation system (Cooke *et al.,* 1997:481 and European Commission, 2003:149), and so differences in the national financial systems will influence the national and regional innovation systems. The financial system can, for example, be market orientated and funds allocated in a developed capital market; the system can be based mainly on credit with considerable control by government; or the system can be based on credit with little control and regulation (Cooke *et al.,* 1997:481).

Venture capital firms are particularly important for the success of new firms (Branscomb & Auerswald, 2002:48). Malkiel (2007:325-330) gives proof of the contribution of the venture capital industry's contribution to innovative activity in the United States, but stated that the, "extraordinary success of the U.S. venture capital industry" in contributing to successful innovation in small enterprises, is not necessarily as successful in the rest of the world. An advantage of venture capitalists is the mentoring and monitoring role of the venture capitalists that often contributes to the success of innovations.

Financial organisations not only play the role of finance providers, but can play an important role in knowledge transfer to firms. This link is usually stronger where there is more control involved in the agreement or contract.

6.2.1.5 Customers

In Chapter Five, it was found that the size of the market does have an effect on innovation, but that it does not determine innovation. Innovation, per definition, includes the creation of new markets (Chapter Two). The existence of customers with buying power may make it easier for firms to innovate. In the absence of buying power in the domestic market, it was found that firms could innovate for the export market. It was also found that consumer's preferences should be considered in the innovation process and that customers therefore do play a role in transferring knowledge to the firms. The studies done by Earl & Gault, (2006:13), and Bogliacino *et al.,* (2009:12), of different surveys both indicate that the customers play, in most cases, a stronger role even than suppliers in knowledge transfer to firms. Bloch (2007:26) identified different aspects of how the customers may affect innovation: first, the knowledge of user needs assists in generating new ideas; second, interaction with users leads to users assisting in seeking solutions for the development of new products; and third, the responsiveness of customers to new products, that is, the propensity of customers to adopt new products, will also affect the requirement to innovate.

6.2.1.6 Education and Training Bodies

Human resource development in an innovation system, a qualified labour force for the firm and R&D by the firm and other participants in the innovation system have been indicated in Chapter Five as being amongst the most important determinants of innovation. Education and training bodies play very important roles in the development of human resources and some in R&D also. Many studies such as those of Ahlbäck, 2005; Baskaran & Muchie, 2010; ; European Commission, 2003; Fromhold-Eisebith, 2007:217; Holbrook, 1997; Nelson, 1996:278; OECD & Eurostat, 2005:37; Orford, *et al.*, 2004:34; Paterson *et al.*, 2003:9-10; and Rooks & Oerlemans, 2005, all include education and training bodies in the innovation systems.

The following elements reside under the heading, “education and training” participants of the innovation system: Universities; Technical training such as Technical Colleges; Teacher training institutions; The basic educational system such as primary and secondary schools; and other education or training institutions including apprenticeship organisations (OECD & Eurostat, 2005:37 and Paterson *et al.,* 2003:9-10).

Some publications concerning innovation systems include only the tertiary education sector as participant and not the primary and secondary education. The reasons for this exclusion might be that, firstly, research (which is regarded as crucial for enhancing innovation) in the education sector is done at universities and not in the primary or secondary schools. Secondly, in the developed countries (from where most publications originate) quality primary and secondary education is assumed and is seen as a given factor. Unfortunately, in many countries, especially developing countries, the standard of primary and secondary education is of such a quality that the majority of pupils attending public, government funded schools, are not able to qualify for university education.

No-one knows in advance which children have the potential to become inventors, innovators or entrepreneurs. Therefore, all children should be taught the basic skills needed for invention, innovation and entrepreneurship. The role of the primary and secondary schools in the innovation system should be to provide quality education that can prepare people for tertiary education, a sufficiently literate workforce and potential entrepreneurs. The innovation system must therefore include the primary and secondary education, as well as tertiary education, as participants if the enhancement of innovation is aimed for.

Technical training bodies share the role of the schools in providing quality education for the need of a literate workforce and in preparing potential entrepreneurs, but there is a skills development component added to their role. This places an extra responsibility on the technical training bodies, in the sense that they should be more job-orientated and entrepreneurial skills training should be an even more important component in the syllabi. Where the schools have a huge role to play in preparing pupils for tertiary education, the technical training bodies mostly have the role of preparing students to enter directly in to the labour market.

The role of universities in the innovation system is very important and universities are even called “critical institutional actors in national innovation systems” by Mowery & Sampat (2005:212).

Universities have a dual role to play in the innovation system: the education component and the research and development component. Universities play the role of promoting scientific knowledge and educating people, as well as initiating innovation by generating knowledge and developing entrepreneurs (Greenhalgh & Rogers, 2010:88; Miyata, 2003:715;736). The promotion of scientific knowledge refers to research.

Edquist (2005:191-192) distinguishes among three different “kinds of learning”. Firstly, the innovation that takes place at firm level, which is regarded as “organisational learning”; secondly, R&D is knowledge that is created either by universities, public research organisations or firms and thirdly, competence building or education and training, that takes place in schools, universities or firms. Universities play a role in all three of these kinds of learning. In competence building and R&D, universities play a direct role, whereas in innovation at firm level, the universities play a more indirect role through the "production" of graduated employees and in different kinds of collaboration with industry.

The dual role of the universities can be explained as follows:

(i) The competence-building role of universities contributes to the enhancement of human capital and in many universities, this role dominates the activities of the university. Apart from supplying firms with competent workers, the university also supplies firms with competent research personnel. These researchers in industry contribute positively to the innovation activities of the firms. Miyata (2003:736) lists examples of the competence-building role of the university as follows:

> "Basic research educates research personnel. Middle class engineers are also generated by university education. In addition, universities generate mathematics and science teachers for elementary and secondary educational institutions".

The competence-building role of universities forms an essential part of the innovation system, but is often neglected in the studies of the innovation system. Edquist (2005:194) agrees with this fact by stating that:

> "… competence building is increasingly considered to be an important activity in systems of innovation, reflecting the importance of skilled personnel for most innovative activities…But no rigorous analyses of competence building have, to my knowledge, been conducted as part of the analysis of innovation".

(ii) Research and development, on the other hand, has been seen as one of the main contributing factors to innovation and many economists used R&D as the main indicator of innovative activities. The OECD, as cited by Edquist (2005:192), claims that in most countries the universities are the most important public organisations performing R&D. Universities play a leading role in basic research, because firms do not benefit directly from it. Firms must first commercialise the basic research before they can benefit from it, and so firms are often unwilling to carry the costs of basic research. Basic research is usually funded by government and is made freely available to everyone through academic publications. However, the research role of Universities is not confined to basic research. Although firms contribute the most to applied research, universities are also involved in different forms of applied research. The examples that Miyata (2003:737) mentions include the generation of inventions, patents, licenses, informal communication with regional firms, and spin-off firms. Mowery & Sampat (2005:212) list, apart from the "skills and human capital" output of the university, other outputs such as,

> "… scientific and technological information (which can increase the efficiency of applied R&D in industry by guiding research towards more fruitful departures), equipment and instrumentation (used by firms in their production processes or their research), … and prototypes for new products and processes".

These examples show that the universities' role goes far beyond basic research and that universities have a crucial role to play in the innovation system.

There are many different ways in which universities contribute to organisational learning. The research role and the competence-building role of universities contribute to organisational learning by means of human resource mobility and by collaboration between firms and universities. The collaboration between the university and firms mostly consists of transfer of knowledge due to research. Miyata (2003:715) mentions different ways in which university and industry can collaborate. These are listed as:

> "contracted research from industry to universities, cooperative research between university and industry personnel, licensing of university-owned patents to industry, informal information exchange between university and industry personnel, consultation by university personnel, and establishing start-up firms by faculty

members or graduates of universities in order to commercialize their research results".

Countries use different terms for the forms of collaboration, but the terms can be categorised in four groups as follow: small business incubators, technology business incubators, science and technology parks, and business parks and high quality industrial estates (Phillimore & Joseph, 2003:751). These categories will be discussed in more detail under a separate group of participants called "science, technology and R&D intermediaries" in paragraph 6.2.1.8 because other organisations, not just universities and firms, are often involved in the collaboration.

An interesting research publication is that of Chen & Kenney, (2007), comparing two successful regional innovation systems in China, their process of developing and the role of universities in the development process. The first region had high-technology firms and the region's innovation system developed due to universities and research institutes. The second region was a fishing village, with a vast pool of relatively unskilled and inexpensive labour. The region's innovation system here developed due to its geographic advantage, favourable policies, deliberate development of a strong industrial structure, and other factors. The second region started as a low-cost production centre, but the government realized that it could not remain successful as a low-cost assembly region alone but needed to be developed into an innovation system, with higher value-added activity with the contribution of universities. The study concludes that the university research institutes have been significant contributors to growth in the Chinese economy. The study of Youtie & Shapira (2008) confirms the role of universities in the innovation system and they found, by comparing case studies of different universities, that the role of universities changed from performing conventional research and education functions to serving as innovation-promoting knowledge hubs.

6.2.1.7 Governments

The role of governments in the innovation system can be very expansive, particularly when all the different levels and divisions of governments are considered. Therefore, within the scope of this study, only a broad overview can be given of the role of governments in innovation systems. “Government” can include the following: Central policy and financing agencies; Relevant parliamentary or governmental committees; Public research institutes (science councils) and/or other government S&T institutes; Specialised regulatory agencies (medicines control, ethics bodies, Genetically Modified Organisms (GMO) registration, patent offices); Government agencies for technology diffusion and incubation; National departments including those with regulatory functions; State corporations; Provincial and local government; Economic development agencies in government; Defence forces, especially their technical support groups; Government advisory mechanisms and statistical agencies; and registering bodies (for example, those of engineers, lawyers and health practitioners) (Paterson *et al.,* 2003:9-10).

The kind of role that governments should play in the innovation system must be of a supportive nature and governments should not seek to restrict innovation. Rules and regulations, for example, have to be in place for guidance and protection of participants in the system, but if these rules and regulations hamper innovative activities, governments miss their goal. The supportive role of governments implies that the central role of government policy in the entrepreneurial economy should be enabling in nature and should seek to create an innovative environment. Therefore, governments should rather focus on the creation and commercialisation of knowledge through education, and increasing the skills and human capital of workers. They should seek to facilitate the mobility of workers in their ability to start new firms, perhaps by lowering administrative burdens for small business. Governments should be seeking to promote knowledge transfer to innovative new enterprises. They should also encourage linkages among firms and other organisations, and must supporting research and development, etc. (Ministry of Economic Development of New Zealand, 2005:5; and Thurik & Wennekers, 2004:140).

The role that governments can play in creating an environment conducive to innovation, determined in the previous chapter, includes the following:

(i) The first role is to develop the human resources of the country. This role is shared with private sector, as was discussed in paragraphs 6.2.1.1 and 6.2.1.5. The Ministry of Economic Development of New Zealand (2005:5) states that the roles of the government include: to ensure that tertiary education is responsive to the skills needs; to raise the skills levels across the population ranging from basic literacy and numeracy to higher level generic and specialist skills; to increase skills level through linking with private sector regarding on-the-job training; and to attract and retain talented people.

(ii) It was indicated in Chapter Five that the family plays the main formative role in human development. In order to have healthy families for the purpose of development of human capital, the government plays a role in securing adequate housing, health care, food and education (Scerri, 2009:6).

(iii) Government further plays a major role in the quality of human resources through their role in the health services of a country. These services may range from preventative through remedial to palliative. The role of governments *versus* private sector in the provision of health services depends on factors such as the capacity of private sector to provide affordable and effective health services, the political system of the country and the development level of the country.

(iv) In the fourth place, government plays a role in research and development. R&D is partly fulfilled by private sector, but research by universities and certain institutions are included in the role that governments have to play. According to The World Bank (2010b:140-141), as indicated in paragraph 6.3.1.1, business sectors finance the majority of R&D, governments finance 30% of R&D in OECD countries and universities finance 7%. The R&D performance pattern is similar, but in developing countries governments plays the major role in financing and performance of R&D. Paterson *et al.* (2003:4-8) classified performance of research, development and innovation as a shared role of government with private sector. According to Edquist (2005:193), the dependence of universities on governments varies in different countries. It ranges from being fairly independent from government in some countries, to falling totally under the responsibility of the government. The role that governments should play regarding R&D is summarised by the European Commission (2003:56) as follows:

> "The priority of government-financed research in this sphere [the knowledge based sphere] is to enrich the knowledge base by supporting R&D carried out at universities and research institutes and in business enterprises, by encouraging exploration of new and challenging scientific and technological areas, and by creating suitable conditions for training future employees".

The European Commission pointed out that governments do not only perform or support R&D based on economic rationales, but governments also have a responsibility to be involved in research, which is in the interest of society at large, research that may affect social welfare, quality of life and the physical environment.

(v) The fifth role of government is to create international trade relationships with other countries in order to facilitate international trade for local firms. The importance of globalisation for innovation was indicated in Chapter Five. According to the Ministry of Economic Development of New Zealand (2005:5), this includes the role of governments in promoting trade, stimulating foreign direct investment, deepening international relationships, and promoting the country internationally.

(vi) Sixth, the access to finances for innovative firms - an important determinant of innovation, as indicated in Chapter Five - is partly the role of government (Paterson *et al.,* 2003:4). Government can here play a vital role in improving access to finances, especially to new ventures that cannot easily get other finances due to the risk involved. This does not, however, imply that government should fund all new ventures. Funds can be made available by means of loans from government, or by helping firms with, for example, business plans to enable applications for funds elsewhere.

(vii) The seventh role of government is to create an institutional framework that inspires confidence. Trust in government and political stability must be instilled. Laws and regulations should be supportive of innovative activities and not hamper them. Policies should be put in place to support innovation; policy formulation and resource allocation should take place at national level; specialised advisory functions should be provided; regulatory policy-making should be in place; and national science, and technology and innovation international relations at the bi-lateral and multi-lateral levels should be sound (Paterson *et al.,* 2003:4). The policies related to innovation include, *inter alia:* intellectual property rights policy; tax policy such as R&D tax concessions; competition policy; education and training policies; policies regarding government funding of specific research; and setting of standards, such as safety (Greenhalgh & Rogers, 2010:103-104; Paterson *et al.*, 2003:6).

The World Bank (2010b:60) contends that there are a few “generic innovation policy functions”:

- Supporting innovators by appropriate incentives and mechanisms;
- Removing obstacles to innovative initiatives;
- Establishing responsive research structures; and
- Fostering a creative and receptive population through appropriate education systems.

(viii) Lastly, the government sometimes has to adopt the role of entrepreneur when markets fail. This far, the firm has been identified as the centre of the innovation system, that is, place where innovation takes place, due to the firm’s role as producer of products and services. The role of the government, on the other hand, has been so far identified as enabling and supportive. Yet, government must sometimes produce goods and services when the private sector fails to do so. Therefore, it is sometimes expected also that government departments or organisations be innovative. Government is not an organisation that aims at maximising profit, but government still has the responsibility to manage the production of goods and services effectively and efficiently. Basson (1994:195) states:

> "For government to act as an entrepreneur, it must use the resources under government control in new ways to maximise productivity and effectiveness".

These "new ways" implies that government should also be innovative in the supply of public goods and services.

6.2.1.8 Science, technology and R&D intermediaries

Countries and innovation systems differ in the forms of, and nomenclature for, these intermediaries. The intermediaries are defined by Dalziel (2010:3-4) as follows:

> "…organizations or groups within organisations that work to enable the innovativeness of one or more firms, or indirectly by enhancing the innovative capacity of regions, nations, or sectors".

The following are included in innovation intermediaries: industry and trade associations, economic development agencies, chambers of commerce, science, technology and business parks, business incubators, research consortia and networks, research institutes, technology transfer companies, industrial liaison offices, innovation centres, high quality industrial estates and standards organisations (Ahlbäck, 2005:12 and Phillimore & Joseph, 2003:751). Dalziel (2010:3-4) qualifies that these mentioned intermediaries are only classified as innovation intermediaries if their purpose is to enable innovation.

The role and importance in the innovation system of the organisations that can be grouped under the term "innovation intermediaries", as well as the number of organisations that falls in this category, necessitates these organisations to be classified as an actor in the innovation system. The case studies by Chen & Kenney, (2007), of the two regions in China prove the importance of research institutes in the development and performance of innovation systems. Urriago, Modrego, Barge-Gil & Paraskevopoulou (2010), on the other hand, show with an empirical study that science parks in Spain have a strong positive impact on the probability and amount of radical product innovation. These findings were confirmed by the empirical study conducted by Squicciarini (2009:19) on Finnish firms, where Squicciarini found that locating inside the science parks positively relates to the innovative output performance of firms.

These innovation intermediaries often involve more than one of the participants in the innovation system. Innovation intermediaries play the role of a bridge linking knowledge directly or indirectly among actors, coordinating interests among actors and promoting the transformation of scientific and technological achievements. Siegel, Waldman, Atwater & Albert (2003:113) state:

> "We contend that the key stakeholders in UITT [university-industry technology transfer] are: (1) university scientists, who discover new technologies, (2) university technology managers and administrators, who serve as liaisons between academic scientists and industry and manage the university's intellectual property, and (3) firms/entrepreneurs, who commercialize university-based technologies. This is by no means an exhaustive list of stakeholders. For example, the federal government, which funds most of these research projects, can also be viewed as a stakeholder".

The innovation intermediaries can be initiated either by governments, by universities, by private sector or by a public/private partnership. Intermediaries are often initiated by governments with the aim of promoting the development of SMEs or promoting technology transfer from research institutions. Universities and research institutions can also be the initiator of these intermediaries with their aim more focused on disseminating research and technology. Lindelöf & Löfsten (2003:245-246) are of the opinion that universities are also involved due to the income potential of these intermediaries. Although universities are mostly non-profit taking institutions, their income is often limited. Generating income through innovation intermediaries may contribute to the resources available to the universities for further research and development activities. Private sector, on the other hand, is usually involved as initiators of these intermediaries when the renting out of business space is profitable. Lindelöf & Löfsten (2003:245-246) confirm this statement by comparing the objective of private sector with that of other stakeholders in the intermediaries:

> "Private sector organisations, such as banks, are likely to have a more strictly commercial set of objectives towards investment in the [science and technology] park or its constituent firms".

The private sector usually does not have research and technology transfer as an aim when forming intermediaries, although these intermediaries can still have positive externalities for the innovation system.

The difference between the definitions of the research park, science park, and technology park lies in the activities that take place in the park, the strength of the link with the university, and the extent to which the link with the university is expected to occur. The similarities in these definitions, on the other hand, include that these 'parks' are property-based initiatives which have a high quality, low density physical environment in a park-like setting, are located near universities and research institutes, and encourage the formation and growth of research, new technology or knowledge-based enterprises (Phillimore & Joseph, 2003:752).

Depending on the form of intermediary, it can be deduced that the roles of intermediaries include the following:

(i) Transfer of knowledge or technology between universities, research institutions and firms;
(ii) Transfer of knowledge or technology between firms;
(iii) Encouragement of small and/or new businesses;
(iv) Encouragement of innovative activities;
(v) Training of management and technical skills;
(vi) Cost benefits from sharing facilities;
(vii) Access to high quality accommodation; and
(viii) Access to advice on technical aspects, marketing, patenting, etc.

The intermediaries, although not the largest participant in the innovation system, do have an important role to play in the innovation system. The form of the intermediary and the extent of the contribution to innovation will differ according to the need in the system. Developed countries make extensive use of these intermediaries in their innovation systems, while developing countries have an even greater need for these intermediaries. Therefore, intermediaries should be promoted in developing countries to facilitate innovative activities in the innovation systems.

6.2.1.9 International participants

The innovation systems do not function in isolation, due to globalisation. It has been shown in Chapter Five, paragraph 5.2.4, that global engagement of firms contributes positively towards innovation. The international trade environment should therefore be conducive for firms to engage globally. In this section, the international participants are identified together with the roles that these participants play or the effects that they have on the innovation system. These international participants include, *inter alia*, the following:

(i) Firms outside the national boundaries, including foreign suppliers and competitors;
(ii) Customers of export products; and
(iii) Multi-national enterprises (MNE).

Foreign suppliers, competitors and customers play the same role as the domestic suppliers, competitors and customers, as was discussed in paragraphs 6.2.1.2 and 6.2.1.4. However, these foreign connections further expand the market and so allow access to inputs of domestic firms. Together with the expanded markets, increased competition is a perhaps unwanted result of international trade (Eaton & Kortum, 2006:2;26; Schneider, 2005:529). This increased competition puts pressure on domestic firms to be more innovative and to comply with international standards. According to Schneider (2005:530):

> “Trade exposes domestic firms to the best practices of foreign firms and to the demands of discerning customers, encouraging greater efficiency”.

As they interact, the foreign firms may contribute to knowledge and technology transfer. The advantage for the domestic firm is that the foreign firms enhance their access to international innovative ideas.

Multi-national enterprises (MNEs), also called multi-national corporations (MNCs) or just multi-nationals, are some of the participants that play a very important role in the innovation systems. According to the International Trade Institute of Southern Africa (2010: 47), MNEs form a huge component of international trade: MNEs is responsible for over 20% of world output and for more than 25% of intra-firm trade (that is, trade between the parent company and its foreign affiliates). The role that the MNEs can play in the innovation system includes the following:

(i) The MNEs are important participants in the worldwide generation of technology and innovation (Archibugi & Lammarino, 1999:324);
(ii) MNEs generate international flows of knowledge through patenting, licensing, foreign direct investment (FDI), trade and scientific collaborations, and through R&D, production and sales that takes place in different countries (Bloch, 2007:25);
(iii) MNEs provide financial resources and new factories to poor countries (Todaro & Smith, 2009:720);
(iv) MNEs supply management experience, entrepreneurial abilities, and technological skills that can be transferred to the local firms by means of training programs and the process of learning by doing (Todaro & Smith, 2009:720);
(v) MNEs bring with them the most sophisticated technological knowledge about production processes through transferring modern machinery and equipment to capital-poor developing countries (Todaro & Smith, 2009:720); and
(vi) Knowledge is often transferred to the broader economy when engineers and managers leave MNEs to start their own companies in the local country (Todaro & Smith, 2009:720).

To be competitive in the international market requires innovation. No country can function in isolation from other countries and no innovation system can function in isolation of other innovation systems. These include foreign innovation systems and international innovation systems. The international trade institutions and bodies play an indirect role in the innovation systems through influencing globalisation. International trade and trade agreements influence the level of competition, expanding of markets, regulations on standards, and other similar functions. All of these aspects have a direct influence on the innovative activities in an innovation system. According to the OECD (2007:13):

> "More innovation-friendly regulation, combined with lower barriers to trade and foreign direct investment would enhance competition and would foster the flow of technology and knowledge across borders".

In the conclusions of Wang & Kafouros' (2009:614) study, they stated that their findings are consistent with past empirical research for other emerging countries:

> "... that highlight the critical role of FDI and international trade as important sources of innovation performance".

The roles of the international trade institutions and bodies therefore include the following:

(i) To promote trade amongst countries. According to Persson, (2008:2):

> "Most of the economic growth and rise in living-standards over time has been due to advances in technology and increased innovation. Open trade and investment policies can contribute to creating conditions that are beneficial for innovation";

(ii) To enhance technology transfer. Customers in a country benefit from importing goods that embodies new ideas and the producers benefit by making use of that new idea (Eaton & Kortum, 2006:1); and

(iii) To assist developing countries with technical training and financial aid needed to improve innovative performance.

6.2.2 Linkages in the innovation system

In Chapter Two, by defining an innovation system, it was found that the innovation system does not consist solely of participants or actors, but that the linkages amongst these participants or actors play an important role in the performance of the system. It has already been said in paragraph 6.2.1.1 that firms do not normally innovate in isolation, but that they act in collaboration and interdependence with other organisations. The existence of other actors or participants in the environment of the innovation system and the extent to which firms interact and network with these actors or participants, has an effect on the innovative performance of the firms.

According to the analysis of empirical studies on innovation by Becheikh *et al.* (2006:657), networking by the firm with different actors was found in most studies to have a positive correlation with innovation, some to have an insignificant correlation, but none recorded a negative correlation. The findings revealed positive correlations of networking with: Universities, in 8 of 12 studies; research centres, in 11 of 15 studies; other firms, in 8 of 16 studies; industrial groups, in 3 of 7 studies; consultants, in 8 of 13 studies; suppliers, in 14 of 19 studies; and customers, in 13 out of 19 studies.

Becheick *et al.* further found that most studies show a positive correlation between government policies and innovation. Lee & Park's (2006:1045) empirical study of Korean firms shows that collaborative R&D with universities and downstream firms improves the chance of successful innovative activities.

Earl & Gault (2006:4) confirm the importance of networking with other actors or participants by stating the following:

> "… innovation was not an isolated activity as actors, usually firms …, engaged in innovation and they were influenced by clients and suppliers, by market conditions and by the economic and cultural environment in which the firms functioned. As a result, not only were actors and their activities important, but so also were the

linkages to other actors in the system, such as government departments, universities, competitors, clients and suppliers".

According to the OECD & Eurostat (2005:20),

> "The innovative activities of a firm partly depend on the variety and structure of its links to sources of information, knowledge, technologies, practices and human and financial resources. Each linkage connects the innovating firm to other actors in the innovation system: government laboratories, universities, policy departments, regulators, competitors, suppliers and customers".

The need to study innovation from a system perspective, as discussed in Chapter Two, is therefore based on the positive effect of networking amongst actors on innovation in the innovation system. The OECD (1997:9) stresses the importance of understanding the linkages, saying:

> "The concept of national innovation systems rests on the premise that understanding the linkages among the actors involved in innovation is key to improving technology performance….The innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation and use, as well as the technologies they use".

The linkages among participants in the innovation system are formed for different reasons. Linkages between firms and suppliers and firms and customers are formed, *inter alia,* for access to inputs or distribution of outputs. Linkages between firms and government may be formed, for example, to gain access to finances or to access support regarding training or starting new businesses. Linkages between firms and training organisations may develop due to the need for skilled human resources. The reasons why firms form linkages may include the advantages from pooling resources, achieving economies of scale, and of gaining synergies from complementary human and technical assets (OECD, 1997:7).

There are many different kinds of linkages, depending on whether the linkages are formal or informal, intentional or incidental and depending on which participants are involved (for example, similar or different kinds of organisations, domestic or international participants).

(i) Formal linkages are consciously created and include co-operative agreements and contractual specifications. These formal linkages are, for example, agreements between firms that use the same technology, but are not in competition, joint industry research and public/private sector partnerships (Balzat, 2006:22-27; OECD, 1997:3). Informal linkages emerge spontaneously and include examples such as trade fairs, personnel mobility, transfer of technology through machinery and equipment, scientific conferences and scientific publications (Balzat, 2006:22-27; OECD, 1997:7).

(ii) Direct linkages are purposely created. They involve the collaborating partners only and they include direct interaction among the actors. An example could be where government provides financial support to firms in carrying out research and development (R&D) activities. Indirect linkages emerge automatically, for example, if the technological knowledge of direct R&D co-operation spills over unintentionally to a third party, then an indirect linkage to this third party has been established (Balzat, 2006:22-27).

(iii) Horizontal linkages include linkages that take place among actors that belong to the same organisational category, for example, interaction between firms or interaction between research bodies (Balzat, 2006:22-27; OECD, 1997:7). Horizontal linkages may also be partly internal and partly external (to the firm). For example, business units may belong to the same enterprise group, but function as separate enterprises, or may be part of multinational enterprises, or belong to marketing chains (OECD & Eurostat, 2005:77). Vertical linkages are, again, linkages formed among actors of different organisational categories, for example, interaction among firms, universities, government and research bodies (Balzat, 2006:22-27; OECD, 1997:7).

The advantages that firms receive from collaboration include the pooling of technical resources, the achievement of economies of scale and the gaining of synergies from complementary human and technical assets (OECD, 1997:7).

6.2.3 Flows in the innovation system

There are certain flows that take place along the linkages in the innovation system. Most innovation system models have the finance flows in common (Ahlbäck, 2005; Baskaran & Muchie, 2010; European Commission, 2003; Holbrook, 1997; and Rooks & Oerlemans, 2005) while some have the knowledge flows in common (Baskaran & Muchie, 2010; Holbrook, 1997; and Rooks & Oerlemans, 2005).

6.2.3.1 Financial flows

The importance of finances, access to finances and financial support for innovative performance was indicated in Chapter Five. It is therefore important that the linkages among participants should be of such a nature as to enhance the appropriate financial flows. Financial flows among participants usually form part of direct and/or formal linkages. These financial flows may, for example, be between firms and financial institutions, firms and venture capitalists, firms part of multi-national enterprises, firms and government (supporting, for example, R&D), government and universities, training and other research organisations, between government and any other organisation in the innovation system that is funded by government, for example (Ahlbäck, 2005; Baskaran & Muchie, 2010; European Commission, 2003; Holbrook, 1997; and Rooks & Oerlemans, 2005). As discussed in Chapter Five, paragraph 5.3.3: the financial sector should be well developed and the monetary authorities should:

(i) consider innovative activities in their policies to ensure a smooth flow of finances to innovative firms;

(ii) venture capitalists should be encouraged to enhance the flow of high risk capital to innovative firms;

(iii) where government financing of innovative activities is involved, it should be well regulated, but without hampering the flow of finances with bureaucratic “red tape”; and

(iv) international relationships should be encouraged to attract the flow of foreign direct investment (FDI) and other foreign funding.

6.2.3.2 Knowledge flows

Knowledge and technology flows can be seen as the “fuel” of the innovation system “machine”. The importance of technological capabilities of firms and human resource development as determinants of innovation, as shown in Chapter Five, gives an indication of the importance of knowledge and technology flows in the innovation system. The knowledge flows are not as easily distinguishable as the financial flows because knowledge flows do not only take place through direct and formal linkages, but also through indirect and informal linkages.

The knowledge flows may be classified in three categories. The first category is that of open information sources, where access of knowledge is gained without payment for the knowledge itself. There may, however, be marginal fees for membership of trade associations, attendance of conferences or subscriptions to journals OECD & Eurostat (2005:78-81). This category includes codified knowledge. Codified knowledge is explained by the OECD & Eurostat (2005:79) as follows:

> “Codified knowledge can take many forms, such as published articles, standards, metrology (methods of measuring items such as liquid or gas flow, time, chemical pollutants, etc.) or knowledge gained from networks, arm’s-length contact with suppliers, or trade fairs”.

According to the OECD & Eurostat, (2005:79), the open information sources may flow via formal and informal linkages in the following way:

> “Informal networks tend to be based on personal contacts or ‘communities of practice’ or simply arise in the normal course of business. Formal or managed networks can be organized by business organizations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organizations or sponsored by local, regional or central governments”.

The linkages that the OECD & Eurostat describe as formal and informal may reside under such classification, but some may also be accommodated under direct and indirect linkages or as horizontal or vertical linkages.

The second category of knowledge transfer is where the acquisition of technology and knowledge involves the purchase of external knowledge and technology without active co-operation with the source (OECD & Eurostat, 2005:78-81). The external knowledge includes the knowledge embodied in machinery and equipment, or the knowledge that can be obtained through employing human resources who possess this knowledge, or even knowledge obtained through contract research and consulting services. External knowledge also includes access to technology through patents, licences, trademarks and software.

The third category of knowledge transfer is through innovation co-operation which involves active participation in joint innovation projects with other organisations (OECD & Eurostat, 2005:78-81).

Two examples of the linkages of knowledge flow are firstly, the linkage along supply chains, involving customers and suppliers in the joint development of new products, processes or other innovations; and secondly, collaboration with enterprises working jointly with other enterprises or public research institutions. The linkages may be horizontal or vertical.

All three categories of knowledge transfer contribute significantly to the innovation activities that take place in the innovation system. Rooks & Oerlemans (2005:1216) regard knowledge as “the basic ingredient of innovation”. Without knowledge that is transferred from education, training and research institutions through human resources to firms, the innovative capacity of firms would be seriously hampered. The flows of knowledge and technology among any of the participants in the innovation system, through any channel that has been discussed, will lead to an expansion of the total knowledge component in the innovation system as a whole. In turn, this will eventually lead to innovative activity and economic development. The flow of knowledge and technology across national borders is but one of the most important aspects to consider in any innovation system, due to the increasingly globalised economy and the increased competition that inevitably must accompany globalisation.

6.3 Summary

The aim of this chapter was to develop a descriptive, conceptual model of an innovation system by first determining who the participants were, and what their roles were in the innovation system and then, secondly, determining the linkages and relationships among the participants.

The participants that play a role in the innovation system were found to include, primarily, the innovative firms that are at the centre of the innovation system due to their importance in the contribution to innovative activities, and this include large, medium and small enterprises. Innovative firms were found to be operating in a complex matrix of other participants or actors. Other participants that were identified included suppliers and competitors, financial organisations and venture capitalists, customers, education and training bodies, government, science, technology and R&D intermediaries, and international participants. The different roles of these participants in the innovation system were subsequently established. Education and training bodies were found to be among the most important participants in supporting firms in the innovation system due to their contributions to the development of sufficiently qualified human resources and for their contribution to R&D capacity - two of the most important determinants of innovation, as was previously demonstrated in Chapter Five. The science, technology and R&D intermediaries contribute to the R&D function and so can play a strong role in the transfer of knowledge and technology and in the interaction and linkage amongst participants. The role of the government was seen as needing to be supportive, but where it is necessary for government to function as entrepreneur, innovative behaviour becomes important for government also. Financial institutions and venture capitalists were also found to be important participants to the innovative firms, due to the role that finances play in innovative activities, also indicated in Chapter Five. It was further indicated that international participants, although not inside the national boundaries of a national innovation system, influence the innovation system because of globalisation. MNEs are some of the most important international participants regarding transfer of knowledge and FDI. Suppliers, competitors and customers are all participants in an innovation system, and all play a role in transfer of knowledge and technology, but their roles are less direct than those of R&D and education and training institutions.

It was further indicated that the strength of the linkages among participants has a positive effect on the innovative performance of the system and so is important for the transfer of finances, knowledge and technology. The different kinds of linkages depend on whether the linkages were to be formed formally or informally, intentionally or incidentally and which participants were involved (similar kinds of organisations or different kinds, domestic participants or international participants). The transfer of knowledge from universities to firms or from MNEs to their national branches is one of the better-known knowledge transfer linkages identified, but this does not imply that the knowledge transfer from, for example, suppliers to firms, or from customers to firms, are not important. The existence and strength of the participants alone does not determine the performance of the system. The strength and kinds of linkages amongst the participants play a role in the performance of the system as a whole.

The innovation system model that was developed will be used in the following chapter as the basis on which to evaluate the Mpumalanga province. This will be done in order to determine if the province functions as an innovation system and how conducive the environment in the province is for innovative activities to take place.

CHAPTER SEVEN

AN EVALUATION OF THE MPUMALANGA PROVINCE FROM AN INNOVATION SYSTEM PERSPECTIVE

7.1 Introduction

The aim of this chapter is to determine if Mpumalanga functions as a regional innovation system and, thereafter, if the economic environment of the Mpumalanga province is conducive to innovation. In Chapter Four, the importance of innovation for economic development was established. The determinants of innovation that were established in Chapter Five and the model of a system of innovation that was developed in Chapter Six will now be used to evaluate the Mpumalanga province in order to determine just how conducive the province is for innovation. The Mpumalanga province was chosen as a case study due to the high need for development perceived in the province. The Mpumalanga province is a region characterised by high potential with many natural resources such as fertile soils, beneficial climatic conditions, minerals, scenic beauty and others, but also by high unemployment and poverty levels, and poor health and education conditions.

Mpumalanga is one of the nine provinces of South Africa and it covers approximately 6,5% (79 490km^2) of the land surface area of South Africa. Mpumalanga borders the Free State and KwaZulu-Natal in the south, the Limpopo province in the north, Gauteng in the west and Swaziland and Mozambique in the east (Statistics South Africa, 2006a:1). The location of Mpumalanga is shown on the map in Figure 7.1. Mpumalanga is subdivided into three district municipalities, Gert Sibande, Nkangala and Ehlanzeni. These three district municipalities are further subdivided into local municipalities. Mpumalanga has eighteen local municipalities. These are listed in Table 7.1 and shown on the map in Figure 7.1.

Figure 7.1 Map of Mpumalanga, showing District & Local Municipal boundaries

Source: Mpumalanga Provincial Government, 2008

In this chapter, the need for a study of an innovation system for the Mpumalanga province will first be examined. In the second place, the Mpumalanga province will be evaluated and the strong and weak points of the system will be identified in terms of innovative activities or potential.

7.2 The need for a study of an innovation system for the Mpumalanga province

The development need that exists in the Mpumalanga province necessitates a study on the existence or potential of Mpumalanga as an innovation system. It was established in Chapter Six that innovation takes place mostly in firms, but that these firms function within a system of innovation. South Africa is regarded as a national innovation system due to the legal status of the nation state (as was found in Chapter Two). The Mpumalanga province is a region within the national innovation system of South Africa, but it must be asked whether or not Mpumalanga can be regarded as a regional innovation system based solely on the regional boundaries of the province.

South Africa has been a constitutional democracy since 1994 and is governed by a central government and nine provincial governments. All provinces are dependent on the central government for budget revenues and the provinces have a wide variety of legislative competencies that include agriculture, industrial promotion, nature conservation, public transport and roads, tourism and casino development, health services, education, housing, rural development, regional planning and development and local government. The executive power in each province vests in the premier, who works with an executive Council appointed by him (Adlam, 2010). In Chapter Two, it was concluded, in agreement with Scerri (2008), that boundaries that have been set for regional innovation systems on the grounds of factors such as political decisions that can easily change, are not sufficient to classify a region as an innovation system. According to Scerri (2008:4), there are three possibilities regarding the identification of provinces as systems of innovation:

(i) A province could be defined based on "explicit and distinct sets of historically determined specific characteristics, networks and linkages among its various sectors"; or

(ii) Some "specific distinguishing characteristics [could exist] within the provincial borders that offer the opportunity for the development of a distinct and viable provincial system of innovation"; and

(iii) "...the foundation may be so weak as to offer no feasible chance for the development of a distinct provincial system of innovation".

For these three scenarios, Scerri indicates the implications for the viability of the provinces. For the first scenario, Scerri states, "the viability of the provincial system of innovation predates the legal formation of the province[s]". For the second scenario, Scerri states, "the creation of the province is based on the potential of the institutional networks in the specified geographic area to develop into a viable and identifiable system". Concerning the third scenario where the provinces lack the pre-requisites for the development of a viable system of innovation, Scerri states, "the only logical role of the provincial government would be to ensure a minimum guaranteed quality of life for its constituency through transfers from the national government. Alternatively, the rationality of its creation in the first place may have to be re-addressed and the possibility of re-configuration of the provincial map may have to be considered".

The Mpumalanga province should not, therefore, be classified as a regional innovation system based solely on the political and administrative boundaries that have been set by the national government. It thus becomes important to evaluate the Mpumalanga province in order to establish if the necessary components (participants, linkages and economic environment) of an innovation system exist in the province, and that these components are functioning to such an extent that the Mpumalanga province can be classified as a regional innovation system. If not, it should be established whether the province has the potential to develop a regional innovation system.

According to Scerri, his last scenario may result in dependence on the national government or the re-configuration of the provincial map. Such permanent dependence may not be the best (or only) solution. A more aggressive effort in creating a more conducive environment for innovative activities should rather be considered. If a re-configuration of boundaries is to be considered, it should not be done by excluding the under-developed areas (to be permanently dependent), because innovation is the essence of development (as was demonstrated in Chapter Four), and this exclusion will only increase the gap between the dual economies of the country.

The need for economic development in Mpumalanga is urgent, as evidenced by the following aspects of development, taken as examples: the distribution of economic activity in only a few local municipalities with the larger part of the province not being developed; the low income per household; the skewed distribution of income; and the high unemployment rate.

According to the DBSA (2004:21), the annual personal income earned or received by citizens in Mpumalanga was R41,8 billion in 2002 and the personal disposable income was R36,8 billion. The first problem that must be highlighted is that this income is not evenly spread among people. The annual *per capita* income ranges between R9 200 for Africans to R47 200 for whites, and the annual per household income ranges from R37 500 for Africans to R153 800 for white households (Table 7.2). The data from 1998 to 2008 regarding the Gini-coefficient indicates that the distribution of income in Mpumalanga has become further skewed (Table 7.3). The gap between high-income and low-income people has therefore increased.

The standard of living in Mpumalanga is also evidence of the need for development in the Mpumalanga province. The Human Development Index (HDI) is frequently used as an indicator of living standard. To understand the HDI of Mpumalanga in context, the HDI for South Africa must first be compared to that of other countries and then South Africa's HDI may be compared with that of Mpumalanga. A study by Todaro & Smith, (2009:53), showed that of a sample of 23 countries, the HDI (2004 data) for Niger was the lowest at 0,311, the HDI for Norway was the highest at 0,965 and the HDI for South Africa was 0,653 (Table 7.4). South Africa was thus classified among the countries with "medium human development". Unfortunately, statistics that could have been used to compare South Africa's national results with those of Mpumalanga were found to differ among sources. Nevertheless, Table 7.5a indicates that Mpumalanga's HDI is lower than that of South Africa as a whole. These figures imply that Mpumalanga deteriorated from ranking fourth in 1991 among the nine provinces to ranking sixth in 1996. Table 7.5b indicates that the HDI shows a general improvement from 1998 to 2001, but only remained steady from 2001 to 2008. What is of particular interest is the comparison of the HDI among the different population groups. This is an indication of the different circumstances, living conditions and quality of life of those groups. As is shown in Table 7.5b, the HDI for Mpumalanga ranges from 0,47 for black Africans to 0,87 for whites in 2008, according to the Department of Economic Development, Environment and Tourism (2009:5).

In Table 7.10, the unemployment rate of the different provinces as well as that for South Africa as a whole is shown, as was determined by Statistics South Africa (2008) during the labour force surveys. The unemployment rate of Mpumalanga (20,6% in 2007) compares well with that of South Africa and is, most often, a little lower than South Africa (23,6% in 2007) as a whole. According to statistics compiled by the World Bank (2010a) South Africa ranks among the countries with the highest unemployment rates (Table 7.7). The unemployment rate for South Africa is 25,9% (2009) for females (% of female labour force) and 22,0% for males (% of male labour force) as compared to corresponding rates for, *inter alia*, Japan: 4,7% (females) and 5,3% (males), United Kingdom: 6,4% (females) and 8,8% (males), Germany: 7,3% (females) and 8,1% (males), United States: 8,1% (females) and 10,3% (males), France: 9,3% (females) and 8,9% (males).

The economic performance of Mpumalanga compares well with the rest of South Africa, but the challenge lies in the concentration of economic activity in only a few local municipalities. The 4 largest local municipalities (of the 18 local municipalities) in terms of economic production contributed almost 71,5% to the Gross Value Added (GVA) of the province in 2002. These four local municipalities are Govan Mbeki, Middelburg, Emalahleni and Mbombela (DBSA, 2004:36-50). The figures are shown in Table 7.8. The GVA of the province seems on par with the rest of the country, but there are large areas that are rural and under-developed. Local municipal areas such as Nkomazi, Thembisile and Dr JS Moroko have among the highest proportions of population in the province (Table 7.9), but contribute very little to GVA (Table 7.8). Bushbuckridge accommodates the highest proportion of the population of the province. Unfortunately, due to demarcation issues, the contribution of Bushbuckridge to GVA is unavailable, but the Bushbuckridge area remains rural and mostly undeveloped. Municipal areas like Emalahleni, Steve Tshwete and Govan Mbeki, on the other hand, constituted population proportions in the province of 8,2%, 4,2% and 6,6% (2001) respectively, but contributed 19,2%, 18,2% and 19,5% respectively, to the GVA (2002) of the province (Tables 7.8 & 7.9). The GVA in these areas results mainly from mining activities and manufacturing such as the steel and petro-chemical production around Witbank, Middelburg and Secunda. The Department of Agriculture, Rural Development and Land Administration (2005) confirmed this concentration of economic activity in certain areas by stating that:

> "Manufacturing is the single largest economic sector in the Mpumalanga, contributing almost one quarter of the Gross Geographic Product (GGP) of the province, with almost two thirds of manufacturing production in the province taking place in the southern part of the Highveld, most notably in the Highveld ridge area where Sasol's coal mining, synthetic fuels and chemical operations at Secunda employ more than 15 000 people and contribute 12% to the provinces GGP … There are also large-scale manufacturing activities in the northern part of the Highveld, particularly in the Middelburg-Witbank area, the most important being chrome alloy and steel manufacturing …".

Growth in terms of contribution to GDP, therefore, creates an incorrect impression of the level of development and living conditions of the people of Mpumalanga. The majority of the people in the province still live in poverty and huge areas are poorly developed.

7.3 Methodology

The innovation system model that was developed in Chapter Six is used to evaluate the Mpumalanga province to determine if it functions as, or has the potential to function as, an innovation system. The Mpumalanga province is studied as a case study and all the different elements necessary to function as a successful innovation system (described in Chapter Six) is investigated and described for Mpumalanga.

The evaluation of the Mpumalanga province is conducted by means of a qualitative and descriptive analysis. Data collection consists of documents of secondary nature. Some of the data are quantitative while others are qualitative. Most documents are statistical reports by relevant official government departments, parastatals and international authoritative bodies to ensure authenticity of documents. In order to ensure reliability, different documents on the same element are compared. It is then indicated if the pattern is similar or different in the documents.

In the analysis of each element, the description of the Mpumalanga province is put into perspective by comparing the data with that of South Africa. South Africa is further compared to the world situation. The description of the Mpumalanga province with regards to each element in the developed innovation system model identifies the strong and weak points in the province.

7.4 A description and analysis of the Mpumalanga province from a regional innovation perspective

The result of an evaluation of the Mpumalanga province against the determinants of innovation that was discussed in Chapter Five, and the innovation system model, that was developed in Chapter Six, is illustrated in the diagram presented in figure 7.2. The figure indicates the strengths and weaknesses of Mpumalanga as compared to the model of an innovation system. The figure indicates that the Mpumalanga province functions within the national innovation system of South Africa. The dotted lines indicate the weaknesses in the participants and the linkages among the participants. The evaluation revealed that the Mpumalanga province, regardless of the province's political, administrative and legal boundaries and power, does not have the essential components necessary to be classified as a regional innovation system. The Mpumalanga province is well endowed, and therefore has strengths, with regard to natural resources in terms of minerals, arable land, climate and scenery, for example. Unfortunately, the availability of natural resources alone is not sufficient for innovative activities to take place. Although there are many aspects that hamper the innovative performance of the Mpumalanga province, the three components that stand out as major restricting components, are:

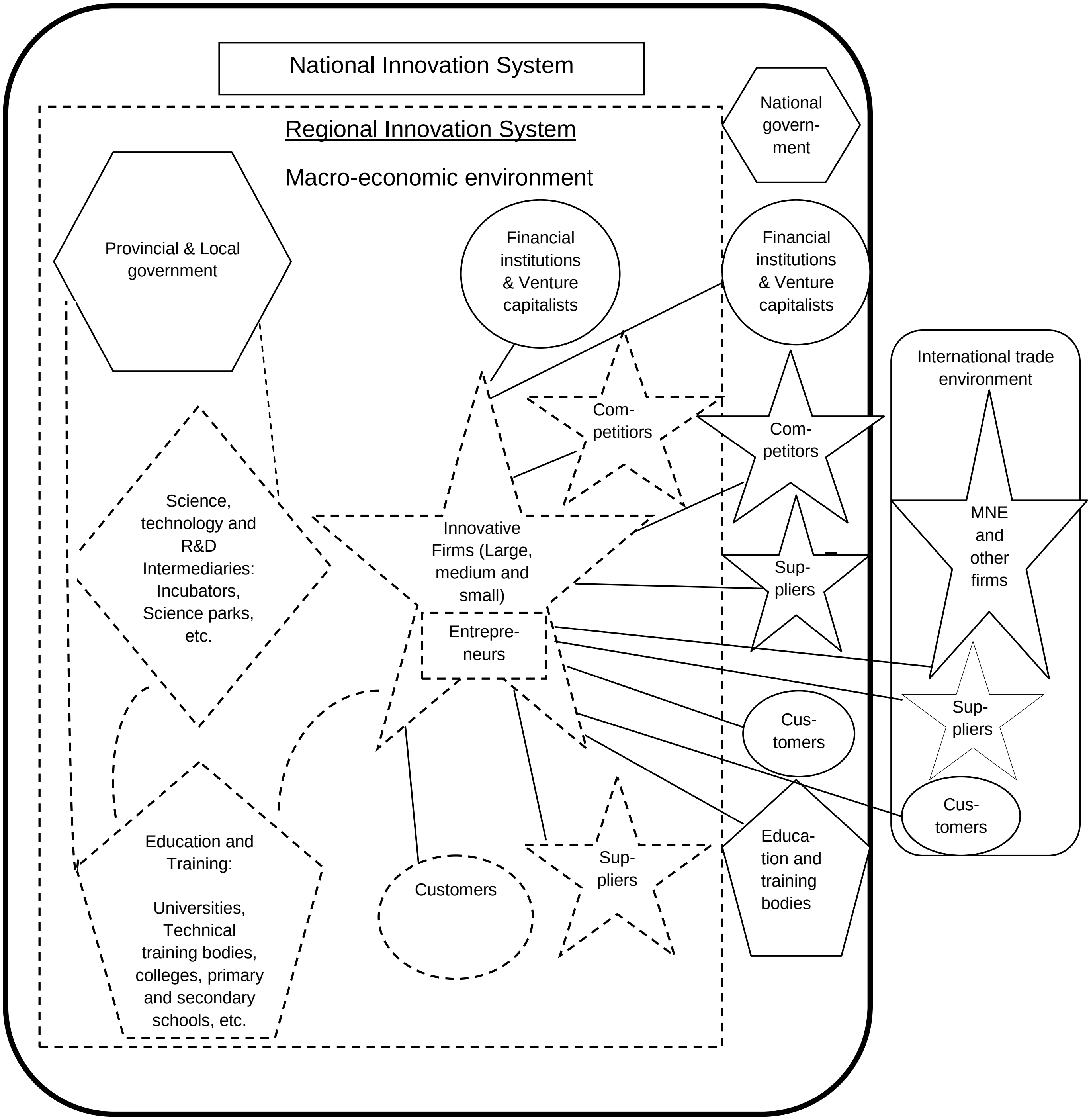
(i) quality of human development;

(ii) level and capacity of research and development; and

(iii) access to finances.

Although the interaction among all participants in an innovation system determines the innovative performance of the system as a whole, human development is the crux of innovation (as was proved in Chapter Five). Entrepreneurs, who are responsible for innovation (as was established in Chapter Two), are also influenced by human development (as was established in Chapter Four). The weakness that has the most severe effect on the innovative capacity of Mpumalanga is the component of human development. The evaluation indicates a lack of education and training bodies, poor performance of many of the education and training bodies that are in place (as will be discussed in paragraph 7.4.3) and a lack of, or poor performance of, government in providing services to ensure a healthy population and workforce in the Mpumalanga province (as will be discussed in paragraph 7.4.3.2). The result of the poor performing primary and secondary education bodies in Mpumalanga leads to a shortage of students qualifying for, or not well enough prepared for, tertiary education. The absence of a

Figure 7.2 An evaluation of Mpumalanga against a conceptual regional innovation system model



Strengths ————

Weaknesses - - - - - -

university, or universities, in the province further affects the human development component. The relevance of universities for innovation was discussed in Chapter Five.

The research and development capacity in the province is another major constraint of the innovative performance in the province, as will be shown in paragraph 7.3.4. This weakness results from the poor human resource component, the absence of universities in the province and the absence or insufficiency of intermediaries such as science and technology parks, incubators, and the like. The weaknesses in the education and training bodies, research and development capacity and the intermediaries all have a negative effect on the knowledge transfer to the firms that are responsible for innovative activities.

The third component that severely affects the innovative capacity of Mpumalanga is the poor, or non-existent, access to finances (as discussed in paragraph 7.3.5). The financial system in South Africa is well developed and the provision of finances to firms in Mpumalanga is not restricted to those of the region (which is an important strength of the innovation system), but the provision of venture capital and financing of smaller enterprises is a particular weakness in the innovation system.

Other weaknesses of participants and their roles include the limited local customers, local suppliers, competitors and venture capitalists. These weaknesses in participants lead to a weak flow of knowledge from these participants to the firm responsible for innovation. There are stronger linkages of the firms with the suppliers, competitors and customers outside the province (nationally and internationally) due to the size and buying power of the local market and the type of products produced in the province. These linkages can, nevertheless, be seen as strengths, due to the advantages of knowledge, technology and finance flows that take place along these linkages.

An overview of the current situation regarding the firms as innovators in Mpumalanga will now be offered, as well as a consideration of the natural resources of the province. Thereafter, a detailed analysis follows of the factors influencing the innovative performance in the province, starting with the three determinants that influence innovation most (as was established in Chapter Five), namely, human resources, research and development and access to finances, followed by all other determinants of innovation systems that were identified.

7.4.1 The firms in Mpumalanga

In the innovation system model that was developed in Chapter Six, the firm has been indicated as the participant within which most innovation takes place. There are a variety of firms in Mpumalanga spread across types of industry, sizes of firm and levels of innovation. Unfortunately, these firms are not spread across the province, thus leaving large areas undeveloped. Because of this skewed distribution, the entrepreneurial activity in the province is not sufficient to alleviate the poverty and unemployment problems of the province. Also, the level of innovation by the different firms in the province varies widely. Some of the very large firms, such as Sasol and the large steel companies, are world leaders in their innovative and technologically advanced products. On the other hand, there are many small and micro-enterprises that operate with very little innovative input. These vast differences in innovation in firms are partly a result of the dual economy in the province and in South Africa.

The firms in Mpumalanga indicate a spread regarding the industry sectors that are represented. Yet, the number of firms and their production is not nearly enough to alleviate the poverty and unemployment problems of the province. The unemployment rate for Mpumalanga was 20,6% in March 2007, as indicated in Table 7.10. A more alarming statistic is the absorption rate of Mpumalanga (Table 7.11). Only 42,2% (2002) of the working age population is employed. That implies that 57,8% of the working age population was either unemployed or not economically active. The absorption rate of Mpumalanga is slightly worse than that of South Africa as a whole at 44,1% (2007).

The poverty situation in Mpumalanga is further evidence of there not being sufficient firms in the province to contribute towards the development need. The poverty rate has increased from 1998 to 2004, and slightly decreased from 2004 to 2008, but is (at 50,5% in 2008) still higher than that of South Africa (at 40,7% in 2008), as shown on Table 7.6. This table provides further evidence of the uneven spread of economic development in the province, indicating that the poverty rate in the Ehlanzeni District is higher than that of Nkangala and Gert Sibande Districts. The majority of Mpumalanga's population are found in areas of the province where there is low economic activity. The areas of high economic activity include the Nelspruit-White River metropolis, the Witbank-Middelburg metropolis, and Secunda and surroundings (Department of Economic Development, Environment and Tourism, 2009:8). The absence of firms in large areas of the province indicates the lack of innovation in these areas, as firms are the units in which innovation mostly takes place. As innovation has been indicated as important for economic development to take place (in Chapter Four), it is therefore important to determine the reasons for the lack of innovative activities in these areas.

The firms in Mpumalanga consist of a few very large firms, a fair number of medium sized firms and a large number of small and micro-enterprises. The few very large firms contributed a major share to the economy of Mpumalanga. Sasol, for example, contributes approximately 12% to the GGP of the province (Sasol, 2004:29). Other examples of the very large firms are Columbus Steel, Highveld Steel, Sappi, TSB Sugar and Xstrata. The fact that these firms contribute a large portion of the GGP of the province does not imply that the small and micro-enterprises are unimportant. The large firms do not provide the number of job opportunities that are needed in the province to alleviate the unemployment problem. The small and micro-enterprises, as well as the agricultural sector, play an important role in the reduction of unemployment in the province.

The diversity of the industries in Mpumalanga is further emphasised by the contribution of the different sectors in the economy, as shown in Table 7.12. From the table, it is clear that the top two industries are manufacturing, and mining and quarrying (Statistics South Africa, 2006a:94). Although the manufacturing and mining sectors contribute most to the Gross Domestic Product per Region (GDPR), it is the trade sector that creates the most employment, followed by the agricultural sector. In Table 7.13, the employment per industry is set out for Mpumalanga. The formal sector is the largest employer with 69,3% of employment in the province, but the informal sector also plays an important role by contributing 30,5% of employment opportunities (Statistics South Africa, 2006a:66). The informal sector, which most frequently consists of small and micro-enterprises, plays a more important role in Mpumalanga than in most other provinces in South Africa. It is only the Limpopo province and the Eastern Cape in which the informal sector contributes a higher proportion of that province's employment, as shown in Table 7.14. Statistics South Africa (2006b:xi) also study non-VAT registered enterprises as an indication of statistics regarding small and micro enterprises. It is estimated that the number of non-VAT registered enterprises in Mpumalanga was 134 948 in 2005, which was 7,7% of all non-VAT registered enterprises in South Africa. The number of people that own non-VAT registered enterprises in Mpumalanga forms 16,1% of the employed people in the province and 12,6% of the labour force of Mpumalanga (calculated from Tables 7.11 and 7.15). This again confirms the importance of small and micro-enterprises in creating employment opportunities. Entrepreneurs, who carry out innovation in any size of firm and any industry sector, are important if development in Mpumalanga is to improve. Entrepreneurship should therefore be supported by other participants in the innovation system to increase the performance of the innovation system as a whole.

7.4.2 The natural resources of Mpumalanga

The lack of sufficient innovative performance by firms is not, by any measure, due to the lack of natural resources in the province. The Mpumalanga province has the potential for production in a wide range of sectors thanks to the natural environment and has a variety of natural resources. The Department of Agriculture and Land Administration (1999) provides an overview of the geography of the province as follows:

> “Mpumalanga is mainly situated on the high plateau grassland known as the Highveld. The Highveld stretches for hundreds of kilometres eastwards, until it rises towards mountain peaks and deep valleys of the Escarpment in the north-east. From the escarpment it plunges hundreds of meters down to the low-lying area known as the lowveld.
>
> The climate of Mpumalanga is as diverse as the other natural resources. This is a summer-rainfall area divided by the escarpment into the Highveld with cold frosty winters and moderate summer, and the Lowveld with mild winters and subtropical climate. During winter the Highveld and Escarpment sometimes experience snow. The annual rainfall falls mainly during summer in the form of heavy thundershowers.
>
> The province falls mainly within the Grassland Biome. In the northern part of the province the vegetation changes to that of the Savanna Biome. Small patches of the Forest Biome are found on the Escarpment”.

This diversity in climate, vegetation and other geographical factors of the province create the potential for the production of a variety of products. The varieties of agricultural products that are currently produced in Mpumalanga include both crop production (field crops and horticultural crops) and livestock production. Table 7.16 shows the kinds of field crops that are produced in Mpumalanga, Table 7.17, the kinds of horticultural crops and Table 7.18, the livestock production in Mpumalanga. These tables provide evidence that there is a potential in the province to produce agricultural products that require divergent environments. The functional land use pattern, as portrayed in Table 7.19, indicates the variety of potential production in the province.

The climate and other geographical factors make the Mpumalanga province also suitable for forestry. Mpumalanga is South Africa's major forestry production area, and forestry contributes 4,7% of the Gross Geographic Product (GGP) of Mpumalanga (Department of Agriculture, Rural Development and Land Administration, 2005). The importance of forestry, as shown in Table 7.19, is evident from the fact that Mpumalanga contributes 38,3% of the forestry production of the country, even though only 6,7% of Mpumalanga's land area is utilised for forestry (DBSA, 2004:43).

Further, Mpumalanga is richly endowed with minerals. There are extensive coal resources situated in the western and south-western parts of the province. Coal represented 85% of the total sales value (1996 data) of all minerals mined in Mpumalanga. These large coal deposits are the reason for Mpumalanga being primarily responsible for the generation of electricity through coal-fired power stations in South Africa. Eight (8) of the 11 coal-fired power stations operational in 2002 were situated in Mpumalanga and they contributed approximately 70% of the total electricity generated in South Africa. The other mining activities of importance in the province include gold mining, iron ore, chrome, alusite, magnetite and vanadium quarrying. There are also deposits of fire clay, silver, asbestos, nickel, platinum group metals, limestone, semiprecious stones, silica and talc in the province (Department of Agriculture, Rural Development and Land Administration, 2005).

The importance of the mining industry in Mpumalanga is evident from its role in employment and remuneration. The mining industry of Mpumalanga employs 12,1% of the total employed in the South African mining industry and contributes 18,0% of the remuneration of the South African mining industry, as shown in Table 7.20. Further evidence of Mpumalanga's importance in the mining industry is shown in the province's contribution to mineral sales revenues. Mpumalanga contributed 20,6% of the total primary mineral sales revenue and 20,6% of the total processed mineral sales revenue of the country in 2002, as shown in Table 7.21. Mpumalanga ranks therefore second, after North West, among the provinces regarding its contribution to primary mineral sales revenues and second, after KwaZulu-Natal, regarding processed mineral sales revenue (DBSA, 2004:46).

The availability of the diverse natural resources provides great potential for the development of the manufacturing industry. The production of synthetic fuel and other chemical products at Sasol, electricity production, as well as the chrome alloy and steel manufacturing on the Highveld are examples of manufacturing taking place thanks to the easy availability of natural resources in the province. In the Lowveld, thanks to the agricultural activities, manufacturing in the food and food related industries dominates and approximately 75% of manufacturing jobs are in these industries. The industries in the Lowveld include sugar mills, paper and pulp mills, sawmills, fruit and vegetable processors and board (plywood, particle, etc.) (Department of Agriculture, Rural Development and Land Administration, 2005).

Not only do the natural resources provide manufacturing potential. The tourism industry has huge potential also as a result of the scenic environment, diversity and climate in the province. The Kruger National Park and the Blyde River Canyon are some of the world renowned attractions in the province. The Department of Agriculture, Rural Development and Land Administration (2005), describes the tourism potential, citing the Mpumalanga Investment Initiative (MII), as follows:

> "Tourism attractions in the province are numerous and varied, ranging from game viewing (including the "big five") in more than seventy game parks to spectacular natural wonders created by the gigantic escarpment of the Drakensberg mountains. Apart from the vast tracts of man-made commercial forests, the province also boasts pristine bushveld and wilderness areas and offers safari lodges, farm holidays, hunting safaris, impressive caves with large dripstone formations, a rich cultural heritage, traditional African tribal art and craftwork and contemporary art work".

Mpumalanga has accurately been described as an area that is well endowed with natural resources. The poverty and unemployment in the Mpumalanga province is not, therefore, likely to be due to a lack of natural resources in the province. It is more likely that a lack of access to these resources or to the expertise to develop or use these resources as a source of income or production is responsible for the widespread unemployment and poverty. The other determinants and participants of the innovation system will now be further evaluated to determine if the Mpumalanga province is conducive for innovation.

7.4.3 Human development

Human development is indicated in Chapter Five as the essential determinant of innovation. Two important components of human development, firstly, education and training and secondly, health, will now be evaluated for the Mpumalanga province.

7.4.3.1 Education and training

The condition and performance of education and training bodies in the Mpumalanga province is a huge constraint in the innovation system of the province and seriously hampers the knowledge flows in the innovation system. South Africa's global ranking of the education system shows a gloomy picture and Mpumalanga performs even worse than most other provinces do. The quality of education in South Africa, as found by The Global Competitiveness Report 2011-2012 (Schwab: 2011:322-323), and shown in Table 7.22, ranks 133rd, secondary education enrolment come in at 51st, and tertiary enrolment, a disappointing 97th of 142 countries. The quality of math and science education ranked an alarming 138th of the 142. Internet access in schools in South Africa is ranked 100th of the 142. The quality of education in South Africa therefore is among the worst in the world. Von Broembsen, Wood & Herrington (2005:41) concluded in the Global Entrepreneurship Monitor: South African Report 2005 that

> "… the South African school system is failing to provide the vast majority of its students with the basic knowledge and skills required to start a business …. All the evidence suggests that the overwhelming majority of young adults do not and historically have not received education of an adequate quality, even by the standards of developing countries that are far poorer than South Africa".

In Mpumalanga, the level of education, quality and performance in the education sector and the condition of the education infrastructure are, to say the least, not conducive to learning. The performance and pass rates at schools on average are low and the literacy rate in the province is alarming, as is evident from the following:

The literacy rate:

According to the General Household Survey, 2010, 11,3% (6,9% for South Africa) of the people in Mpumalanga aged 20 and older have no schooling, 17,5% (17,7% for South Africa) have completed primary school or lower, only 24,4% have completed Grade 12/Standard 10 (25,7% for South Africa) and 9.5% (10,6% for South Africa) have qualifications higher than Grade12/Standard 10, as calculated from Table 7.23 and Statistics South Africa (2011:51-52). This literacy rate has a negative impact on the quality of human resources and potential entrepreneurs. The number and percentages of the population attending the different levels of educational institutions are shown in Table 7.24 for the provinces of South Africa. According to the General Household Survey, July 2003 (Statistics South Africa, 2004a:v), there are also approximately 13 000 children aged 7 to 15 that do not attend an educational institution at all. The General Household Survey, 2010 states that just under 89% of individuals above the age of 5 years in South Africa attend school (Statistics South Africa, 2011:9).

Quality and performance:

There are exceptions where some schools in the province are of a very high standard, but there are too many schools in which education is not conducive to a well-developed innovation system. The matric pass rate has been declining during the period 2006 to 2009 with some improvement in 2010, but remains lower than that of the country as a whole (Table 7.25). In 2010, the matric pass rate was 56,8% compared to 67,8% for the country as a whole. Apart from the low pass rate, there have been well-documented irregularities regarding the matric examinations during the past years. In "The Teacher", (Mpumalanga Premier promises to stop matric exam leaks, 2010), an overview is provided of these irregularities and reads as follows:

> "Over the past 10 years the province's education department has been notorious for matric examination paper leaks which have cast a shadow over the overall credibility of the entire examinations….In 2004 the results were withheld due to irregularities, while in 1998…the province was in the news after it was discovered the matric results were inflated by 20%.
>
> The 2009 exams saw investigations into leaks in maths, science and accounting exams papers…The province's grade 12 pass rate was 47%."

These irregularities have been confirmed by the SABC News (More arrests likely in Mpumalanga matric results scandal, 2010) and the report stated:

> "The provincial education department has been completely discredited. National officials will assume control of the exam unit until Mpumalanga cleans up its act and meets all criteria".

Mpumalanga has been indicated as one of the provinces in South Africa with the lowest quality of education. The Department of Education (2008:11) confirmed the low quality of service in the province as follows:

> “Compared to other provinces on matters of performance, the department’s rating on performance targets in critical service delivery support programs to the benefit of the core business is amongst the lowest”.

Learner-educator and learner-school ratio:

The learner-educator ratio in ordinary public schools (32:1) is slightly higher in Mpumalanga than that of the country as a whole (31:1) and the learner-school ratio is amongst the highest (552:1) of the provinces in the country (480:1 for South Africa), as indicated in Table 7.26 (National Treasury, 2009:24). Although larger schools may lead to more opportunities for learners if the infrastructure is sufficient, a lower learner-educator ratio may positively influence pass rates.

The skills level of the teachers:

The National Treasury (2009:41) found that one of the main contributing factors to the poor quality of education in South Africa is the low skills of many teachers. The Department of Education (2008:11) indicated that Mpumalanga has a shortage, specifically, of mathematics, science, mathematical literacy and of Further Education and Training (FET) teachers and lecturers.

School infrastructure:

The basic facilities at schools may contribute to the performance of the students. In Table 7.27, the number of schools without electricity, water, adequate toilet facilities and schools with more than 40 learners per class is shown. From Table 7.27, it becomes clear that there are still many schools without the basic facilities such as electricity, water and toilets and that many schools do not even have sufficient classrooms (Department of Education, 2008: 30). Apart from the health risks involved, learners are not exposed to technology such as computers and the internet under these conditions.

Retention of skills and knowledge:

Rooks & Oerlemans (2005:1221) noted that, quite apart from the low levels of education in South Africa, there is also the problem of many technical or professional people who leave the country as part of the so-called “brain drain”. Porter & Schwab (2008:446) also found that South Africa has a competitive disadvantage concerning the “brain drain”.

One of the most serious weaknesses that is experienced in Mpumalanga is the absence of universities in the province. Universities in an innovation system are proven in Chapter Five to be an important determinant for the improvement of innovative performance of the system. Universities play a role in the innovation system by developing human resources, potential entrepreneurs, as well as by contributing to the R&D that can lead to innovation. Universities can be the hubs for centres of excellence, business development centres, science and technology parks and the like. Therefore the absence of a university leaves a gap in the development of other participants in the innovation system and in the knowledge flows that should take place among these participants. In Mpumalanga, only 3,1% of the people attend university (but must go to other provinces) while 4,3% of the people of South Africa attend university. These percentages for Gauteng and the Western Cape are 8,4% and 7,2% respectively (Table 7.24). The absence of a university in the province may be the reason for this low percentage of people attending university. Another reason may well be the low percentage of learners who obtain a matriculation pass with university endorsement (Table 7.28). Only 12,0% of the matric candidates in Mpumalanga obtained university endorsement in 2008, compared to 19,1% in South Africa as a whole. In Gauteng and the Western Cape, these percentages were 29,3 and 32,4 respectively. In the Budget Vote Speech by the Minister of Higher Education and Training (Nzimande, 2010), the Minister said that work towards the establishment of a university in Mpumalanga will continue. This is a timely process, but for the university or universities to develop to such a level that centres of excellence and contributions towards science and technology parks contribute significantly towards innovation will take a considerable time.

7.4.3.2 Health

Health conditions are also affecting human resources and entrepreneurs in Mpumalanga. With a workforce that endures health provision conditions that rank among the world's worst health, the quantity and quality of the human resource component and potential entrepreneurs of Mpumalanga is seriously impaired. In Mpumalanga, the number of deaths per 1 000 of the population is amongst the highest, when compared to the rest of South Africa, as shown in Table 7.29 (Statistics South Africa, 2009b:17). The primary risk, communicable diseases in the province are malaria, tuberculosis, HIV & AIDS, cholera and measles (DBSA, 2004:4). In Table 7.30 it is shown that Tuberculosis is the leading cause of death in Mpumalanga and in South Africa, responsible for 14,1 and 12,8% respectively for Mpumalanga and South Africa, followed by Influenza and Pneumonia (10,9% for Mpumalanga and 8,3% for South Africa) (Statistics South Africa, 2009b:62&70). The percentages of deaths caused by these two illnesses are higher in Mpumalanga than in South Africa as a whole. Compared to the world's figures, the business impact of tuberculosis in South Africa is ranked 135th of 142 countries and the number of tuberculosis cases per 100 000 of population put South Africa in position 141 on the list of 142 countries (Schwab, 2011:423).

Malaria remains a serious health problem in Mpumalanga, even though the number of deaths due to malaria is not significant if compared to the ten leading underlying causes of death mentioned in Table 7.30. The number of malaria cases remains high in Mpumalanga and in two other provinces, KwaZulu-Natal and Limpopo. The number of malaria cases and deaths are shown in Table 7.31. Compared to the rest of the world, malaria cases per 100 000 population placed South Africa in the 90th position and the business impact of malaria, in 103rd position of the 142 countries, as shown in Table 7.22 (Schwab, 2011:322-323).

It is no secret that HIV prevalence is alarmingly high in the country and Mpumalanga is one of the provinces that is most seriously affected. Table 7.32 shows the provincial HIV prevalence of antenatal clinic attendees. This table indicates that Mpumalanga has the second highest (after KwaZulu-Natal) HIV prevalence among antenatal attendees of all provinces in South Africa. The HIV prevalence among antenatal attendees is 35,5% in Mpumalanga, compared to the national prevalence of 29,3% in 2008. Mpumalanga is the only province that continues to show an increase in HIV infection from 32,1% in 2006 to 35,5% in 2008 (Department of Health, 2009:10). Another study, excluding antenatal, shows an even wider gap between the HIV prevalence in Mpumalanga and the national average. The study shows that Mpumalanga has a HIV prevalence of 40,0%, compared to the national average of 28,3% (2008/09) as indicated in Table 7.33 (National Treasury, 2009:55). Although South Africa as a whole is slightly better off than Mpumalanga regarding HIV prevalence, South Africa shows a very gloomy picture if compared to the global scenario. South Africa ranks a poor position of 139th of the 142 countries regarding HIV prevalence, as shown in Table 7.22 (Schwab, 2011:323).

HIV & AIDS not only has far-reaching effects on the lives of people, but also has a cost effect on businesses. According to The Global Competitiveness Report 2011-2012, the response on how serious the companies consider the impact of HIV & AIDS would be on their companies, South Africa ranked at position 132 of the 142 countries (Schwab, 2011:323). Rooks & Oerlemans (2005:1221) state, that in some firms, the whole labour force is replaced every 3 years due to the consequences of HIV & AIDS.

The infant mortality rate in a country is also an indication of the health conditions. The number of deaths by age for Mpumalanga and for South Africa is portrayed in Table 7.34. This Table indicates that 8,2% of deaths in Mpumalanga are those of infants and a further 3,1% for the age group 1-4, compared to South Africa at 7,7% and 2,5%, respectively. The infant mortality rate of South Africa compared to the world is also not a pleasant picture with South Africa ranked in position 111 of the 142 countries (Schwab, 2011:323).

The health services in Mpumalanga rank among the worst of the provinces in South Africa. The number of people per doctor, number of people per nurse and the number of hospital beds per thousand people are shown for all provinces in Table 7.35. The table shows that Mpumalanga has almost double the number of people per doctor (7 377) than South Africa as a whole (3 749), and Mpumalanga is one of the 3 provinces that are worst off regarding the number of people per doctor. Mpumalanga is also one of the 2 provinces that have the most people per nurse (405) with a situation that is far worse than South Africa as a whole (255). Mpumalanga is the worst performing province concerning hospital beds per thousand people (1,8 public and 1,6 private hospital beds, per thousand people compared to 2,9 and 2,9 respectively, for the country as a whole).

The poor quality of education and health in the Mpumalanga province result in a human resource component (including the potential for entrepreneurs) that is not sufficiently developed for fulfilling the need for innovative performance. It has further negative consequences in the innovation system through its effect on other determinants of innovation, such as research and development and technology absorption.

7.4.4 Research and development

Although not an essential determinant of innovation, R&D was indicated in Chapter Five as an important determinant having a positive effect on innovation. The expenditure on R&D in Mpumalanga is amongst the lowest of the provinces in South Africa. The R&D expenditure in Mpumalanga is only 2,4% of the total of South Africa, compared to 19,6 and 51,7% in Western Cape and Gauteng, respectively, as shown in Table 7.36 (HSRC, 2009b:5). The 2,4% R&D expenditure is low even if compared to Mpumalanga's population proportion of 7,3% and GDPR proportion of 6,8% to the totals of South Africa (Table 2.2).

From Table 7.36, it is evident that the R&D contribution of the business enterprises in the province is very low at 1,8% of the business enterprises' contribution in the country. This contribution by the province's business sector is particularly low if it is considered that the business sector's share in R&D expenditure in the country is by far the largest. Table 7.37 shows that business enterprises contributed 57,7% of the R&D expenditure in the country in 2007/08 (HSRC, 2009b:xiii). Company spending on R&D in South Africa is ranked quite high by The Global Competitiveness Report 2011-2012 (Schwab, 2011:323). South Africa was ranked number 36 on the list of 142 countries, as shown in Table 7.22. One reason that the R&D expenditure by the business sector of Mpumalanga is so low in comparison with the rest of South Africa may be that many businesses in Mpumalanga are branches of, or form part of, a conglomerate or multinational whose headquarters are in another province or country and that the R&D of these business enterprises often takes place at the main branches or head offices in the other province or country. This is not to imply that R&D by business enterprises is sufficient in the province, but there may be R&D where the cost is incurred in one province and the benefit is reaped by, or shared by, another province.

R&D expenditure by the higher education sector classifies Mpumalanga among the three lowest performing provinces with a 2,9% contribution (Table 7.36). This may be due to the lack of a university in the province. The involvement of universities of other provinces and of satellite campuses of other universities in Mpumalanga probably contributed to the R&D expenditure. The share of R&D expenditure that higher education contributes as a sector in the country is 19,4%, causing higher education to be the second largest contributor to R&D expenditure after the business sector, as shown by Table 7.37.

The R&D expenditure by science councils and not-for-profit institutions is also very low in the province at 2,3 and 4,4%, respectively (Table 7.36), probably due to the same reasons that were mentioned for higher education institutions. The R&D expenditure by science councils forms 15,5% of the R&D expenditure in the country (Table 7.37). Most of these institutions operate from the high economic activity areas like Gauteng and Western Cape, benefitting most these areas in which they are situated.

The R&D performance in Mpumalanga does not compare well with that of the country, but it is important to put the R&D performance of the country into global perspective. The gross expenditure on R&D as a percentage of GDP is shown in Table 7.38 for a number of countries. South Africa's R&D expenditure as a percentage of GDP (0,93%) compares well with other developing countries, such as India (0,8%) and Argentina (0,51%), but countries like Sweden, Korea, Finland and Japan have R&D expenditures that exceed 3,0% of GDP (HSRC, 2009a:12-13). Another indicator of R&D performance is the number of full time researchers per 1 000 employees and South Africa's performance is compared with other countries in Table 7.39. The Table shows that South Africa has a relatively low number of researchers (1,5) per 1 000 employees in comparison with other countries (11,0 for Japan and 10,6 for Sweden) (HSRC, 2009a:12-13). The Global Competitiveness Report 2011-2012 (Schwab, 2011:323) also indicates that South Africa has a disadvantage in the availability of scientists and engineers. In this respect South Africa was ranked 111th on the list of 142 countries, as indicated in Table 7.22.

However, South Africa performs quite well in a few other R&D aspects. The Global Competitiveness Report 2011-2012 measured the local availability of specialised research and training services and South Africa is ranked fairly high in comparison with the rest of the world. South Africa was ranked 30th of the 142 countries measured. The Report also measured the "capacity to innovate" by measuring how companies obtain technology. On a Likert scale of 1 to 7, (where 1 represents whether companies that obtain technology exclusively from licensing or imitating foreign companies, and 7 represents whether companies obtain technology by conducting formal research and pioneering their own new products and processes), South Africa scored 3,4 and was ranked thus 46th of the 142 countries. The number of utility patents for invention granted per million population was 2,3 and that placed South Africa 42nd on the list of 142 countries. The quality of scientific research institutions was ranked 30th of the 142 countries (Schwab, 2011:323). Although South Africa as a whole performs well in comparison with the rest of the world regarding some R&D aspects, Mpumalanga remains far behind the rest of the country.

7.4.5 Science, technology and R&D intermediaries

In the light of the absence, or poor condition of education and training bodies, and the low investment in R&D in the Mpumalanga province, the lack in science, technology and R&D intermediaries does not surprise. Therefore, the flow of knowledge that could be enhanced via these intermediaries does not take place as needed (as was shown in Chapter Six). The innovation intermediaries in Mpumalanga are restricted to a few small business incubators. The other kinds of intermediaries like the research, science and technology parks and high quality industrial parks, which require the participation of academics and scientists, are not operational in the province. This may be because there are no universities in Mpumalanga. Universities usually play an important role in innovation intermediaries (again, as was indicated in Chapter Six).

The small business incubators in Mpumalanga include the following:

(i) The Mpumalanga Stainless Initiative (MSI) in Middelburg is an incubator funded by the Department of Trade and Industry and supported by industry. The incubator is aimed at assisting emerging entrepreneurs during the start-up of their businesses. These businesses are involved in beneficiation of Stainless Steel. Training in technical and business skills are provided as well as assistance in the marketing of the products (Department of Trade and Industry, 2010). According to the survey of industry in Mpumalanga by Jooste, Eggink & Sieberhagen (2004:26), industry has indicated that this incubator is only partly successful and that there are many entrepreneurs that stay for longer than two years due to the lack of an exit strategy. That implies that small businesses remain dependent on the support from the larger firms, or government, and do not move out of the incubator to function as a successful and independent firm.

(ii) The Highveldridge Business Development Centre (HBDC) in Secunda is an incubator aimed at the development of SMMEs and is sponsored by Sasol. The services by the HBDC includes accrediting and registering SMMEs, providing tender advice, rental of premises, facilitation in finances, expert advice and mentoring. These SMMEs are service providers mainly for Sasol (Jooste *et al.*, 2004:26).

(iii) The Coaltech 2020 project in the mining industry can also be seen as a form of an incubator, although it does not include the use of specific buildings, because it is not a manufacturing industry that needs factory space. Coaltech 2020 is a joint project of different coal mining companies. A survey was done of remnant and small coal deposits that could be exploited by small-scale coal miners and a document was published with relevant information on small-scale coal mining. Assistance is offered by experts in the field (Coaltech 2020, 2003).

(iv) In the sugar industry, TSB Sugar has a program with which they support Small Scale Growers (SSG). The support includes technical assistance, support with production activities, maintenance of irrigation infrastructure, training and development in production, financial management, business management and literacy training. The program is only partly successful due to the concerns of industry regarding quality and sustainability and to the small farmers concerns about their limited choice in what to produce and their limited influence on the price paid for their output (Jooste *et al.*, 2004:25).

(v) Furntech is an incubator in the wood products and furniture industries and is situated in White River. The Department of Economic Development and Planning, (2009:44), reports some successful cases of entrepreneurs exiting the incubator.

(vi) Other incubators or similar programs that the Department of Economic Development and Planning is in the process of developing include a food technology centre in Ehlanzeni; a wool processing centre in Gert Sibande; a jewellery manufacturing centre in Ehlanzeni; a bio-fuel production plant in Ehlanzeni; a Kruger-Mpumalanga

International Airport (KMIA) industrial park: and a Witbank/Middelburg industrial park (Department of Economic Development and Planning, 2009:44).

The incubators planned and facilitated by government are thoughts in the right direction, but the successful entrepreneurs exiting from the existing incubators are still in the single digits: just two businesses exited from the MSI and three from Furntech during the financial year 2008/09 as recorded by Department of Economic Development and Planning (2009:43-44).

7.4.6 Financial sources

An important determinant of innovation, as indicated in Chapter Five, is the access to finances. The financial sources include, *inter alia*, the private financial market, the government and many other sources:

Private financial market

The private financial market is highly developed in South Africa. Even though businesses are situated in Mpumalanga, this does not confine their access to finances to the province. Finances can be obtained nationally and even internationally. Despite the highly developed financial market, small or micro-enterprises experience problems in accessing finances in both Mpumalanga and South Africa. Finances, *per se,* are not restricting the innovative activities in the Mpumalanga province, but access of financing for small and micro-enterprises does have a restricting effect.

The small businesses in Mpumalanga indicated in an industrial survey (Jooste *et al.*, 2004:29-30) that one of the constraints that they experience is the lack of financial resources. The main problem that the small businesses highlighted was not the availability of funding, but the problem of accessing the funding. The reasons that the small businesses identified regarding the difficulty in accessing funds include: lack of collateral; lack of information about available finance providers; lack of suitable black economic empowerment (BEE) partners; and lack of competencies in compiling and presenting business plans.

Access to finances is a problem, not only for the province, but nationally. By studying access to finances from a national perspective, it was also found by Schwab (2011:323) that access to finances is on the list of the most problematic factors for doing business in South Africa. Rooks & Oerlemans (2005:1219) confirmed that South African firms relatively often experience a lack of financial capital and that 1 in 5 innovating firms did not start an innovation project due to a lack of capital. Porter & Schwab, 2008:450-475) found the access to financing a paradox to the financial market sophistication. The paradox may also be ascribed to the differences in what small and micro-businesses experience in contrast with that of large businesses that make use of the highly sophisticated financial market for funding. The Global Competitiveness Report 2011-2012 scored the financial market development very high at 5,5 on a scale of one to seven and that gave South Africa the 4th position among 142 countries. Raising money by issuing shares on the stock market is found to be very easy in South Africa and South Africa is ranked 4th of the 142 countries measured. Ease of access to loans in South Africa with only a good business plan and no collateral is found to be fairly easy and South Africa ranked 36th of the 142 countries. Even venture capital availability is fairly easy to find in South Africa, as shown by the 44th position that South Africa reached among142 countries. South Africa further ranked very high - in 15th position - regarding the soundness of banks. Similarly, South Africa is ranked 1st regarding the regulation of security exchanges. Overall, the financial market sophistication is amongst the best in the world.

In order to indicate how difficult it is for small and micro-enterprises to obtain finances, a survey of Statistics South Africa (2002) of small and micro enterprises in South Africa, provides evidence. Businesses that are not registered for value-added tax (VAT) were chosen as the population for the reason that these businesses are mainly small and are often informal. It was found that among the 2,3 million business owners, 1,4 million needed money to start their businesses and 0,9 million did not need money. Of the 1,4 million who needed money, only 16 000 obtained a grant. Of these 16 000 who obtained a grant, 5 000 obtained it from government, 3 000 from non-governmental organisations and 8 000 from other sources. A further 217 000 persons borrowed money to start their businesses and the majority obtained it from loans from friends or relatives (Table 7.40). This evidence confirms the restricted effect of access to finances that small and micro-enterprises experience, despite the highly sophisticated financial market in South Africa.

Financial assistance provided by government

The national Department of Trade and Industry, as well as the Mpumalanga government, have programmes in place to make access to funds easier for these enterprises. The Department of Trade and Industry participate in the province mainly through the Small Enterprise Development Agency (SEDA), Khula Enterprise Limited and the African Micro Finance Apex Fund (SAMAF). The Mpumalanga government, through the Mpumalanga Economic Growth Agency (MEGA), has different financial support programme products which are, according to MEGA (2010),

> "designed to promote economic empowerment through maximizing of access to finance for SMME's and Cooperatives, in a manner that leads to development of sustainable enterprises and the creation of sustainable jobs to reduce poverty".

Despite these national and provincial government programs, the evidence indicates that these programs are insufficient to provide the need for finances. Rooks & Oerlemans (2005) ascribed lack of finances to possible causes such as limited governmental funds, lack of trust in government or too many bureaucratic procedures.

7.4.7 Other innovation system components

Apart from the education and training bodies, science, technology and R&D intermediaries and lack of access to finances in small enterprises (which have each been indicated as major constraints for innovation in Mpumalanga), other innovation system components have also been evaluated. The following has been found:

7.4.7.1 Government

It is not possible within the scope of this study to evaluate the capacity and capability of the different government institutions and departments. Only a broad view of their roles as these roles affect the innovative performance in the province will be essayed.

The Mpumalanga provincial government consists of the following departments: Office of the Premier; Health; Education; Culture, Sport and Recreation; Social Development; Finance; Agriculture, Rural Development and Land Administration; Public Works, Roads and Transport; Safety, Security and Liaison; and Economic Development, Environment and Tourism. The municipalities form part of local government and are one level down from the provincial government, forming the lowest level of democratically elected government structures in the country. These municipalities manage local affairs, subject to national and provincial legislation (Adlam, 2010).

It was established in Chapter Six that government should play a supportive role to the other participants in the innovation system in order to improve the innovative performance of the innovation system. The role of government in education and training, R&D, and financial support has already been discussed. The government has a further role to play in promoting innovation. A strong positive point of South Africa is that government realises the importance of innovation and economic development and so prioritise their policies accordingly. South Africa was the first of the developing countries to have the National System of Innovation approach as a national policy. The Ministry of Science and Technology was created after the 1994 elections. In 2002, the National Research and Development Strategy came into being (Rooks & Oerlemans, 2005:1222-1223). As stated in South Africa's National Research and Development Strategy, (Department of Science and Technology, 2002:15), the strategy "rests on three pillars":

(i) innovation;

(iii) science, engineering and technology, human resources and transformation;

(iii) and creating an effective government science and technology system.

In 1996, the White Paper on Science & Technology was published and innovation plays an important part in the document. The vision and goals of an innovation policy are set out in the White Paper (Department of Science and Technology, 1996:3) as follows:

(i) The establishment of an efficient, well coordinated and integrated system of technological and social innovation within which –
   - Stakeholders can forge collaborative partnerships and interact creatively in order to benefit themselves and the nation at large;
   - Resources from engineering, the natural sciences, the health sciences, the environmental sciences and the human and social sciences are utilised for problem-solving in a multidisciplinary manner;
   - Stakeholders, especially those who were formerly marginalised, are part of a more inclusive and consultative approach to policy, decision-making and resource allocation for science and technology (S&T) activities.

(ii) The development of a culture within which the advancement of knowledge is valued as an important component of national development.

(iii) Improved support for all kinds of innovation which is fundamental to sustainable economic growth, employment creation, equity through redress and social development.

It is not clear how strongly this policy and strategy is carried through to the provinces. There is little, if any, clear evidence in the strategies of the departments of the Mpumalanga government that this national strategy is seen as a priority. It is also unclear if there is any co-operation among the different departments in striving towards an improved innovation system in the province.

7.4.7.2 Suppliers and competitors

The importance and role of suppliers and competitors in the innovation system was indicated in Chapter Six (paragraph 6.2.1.3 and 6.2.2) where it was shown that these participants play an important role in the innovation system due to their contribution towards technology and knowledge transfer to the innovating firms. Some of the competitors and suppliers form part of the innovative firms that were discussed in paragraph 7.3.1, but the Mpumalanga firms also compete with, and get supplies from, firms in other provinces in the country and/or from foreign countries. The manufacturing activities in Mpumalanga are clustered around the main concentrations of natural resources, but apart from the natural resources, firms often buy their other supplies from, largely, Gauteng. According to Jooste *et al.*, (2004:35), there was a strategy developed by industry together with the provincial government in 1996 that determined, *inter alia*, to "buy local". A follow-up survey of industry in Mpumalanga was done in 2004 to determine the progress in achieving the determined goals. The findings of the survey regarding the "buy local" campaign is as follows:

(i) Most large businesses buy their raw materials in Mpumalanga, but buy their other production requirements from outside the region. Since 1996, some small contractors have been given an opportunity by industry.

(ii) Industries do have it in their policies to buy from local businesses, but they use local contractors mostly for non-core business, and expert contractors from outside the province.

(iii) Businesses in close proximity to Gauteng find the Gauteng support services more accessible and sometimes more cost effective.

(iv) Local SMME contractors are not always efficient, effective, reliable, offer quality products or comply with international standards. Industry indicated that sub-contracting certain local SMMEs increase risk.

(v) The respondents from the agricultural sector, both large and small farmers, indicated that they “buy local”, unless the product or service is not locally available.

(vi) Industry indicated that the provincial government has not been contracting or buying from local businesses.

(vii) The “buy local” campaign was accepted in principle by businesses, but economics, quality and safety considerations play a more important role in determining their decisions (Jooste *et al.*, 2004:35-36).

Although there is a strategy in the province of encouraging the use of local suppliers, the benefits from transferring knowledge from outside the province or country should not be discouraged. The strategy was put in place in order to encourage the development of Mpumalanga firms. However, it must be asked if such a strategy encourages innovation (by means of the forming of new firms) or harms innovation through the lack of technology and knowledge transfer from outside the province.

Linkages among competitors are not restricted to competitors within the province. The more technically advanced products, and even the raw material produced in the province, compete mostly with firms from outside the province. Many agricultural products are not sold in the province. Most of the fruit and vegetable production (that is not exported) is sold at the national market in Gauteng - ironically, even those products that are consumed in Mpumalanga. The producers, therefore, compete on the national market. There are also agricultural products that are exported and these must compete directly on the international market. The same process is followed by the mining products that are sold at prices determined internationally. Innovation is important for firms especially if they are to be nationally and internationally competitive. Knowledge transfer from the customers, nationally and internationally, is important if these local firms are to remain competitive.

7.4.7.3 Customers

In Chapter Six, paragraph 6.2.1.5, it was indicated that a larger local market can make innovation easier, but in the absence of a local market, firms can innovate for the export market. It was also shown that customers are important in the transfer of knowledge to firms. The local customers in the Mpumalanga province do not have the buying power to create sufficient demand for growth in industry. It is shown in Table 7.41 that the percentage disposable income in the province compares with the lowest four provinces of the country. The larger firms focus mostly on markets outside the province. Electricity production, mining production, the steel industry and the petro-chemical industry are all examples of products produced in Mpumalanga of which the larger portion is consumed outside the region. According to the Department of Agriculture, Rural Development and Land Administration (2005), approximately 70% of the electricity generated in South Africa is generated in Mpumalanga. Yet, the electricity consumption in Mpumalanga is only approximately 13% of the total electricity consumed (calculated from Statistics South Africa, 2004d:104). Mining and quarrying contribute to approximately 19% of Mpumalanga's GDPR (calculated from Table 7.12) and coal contributes to approximately 70% of income generated by the mining industry in the province (calculated from Statistics South Africa, 1996:82). Of the total amount of coal produced in the country, 31% is exported, 41% used for electricity production, 19% used for synfuels, and 9% for other local uses (DBSA, 2006:45). Therefore, a large portion of the coal produced in the province is either used for electricity production (where the electricity produced is mainly used outside the region) or exported. Production for markets outside the region or country does not restrict innovative activities, but if the market within the region is large, then the market can serve as an incentive to become more innovative. In this regard, the limited market in the province has a restrictive effect on innovation in the province. On the other hand, the production for customers outside the province further encourages innovation, due to the variety in demand and the expansion of buying power of customers. As most of the technologically advanced products that are currently produced (petro-chemical products, steel products, electricity, etc.) are for consumption outside the province, it indicates the importance of the linkages with customers outside the province.

7.4.7.4 International participants

In Chapter Five, paragraph 5.2.4, and in Chapter Six, paragraph 6.2.1.9, it was indicated that global engagement has a positive relationship with innovation and that different international participants form part of an innovation system. The demand and buying power in the Mpumalanga province has been indicated, in paragraph 7.4.6.3, as insufficient for industry to produce only for the local market. For businesses to grow, they will also have to target markets outside the province (Department of Economic Development and Planning, 2008). These markets may be in other provinces, but may also be in other countries. Somewhat to the contrary, South Africa in general seems to have a competitive edge concerning both the domestic market size and foreign market size. The Global Competitiveness Report 2011-2012 (Schwab, 2011:323) shows that South Africa is in 24th position in comparison with the 142 other countries regarding the domestic market size. The domestic market size index is measured as follows: the sum of GDP plus the value of imports of goods and services, minus the value of exports of goods and services. The foreign market size index is measured as the value of exports of goods and services and South Africa reaches position 38 in comparison with the 142 other countries measured.

The international trade trends of Mpumalanga since 1996 are shown in Table 7.42. The table shows that Mpumalanga's exports of goods form a small portion of less than 6% of the province's GDP from 2003 to 2007. The trade percentage (exports of goods and services) forms between 6% and 8% of the province's GDP over the same period. Table 7.42 also shows that exports from Mpumalanga contributes to less than 2% of the country's exports and Mpumalanga's imports are not more than 0,6% of the country's imports (Department of Economic Development and Planning, 2008). These percentages are very low in comparison with the country for which the exports as a percentage of GDP during the same period ranges between 20% and 22% approximately, and trade as a percentage of GDP is in the region of 28% to 30% approximately, as shown in Table 7.43 (SARB, 2010:S-146). South Africa largely competes in the international market by producing low-cost or local natural resources, rather than unique products and processes (Porter & Schwab, 2008:479). Mpumalanga shows the same trend in exports by producing and exporting mainly mining and agricultural products.

If it is recalled that Mpumalanga does not have its own port or an airport that can handle freight, it has not been a favourable area for producing products for export. The international airport has no cargo storage, cold storage or pack-house facilities available, the lack of which hampers the potential exports of high-value, low-mass products, such as the fruit and flower industry (Jooste *et al.*, 2004:33). Mpumalanga has no coastline, and therefore no port. The South African ports that the industries in Mpumalanga make use of are Durban, mainly for container and general freight, and Richards Bay for bulk products such as coal. The Durban port is close to capacity limits for many products and the Richards Bay port has a draught limitation that restricts access to larger deeper-draught vessels (DBSA, 2006:105). The re-opening of the Maputo port, as part of the Maputo Development Corridor, expands Mpumalanga's potential for exports through ports and improves the potential for innovation. The infrastructure development, for example, the re-opening of the Maputo port, the development of the Maputo Corridor and the potential of the new international airport (KMIA), may lead to Mpumalanga becoming more conducive to innovation for export businesses.

There are certain conditions that can have a harmful effect on international trade for both Mpumalanga and the country as a whole. The effect of rules and regulations on foreign trade is found as a competitive disadvantage for South Africa. The Global Competitiveness Report 2011-2012 (Schwab, 2011:322-323), as indicated in Table 7.22, showed that South Africa ranked 51st of the 142 countries regarding the prevalence of trade barriers, that is, when measuring if tariff and non-tariff barriers significantly reduce the ability of imported goods to compete in the domestic market. South Africa ranked 72nd in the percentage import duty, implying that the average rate of duty is fairly high in comparison with other countries, especially South Africa's main trading partners. South Africa is ranked 62nd concerning the burden of customs procedures regarding imports and exports. However, it seems that the South African government has realised the restricting effect that trade barriers have on trade, because according to the Department of Trade and Industry (Department of Trade and Industry, 2009:27):

> "South Africa's global economic strategy focuses on improving the country's export performance by dismantling barriers to trade, and gaining increased market access".

The progress that has been made since 1994 include the simplification of the tariff structure and the signing of a number of trade agreements.

The Mpumalanga government also has a role to play in trade promotion of the province (apart from the national Department of Trade and Industry's programs to increase international trade). The programs that the Mpumalanga government are currently involved in, include awareness campaigns, trade exhibitions, training programs and the like (Department of Economic Development and Planning, 2009:41).

The exporting firms in Mpumalanga are mostly large firms like the mining companies, the large steel companies, Sasol, Sappi, TSB and commercial farms. Many of the larger firms are also multinational companies that make access to foreign markets easier. The smaller firms often have difficulty in competing in the foreign market due to cost constraints and meeting required quality standards. In the export strategy of the Mpumalanga government (Department of Economic Affairs, Gaming and Tourism, S.a.:6) some of these constraints are mentioned, for example, fear of big export volumes, lack of financial resources, issues related to market access, meeting world standards and safety and health regulations, technology development, etc.

If innovation is to be enhanced in the province, it may be easier to import knowledge and technology by means of MNEs rather than by doing the groundwork for new technology, at least until the province is suitably developed to be conducive for high technology innovative activities. The linkages between domestic firms and foreign firms regarding technology transfer, from a South African perspective as a whole, seem to be quite strong. Rooks and Oerlemans (2005:1217) found that South African firms have relatively many technology alliances in comparison with the European Union (EU) and that these partnerships are mainly formed with foreign firms. They found that South African firms have even more EU partners than European firms themselves do. The Global Competitiveness Report 2011-2012 (Schwab, 2011:323) shows that South Africa has a competitive advantage in the transfer of knowledge from the foreign sector. It was found that South Africa ranks 41st on the list of 142 countries regarding technology transfer by means of FDI.

Overall, Mpumalanga does not compare well with the whole of South Africa concerning international trade. The infrastructure constraints, as well as rules and regulations regarding trade and FDI seem to be the factors that mostly restrict trade and cause negative effects on globalisation. Even though the South African government has made some progress in the simplification of trade barriers and the forming of trade relations with other countries, improvement in infrastructure and trade negotiations are still needed, as well as aggressive marketing of the province, in order to enhance the potential for international trade by the province. Innovative activities are hampered if the international market is not accessible to local firms.

7.5 Summary

The aim of this chapter was to determine if the Mpumalanga province functions as a regional innovation system and if the environment is conducive for innovative activities to take place. The model for an innovation system that was developed in the previous chapter was used as a basis for the evaluation. The Mpumalanga province was analysed according to the innovation system macro-economic environment, the innovation system participants or actors and the interactions or linkages among the participants.

The Mpumalanga province was found to be well-endowed with natural resources such as arable land, a variety of vegetation and climatic conditions conducive for different agricultural activities and forestry, as well as mineral deposits of a variety of minerals. It was further found that there are small concentrations of highly developed industrial areas (mostly situated on the Highveld near other industrial developments in Gauteng), but that the larger part of the province is under-developed and the majority of the people live in poverty. The portion of GDP contributed by the firms in the province compares well with the rest of the country, but the income is generated mostly by a few large firms. Despite the potential provided by the natural resources and a few highly developed areas, it is not sufficient to alleviate the unemployment and poverty in the province. There remains a great and urgent need for innovation and development in the province.

The regional innovation system of Mpumalanga has been illustrated in Figure 7.2, indicating the strengths and weaknesses in the system. Considering the strengths and the weaknesses, it was found that the Mpumalanga province, despite its political, administrative and legal boundaries and power, does not function as a regional innovation system. The economic environment was found not to be conducive for innovative activities to take place. The three components that were found to be severely restricting are the quality of human development, the level and capacity of research and development, and access to finances.

The weakness that probably has the most severe effect on the innovative capacity of Mpumalanga is the human development component. The knowledge flows were found to have weaknesses largely due to the absence or ineffectiveness of the relevant participants, such as the absence of universities and the poor quality of education. Education and training is one of the participants that lacks greatly in providing a service conducive for innovation to be enhanced in the province. Although the interaction among all participants in an innovation system determines the innovative performance of the system, human resources are the crux of innovation. The entrepreneur, who is responsible for innovation, forms part of human resources. The evaluation indicates a lack of sufficient education and training bodies, poor performance of many education and training bodies that are in place and a lack of, or poor performance of, government in providing services to ensure a healthy population and workforce in the Mpumalanga province. The result of the poor performing primary and secondary education bodies in Mpumalanga manifests into a shortage of students qualifying for, or not well-enough prepared for, tertiary education. The absence of a university, or universities, in the province further affects the development of the human resource component. The quality of education is a point of concern in the province, especially the mathematics and science education, which is essential if innovation has to be increased. The absence of universities also affects the R&D that is essential for innovative activities. It further has a negative effect on the establishment of science and technology parks and other intermediaries in the innovation system, which was found to be a most noticeable lack in the province.

The finance flow shows some weaknesses, mainly due to limited access to finances for small and medium enterprises, despite the well-developed financial market in the country. There are a few strong factors in the macro-economic environment of Mpumalanga such as the well-developed financial system, national government policies that focus on innovation and international trade negotiations by government. Unfortunately, these factors by themselves are not sufficient to ensure innovative activities.

The Mpumalanga firms form stronger knowledge linkages with markets, competitors and suppliers in other provinces or even other countries than they do with local participants, due to insufficient quantity or quality of these participants in the province. The provincial market has been found to be too small to be conducive to innovation, therefore the customers are not only local but often have to be found in other provinces or countries. Suppliers have also been found to be a weak point of the province and, here again, suppliers from other provinces are often used. It was further found that local firms often have to compete nationally or internationally where quality and price makes competition in those markets problematical. Yet, the linkages with markets, suppliers and competitors outside the region contributes towards knowledge flow into the region and should be seen as having a positive effect on the innovative abilities of the local firms. MNEs have the advantage of technology and knowledge transfer that is needed in the province, as the current capacity in the province is insufficient to improve the innovative activities on a large scale in a short period (due to the state of education and training that will take time to change).

If Mpumalanga is to function as an innovation system, serious, concerted and prolonged effort is needed to create an environment conducive for innovation. If the human resource component, as the essential determinant of innovation, is not improved on all different levels mentioned (primary, secondary and tertiary education, as well as health), then Mpumalanga will be among the provinces classified by Scerri (2008) as being “dependent on national government”. This implies that development will not take place in the province and its people will remain poor and unemployed, as it is innovation that leads to development.

CHAPTER EIGHT

CONCLUSION

8.1 Introduction

In this study, the aim was to determine the role that innovation plays in economic development and how an economic environment can be created that is conducive to innovation. The extreme poverty situation in the larger part of the world, including regions of South Africa, was discussed to emphasise the need for development. This urgent need for development indicated the importance of increased innovative activities, as innovation was found to be the engine of growth and development.

The role of innovation in economic development has been analysed, the historical significance of innovation has been indicated and the complex relationship between innovation and economic development has been emphasised. The important determinants of innovation have been identified, to once more emphasise the very significant role that innovation plays in economic development.

A conceptual, descriptive model of an innovation system was then developed, indicating the different participants, their roles, the interaction among them, and the economic environment within which the participants function. This model was developed with the view of indicating those elements necessary to create an innovation system that is conducive to the improvement of innovative performance. The model was applied to the Mpumalanga province's innovation system, which was identified as a case study, due to the province's poor state of employment, wealth and development. The evaluation of the Mpumalanga innovation system against the model served to identify strengths and weaknesses in Mpumalanga to determine whether or not the province has the necessary elements to function as an innovation system. Conclusions were drawn on ways that the Mpumalanga innovation system could be improved, which in turn should lead to an improvement in economic development for the province.

8.2 Findings

In order to address the need for development in a country or region, innovation should be enhanced through the improvement of the innovation system in that country or region. Innovation, which was defined as the successful implementation of a new or improved product (good or service), a process, a new marketing method, or a new organisational method, takes place within an innovation system and should be studied from a system perspective. The system perspective takes cognisance of the fact that there are different participants and that these participants function individually, but also interact (wittingly or unwittingly) with one another. The innovation system was defined as a system that includes the participants or actors, their activities and interactions, as well as the socio-economic environment within which these actors or participants function, that together determine the innovative performance of the system.

Innovation is an essential component of the Schumpeterian theory due to the disturbing effect that innovation has on equilibrium, but it should be studied from a system perspective, as contended by the neo-Schumpeterian view, due to the complexity of the innovation process. The classical and neoclassical theories idealised perfectly competitive markets and equilibrium in markets and do not adequately explain the entrepreneur and his innovative activities. Schumpeter's theory of development criticised the neoclassical view by contending that the entrepreneur and his innovative activities actually disturb the equilibrium situation in the markets and that it is this disturbance that leads to development. It therefore follows that a static equilibrium market cannot bring forth development. The neo-Schumpeterian school of thought is based on Schumpeter's theory, but studies innovation from a system perspective and not solely from an individual firm's perspective, as Schumpeter had. Innovation here, therefore, is studied both from a Schumpeterian perspective and from a neo-Schumpeterian perspective to gain a fuller, more accurate perspective.

Innovation is important if economic development is to take place. The relationship between innovation and economic development was indicated by the patterns of historical events of major innovations and *per capita* GDP growth and population growth. Since the 1800s, the GDP *per capita* growth, as well as population growth, suddenly started increasing exponentially. These increases are linked to major innovations. Empirical evidence from different studies indicated that the studies that are based on the later neoclassical models or the new growth models show a positive relationship between innovation and economic growth, but make use of simple systems of equilibrium models. In some neo-Schumpeterian studies, innovation has been reduced to an index of different determinants and evidence has been given of empirical studies that indicated a positive relationship between innovation and economic development. There are neo-Schumpeterian economists who reason that innovation cannot be reduced to a single number and that there are quantitative, as well as qualitative, differences in innovation systems.

The determinants of innovation that have been identified include those that are internal to the firm (or other organisation), and those that are external to the firm, also known as environmental determinants.

The internal determinants include:

- technological capabilities (R&D intensity, absorptive capacity of technology and a qualified labour force);
- characteristics of the firm (the size of the firm and the willingness to accept and create change);
- availability of internal funds; and

- global engagement.

The external or environmental determinants include:

- R&D (by organisations other than the firm);
- human development;
- external financial support;
- market size; and
- protection of intellectual property rights.

Human resources are the crux, the *sine qua non*, of innovation, even though the interaction among all participants in an innovation system determines the innovative performance of the system. The entrepreneur, the agent who carries out innovation, forms part of human resources. Other determinants of innovation such as R&D, absorptive capacity, a qualified labour force and culture and management of the firm, are all based on the level of human development. Whereas the other determinants contribute to innovation, innovation can take place in their absence. This is not the case for human development. For example, some innovation takes place without preceding R&D; some innovations do not require high financial expenses; in the absence of a large enough market, export markets can be created; in the absence of international trade, local markets can be explored.

The descriptive, conceptual innovation system model that was developed, revealed the participants that play a role in the innovation system. The innovative firms are the centre of the innovation system due to the importance of their contribution to innovative activities. These firms include large, medium and small enterprises. Innovative firms operate within a complex network of other participants or actors. Other participants include suppliers, competitors, financial organisations, venture capitalists, consumers, education and training bodies, government, science, technology and R&D intermediaries, and international participants. The different roles of these participants in the innovation system have been established.

Education and training bodies were found to be the most important participants that support firms in the innovation system, thanks to their contribution to the development of entrepreneurs and sufficiently qualified human resources, as well as because of their contribution to R&D capacity - two of the most important determinants of innovation. The science, technology and R&D intermediaries further contribute to the R&D function and can play a strong role in the transfer of knowledge and technology and the interaction and linkages among participants. It was found that government should best play a supportive role, but that where it was necessary for government to function as entrepreneur, innovative behaviour becomes more important for government too. Financial institutions and venture capitalists were also found to be important participants with the innovative firms, due to the role that finances play in innovative activities. It was further demonstrated that international participants, although not inside the national boundaries of a national innovation system, nevertheless influence the innovation system due to globalisation. MNEs are very important international participants when considering transfer of knowledge and FDI. Suppliers, competitors and consumers all participate in an innovation system, and so play a role in transfer of knowledge and technology. However, their roles are more indirect than are those of R&D and education and training institutions.

The strength of the linkages among participants has a positive effect on the innovative performance of the system and is important for the transfer of finances, knowledge and technology. The different kinds of linkages depend on whether the linkages are formed formally or informally, intentionally or incidentally and depend on which participants are involved (similar kinds of organisations or different kinds, domestic participants or international participants). The transfer of knowledge from universities to firms and from MNEs to their national branches is perhaps the best-known knowledge transfer process identified, but that does not imply that the knowledge transfer from, for example, suppliers to firms, or consumers to firms are unimportant.

The evaluation of the Mpumalanga province produced evidence that, although the political and administrative boundaries would suggest the province functions as a system, the Mpumalanga province certainly does not function as an innovation system. In the light of the great development need in the province, and the proof of the important role that innovation play in development, it should be considered vital that the innovative performance in the province be enhanced. The province is blessed with resources such as fertile land, climatic conditions, minerals and scenic beauty, but the elements needed to turn these advantages into successful innovative ventures are not always present. Innovation in the Mpumalanga province and the possibility that the province will function as an innovation system in the future will be enhanced if the following takes place:

(i) Improvement of the quality of education and training in the province. Government plays a leading role in the development of human resources. Provincial government should improve the quality of education at primary and secondary level and national government should ensure the development of quality tertiary education in the province. Improved management in the provincial departments is one of the most essential prerequisites for quality in education and training, as education and training is a government responsibility.

The evaluation indicated a dearth of education and training bodies, poor performance of some existing education and training bodies and a lack of, or poor performance of, government in providing the services necessary to ensure a healthy population and workforce in the Mpumalanga province. The result of the poorly performing primary and secondary education bodies in Mpumalanga spills over into a shortage of students qualifying for, or not well enough prepared for, tertiary education. The absence of a university, or universities, in the province further adversely affects the development of the human resource component.

(ii) Improvement of the mathematics and science performance in schools. More and better-qualified teachers in these subjects should be trained or recruited by the department of education. The quality of education is a point of great concern in the province, especially concerning mathematics and science education, which is vital if innovation is to be increased.

(iii) Provision by government of sufficient infrastructure for education. The number of schools or classrooms must increase. The condition of many of the existing schools should be rectified and upgraded. Schools should each have electricity, water, sanitation, sufficient classrooms and other facilities such as libraries, electronic research centres, recreation halls and other school necessities. Schools must have sufficient computer and internet facilities. The development of human resources for an innovative society needs exposure to these forms of technology.

(iv) The development or improvement by provincial government of programs for the prevention and cure of diseases such as tuberculosis and HIV/Aids. Programs for primary health care and health education should also be increased in order to decrease the high infant mortality rate. Nutrition programs at schools, but also for the public that suffer from severe poverty should be put in place or improved where functioning inadequately.

(v) Establishment of an independent university in the province. Some of the most important participants in an innovation system are universities, thanks to the role they play in the development of entrepreneurs and human resources, their contribution to R&D, and their role in intermediaries such as science parks, technology parks and incubators.

(vi) The involvement of universities situated in other provinces to play an interim role in Mpumalanga through the development of human resources, R&D activities, and the establishment of science and technology parks and incubators. This is to mitigate the delay before an independent university can be established in Mpumalanga and developed to a stage that it can operate on a R&D level and can support these necessary activities.

(vii) Facilitation of the access to funding of small and micro-enterprises by the Mpumalanga government, as well as improvement in the marketing of the funding opportunities to make these enterprises aware of funding opportunities. These enterprises cannot easily access funding from the private sector, due in part to the lack of collateral. Therefore government should take responsibility in this regard in order to spread development to all segments of the economy. The finance flow shows some weaknesses mainly due to difficulties for small and medium enterprises in accessing finances, despite the well-developed financial market in the country.

(viii) Expansion and promotion of government venture capital programs. Access to these programs should be made easier and simpler for SMMEs.

(ix) Improvement in the marketing of the province in order to attract more MNEs, to foster the advantages that linkages between the local branch and its foreign counterpart bring to the province. Knowledge transfer and FDI from MNEs are flows that can more easily enhance innovation in the province than the creation of new knowledge can. The Mpumalanga firms have formed stronger knowledge linkages with markets, competitors and suppliers in other provinces, or even other countries, than with local participants, due to the lack of quantity or quality of these participants in the province. The provincial market has been found to be too small to be conducive to innovation, as the consumers are not only local, but are to be found in other provinces or countries too. Suppliers have also been found to be a weak point for the province and suppliers from other provinces are often used. It was further found that local firms often have to compete nationally or internationally, and in this case, quality and price makes competition with those markets particularly difficult. Currently, the capacity needed in the province to improve the innovative activities on a large scale in a short period is insufficient (due to the state of education and training that will take time to change).

Serious and concerted effort is needed to create an environment conducive to innovation if Mpumalanga is to function as an innovation system. If the human resource component, as the essential determinant of innovation, is not improved on all different levels mentioned (primary, secondary and tertiary education, as well as health services), then Mpumalanga will be among those provinces classified by Scerri (2008:4) as “being dependent on national government”. The implication is that development will not take place in the province and that the majority of the population will remain poor and unemployed, as it is innovation that ultimately leads to development.

8.3 Limitations of the study

The Mpumalanga province was chosen as a case study to be analysed with respect to the functioning of the province as an innovation system or the potential to function as such. The question can be asked whether provinces should be evaluated as innovation systems. In this study the provincial boundaries was chosen as innovation system boundaries because budget allocations and government decision-making are done at the provincial level. The budget allocation, decision-making and execution of decisions greatly influence the economic environment of the innovation system.

Statistical data at the provincial level is limited in South Africa. Data is more easily available for South Africa as a whole. Primary data collection on provincial level can positively contribute to the analysis of provinces as innovation systems.

8.4 Recommendations for further research

Further research that can contribute to improved innovation performance and economic development in South Africa include similar studies for the other provinces in South Africa, as well as the comparison of the Mpumalanga province with the regional innovation systems of the other provinces or with the national innovation system of South Africa.

It may also be of value if innovation systems of provinces in developing countries could be compared to innovation systems of provinces in developed countries. Although these systems may differ widely, and considering that there is no ideal system, a comparison may still reveal some elements that can eventually lead to economic development if implemented.

TABLES

Note: No editing was done on tables that were directly taken from the original source

Table 2.1

Major innovations during 19th and 20th centuries

	Invention	Innovation	Innovator
crucible steel	1740	1811	Krupp (Germany)
street lighting (gas)	1801	1814	National Light & Heat Co.(GB)
mechanical printing press	1811	1814	*The Times* (GB)
sulphuric acid (lead chamber process)	1740	1819	Ringkuhl (Germany)
quinine	1790	1820	Pelletier-Ceventan (Fr)
portland cement	1756	1824	Great Britain
coke blast furnace	1713	1829	Neilson (GB)
steam locomotive	1769	1830	Liverpool & Manchester Railway (GB)
puddling furnace	1784	1832	Hall (GB)
electric motor	1821	1837	Davenport (USA)
steamship ((Atlantic crossing)	1783	1838	Sirius (GB)
photography	1727	1839	Giroux (France)
electric telegraph	1793	1839	Paddington-Hanwell (GB)
vulcanized rubber	1839	1840	Goodyear (USA)
arc lamp	1810	1841	Paris, France
rotary press	1790	1846	Hoe Rotary (USA)
anaesthetics	1799	1846	Massachusetts Gen. Hosp. (USA)
steel (puddling process)	1840	1849	Lohage & Bremme (Germany)
sewing machine	1790	1851	Singer (USA)
safety match	1805	1855	Lundström (Sweden)
Bunsen burner	1780	1855	Bunsen (Germany)
Bessemer steel	1855	1856	Various countries
Elevator	1818	1857	Otis Elevator (USA)
lead battery	1780	1859	Planté (France)
drilling for oil	1859	1959	Pennsylvania Rock Oil Co. (USA)
internal combustion engine	1853	1860	Société des Monteurs Lenoir (Fr)
sodium carbonate	1791	1861	Solvay (Belgium)
Siemens-Martin steel	1857	1864	Various countries
aniline dyes	1771	1865	BASF (Germany)
atlantic telegraph cable	1851	1866	Atlantic Telegraph Co. (USA)
Dynamo	1820	1867	Siemens (Germany)
dynamite	1844	1867	Nobel (Sweden)
typewriter	1714	1870	Jürgens (Denmark)
Celluloid	1865	1870	Hyatt (USA)
combine harvester	1826	1870	McCormick (USA)
margarine	1869	1871	Jurgens (Netherlands)
reinforced concrete	1867	1872	Ward (USA)
sulphuric acid	1819	1875	Winkler (Germany)
four-stroke engine	1862	1876	Gasmotorenfabriek Deutz (Germ.)
telephone	1860	1877	Bell Telephone (USA)
Thomas oven	1877	1879	Various countries
electric railway	1834	1879	Siemens-Halske (Germany)
water turbine	1824	1880	Pelton (GB)
incandescent lamp	1854	1880	Edison Lamp Works (USA)
half-tone process	1865	1880	*The Daily Graphic* (USA)
electric power station	1867	1881	Siemens Brothers (Germany)
punched card	1823	1884	Hollerith (USA)
cash register	1879	1884	NCR (USA)
fountain pen	1656	1884	Waterman (USA)
steam turbine	1848	1884	Clarke, Chapman & Co. (GB)

Table 2.1 (Continues)

Major innovations during 19th and 20th centuries

	Invention	Innovation	Innovator
transformer	1831	1885	Stanley (GB)
Bicycle	1839	1885	Starley (GB)
Linotype	1884	1886	*New York Tribune* (USA)
aluminium	1827	1887	Various countries
motor car	1883	1888	Benz (Germany)
cylindrical record player	1877	1888	Columbia, Edison (USA)
portable camera	1881	1888	Eastman Kodak (USA)
alternating-current generator	1856	1888	Tesla Electric Co. (USA)
mechanical record player	1887	1889	Kämmerer & Rheinhardt (Germ.)
pneumatic tyre	1845	1889	Dunlop Pneumatic Tyre Co. (GB)
rayon (nitro-cellulose pr.)	1857	1892	De Chardonnet (France)
motion picture film	1888	1894	Kinetoscope (USA)
motor cycle	1885	1894	Hildebrand& Wolfmüller (Germ.)
monotype	1887	1894	Sellers & Co. (USA)
diesel engine	1892	1895	Akroyd-Hornsby (USA)
electric automobile	1874	1895	Acme & Immisch (GB)
X-rays	1895	1896	Various countries
rayon (cuprammonium pr.)	1890	1898	France
Aspirin	1853	1899	Bayer (Germany)
submarine	1624	1900	US Navy
safety razor	1895	1903	Gillette Safety Razor Co. (USA)
oxy-acetylene welding	1893	1903	Fouch & Picard (France)
viscose rayon	1892	1905	Courtauld & Co. (GB)
vacuum cleaner	1901	1905	Chapman & Skinner (USA)
chemical accelerator for rubber vulcanization	1906	1906	Diamond Rubber Co. (USA)
electric washing machine	1884	1907	Hurley Machine Corp. (USA)
Airplane	1903	1910	military airplanes, France
Bakelite	1905	1910	Bakelite Corp. (USA)
gyro-compass	1852	1911	British, German, US navies
vacuum tube	1904	1913	AT&T (USA)
assembly line	1913	1913	Ford Motor Co. (USA)
thermal cracking	1909	1913	Standard Oil of Indiana (USA)
domestic refrigerator	1834	1913	Domelre (USA)
synthetic fertilizer (nitrogen)	1908	1913	BASF (Germany)
stainless steel	1911	1914	Th.Firth & Sons (GB)
cellophane	1912	1917	La Cellophane (France)
zip fastener	1891	1918	US Navy
acetate rayon	1902	1920	British Celanese (GB)
continuous thermal cracking	1909	1920	Texas Co. (USA)
AM radio	1900	1920	Westinghouse Co. (USA)
Insulin	1921	1923	Connaught Labs, Toronto (Can.)
continuous hot strip rolling	1892	1923	Armco (USA)
dynamic loudspeaker	1906	1924	United States
Leica camera	1913	1924	Leitz (Germany)
electric record player	1908	1925	Brunswick Co. (USA)
polystyrene	1925	1930	I.G. Farben (Germany)
rapid freezing	1929	1930	Birdseye (USA)
synthetic detergents	1886	1930	I.G. Farben (Germany)
freon refrigerants	1930	1931	Kinetic Chemicals (USA)
gas turbine	1900	1932	Brown-Boveri (Switzerland)
polyvinylchloride	1931	1932	I.G. Farben (Germany)
antimalaria drugs	1932	1932	Eli Lily Co. (USA)
sulfa drugs	1917	1932	I.G. Farben (Germany)
synthetic rubber	1882	1932	DuPont (USA)
crease-resisting fabrics	1926	1932	Tootal Broadhurst Lee (GB)
plexiglas	1912	1935	Röhm & Haas (USA)
magnetic tape recorder	1899	1935	Magnetophon (AEG) (Germany)
colour photography	1912	1935	Eastman Kodak (USA)
Radar	1887	1935	Various countries
FM radio	1902	1936	Telefunken (Germany)

Table 2.1 (Continues)

Major innovations during 19th and 20th centuries

	Invention	Innovation	Innovator
television	1907	1936	Electrical & Musical Ind. (GB)
catalytic cracking	1927	1937	Sun Oil, Socony-Mobil (USA)
electron microscope	1931	1937	Siemens-Halske (Germany) Metropolitan-Vickers (GB)
Nylon	1934	1938	DuPont (USA), I.G. Farben (Germany)
fluorescent lamp	1896	1938	Westinghouse, Gen. Electric, Sylvania Electric (USA)
helicopter	1907	1938	Focke-Wulf (Germany)
polyethylene	1936	1939	ICI (GB)
jet airplane	1930	1942	Messerschmitt (Germany)
penicillin	1929	1942	Kemball, Bishop & Co. (GB)
continuous catalytic cracking	1942	1942	Standard Oil of New Jersey (USA)
DDT	1874	1942	Allied forces
guided missile	1903	1942	V2 (Germany)
silicones	1904	1943	Dow-Corning (USA)
aerosol spray	1862	1934	United States
high-energy accelerators	1929	1943	General Electric (USA)
ball-point pen	1938	1945	Eterpen Co. (Argentina)
streptomycin	1924	1946	Merck & Co. (USA)
phototype	1936	1946	American Intertype Corp. (USA)
orlon	1945	1948	DuPont (USA)
cortisone	1931	1948	Merck & Co. (USA)
long-playing record	1948	1948	CBS (USA)
automatic transmission (passenger cars)	1904	1948	Buick (USA)
Polaroid land camera	1937	1948	Polaroid (USA)
xerography	1937	1950	Haloid Corp.(USA)
terylene	1941	1950	ICI (GB)
radial tyre	1949	1950	Michelin (France)
sulzer loom	1928	1950	Warner & Swasey (USA)
transistor	1947	1951	Bell Telephone Labs (USA)
electronic computer	1944	1951	Remington Rand (USA)
power steering (passenger cars)	1926	1951	Chrysler (USA)
continuous casting of steel	1927	1952	Mannesmann (Germany)
oxygen steel making	1939	1953	Vöest (Austria)
colour television	1925	1953	RCA (USA)
gas chromatograph	1905	1954	Perkin-Elmer Corp. (USA)
remote control	1898	1954	Argonne National Lab. (USA)
silicon transistor	1947	1954	Texas Instruments (USA)
numerically controlled machine tools	1927	1955	United States
nuclear energy	1942	1956	Calder Hall, Great Britain
fuel cell	1885	1958	Union Carbide (USA)
polyacetates	1924	1959	DuPont (USA)
float glass	1952	1959	Pilkington bros. (GB)
polycarbonates	1935	1960	Bayer (Germany), General Electric (USA)
contraceptive pill	1954	1960	Searle Drug (USA)
hovercraft	1928	1960	Saunders-Roe (GB)
integrated circuit	1959	1961	Fairchild, Texas Instruments (USA)
communication satellite	1957	1962	USA, USSR
laser	1954	1967	Hughes Aircraft (USA)
Wankel-motor	1954	1967	NSU (Germany)
video cassette recorder	1956	1970	Philips (Netherlands)
micro-processor	1959	1971	Intel (USA)

Taken from: Van Duijn, 1983:176-179

Table 2.2

The provinces of South Africa, comparative statistics

	WC	MP	LP	GP	NW	KZN	FS	NC	EC	SA
Area (sq km) as %	10,6	**6,5**	10,2	1,4	9,5	7,6	10,6	29,7	13,9	**100,0**
Population size ('000) 2010 (GHS 2010)	5 468	**3 639**	5 250	10 754	3 479	10 551	2 919	1 154	6 656	**49 869**
% of total South African population	11,0	**7,3**	10,5	21,6	7,0	21,2	5,9	2,3	13,3	**100,0**
Number of households ('000) 2010 (GHS 2010)	1 532	**1 015**	1 394	3 684	982	2 712	885	320	1 781	**14 304**
Density (persons/sq km), 2001	35	**39**	43	520	32	102	21	2	38	**37**
Age dependency ratio, 2001 (per 100 people of working age)	48	**65**	82	38	57	65	55	56	76	**59**
% GDPR contribution, 2004	14,4	**6,8**	6,7	33,3	6,3	16,7	5,5	2,2	8,1	**100,0**
Average annual economic growth rate,1996-2004	3,4	**3,0**	3,5	3,3	2,2	3,1	2,0	2,2	2,5	**3,1**
Urbanised, 1999 (%)	88,9	**40,2**	11,6	96,4	36,6	46,3	70,5	68,7	33,2	**54,0**
% of employed earning less than R1 000 pm, 1999	31,0	**49,0**	48,6	25,1	42,2	42,9	51,3	58,4	55,2	**39,4**
% of employed earning more than R4 500 pm, 1999	16,0	**11,8**	10,2	19,5	9,2	10,9	10,1	10,1	9,2	**13,6**
Real GGP per capita (PPP$) 1999	3 925	**2 819**	619	6 213	2 198	1 819	3 349	2 837	1 146	**2 782**
% of households with household income less than R1 000 pm, 1999	16,8	**41,7**	54,8	27,3	44,3	44,1	45,9	39,9	58,0	**40,7**
HDI, 1996	0,76	**0,66**	0,63	0,77	0,61	0,66	0,67	0,679	0,64	**0,69**
Life expectancy in years, 1996	60,83	**53,49**	60,10	59,62	53,29	52,98	52,78	55,62	60,41	**57,04**
Adult literacy rate, 1996	95,76	**79,42**	77,70	98,13	73,16	89,17	88,77	83,79	76,47	**85,93**
% of households with tap water in dwelling, 2010	78,2	**26,1**	12,0	57,2	23,9	35,5	40,3	42,8	28,7	**41,5**
% of households living in informal (not traditional) dwelling, 2010	17,0	**9,9**	3,7	21,5	18,8	7,2	13,1	8,8	7,4	**13,0**
% of households with landline phone, 2010	36,9	**7,2**	4,5	22,8	8,5	16,3	9,6	16,6	10,6	**16,7**

Abbreviations: WC = Western Cape, MP = Mpumalanga, LP = Limpopo, GP = Gauteng, NW = North West, KZN = KwaZulu-Natal, FS = Free State, NC = Northern Cape, EC = Eastern Cape, and SA = South Africa, GHS = General Household Survey

Sources: Statistics South Africa, 2004c:2; Statistics South Africa, 2006a:9,19,91-93; Statistics South Africa, 2011:6-7

Table 3.1

A long wave chronology of world industrial production

Juglar	**2nd Kondratiev**	**3rd Kondratiev**	**4th Kondratiev**
Prosperity 1	1845-1856	1892-1903	1948-1957
Prosperity 2	1856-1866	1903-1919	1957-1966
(war)		1913-1920	
Recession	1866-1872	1920-1929	1966-1973
Depression	1872-1883	1929-1937	1973-
Recovery	1883-1892	1937-1948	

Taken from: Van Duijn, 1983:155

Table 3.2

Long wave upswing and downswing growth rates, industrial production

	United Kingdom		**United States**		**Germany***	
2nd Kondratiev						
Upswing	1945-1873	3.0	(1864-1873)	(6.2)	(1850-1872)	(4.3)
Downswing	1873-1890	1.7	1873-1895	4.7	1872-1890	2.9
3rd Kondratiev						
Upswing	1890-1913	2.0	1895-1913	5.3	1890-1913	4.1
	1920-1929	2.8	1920-1929	4.8	1920-1929	-
Downswing	1929-1948	2.1	1929-1948	3.1	1929-1948	-
4th Kondratiev						
Upswing	1948-1973	3.2	1948-1973	4.7	1948-1973	9.1
	France		**Italy**		**Sweden**	
2nd Kondratiev						
Upswing	1947-1872	1.7				
Downswing	1872-1890	1.3	1873-1890	0.9	1870-1894	3.1
3rd Kondratiev						
Upswing	1890-1913	2.5	1890-1913	3.0	1894-1913	3.5
	1920-1929	8.1	1920-1929	4.8	1920-1929	4.6
Downswing	1929-1948	-0.9	1929-1948	0.5	1929-1948	4.4
4th Kondratiev						
Upswing	1948-1973	6.1	1948-1973	7.9	1948-1973	4.7

* 1948-73: West Germany

Taken from: Van Duijn, 1983:156

Table 3.3

Long wave upswing and downswing growth rates, total output, 1870s-1973

	2nd Kondratiev	**3rd Kondratiev**			**4th Kondratiev**
	downswing	**upswing**		**downswing**	**Upswing**
	1870s-90s*	**1890s-1913***	**1920-29**	**1929-48**	**1948-73**
Australia	2.9	3.9	2.3	2.2	4.8
Belgium	2.0	1.9	3.4	0.3	4.2
Canada	3.4	4.4	4.0	3.1	5.1
Denmark	2.8	3.5	2.1	1.7	4.1
France	0.8	1.8	4.9	0.0	5.3
Germany	2.3	3.2	4.9	-0.0	6.8
Italy	0.7	2.2	3.0	0.6	5.6
Japan		2.4	3.4	-0.2	9.4
The Netherlands	1.4	2.3	3.9	1.5	4.9
Norway	1.4	2.5	3.2	2.9	4.2
Sweden	1.8	3.3	4.8	2.5	3.9
United Kingdom	1.9	1.8	1.9	1.6	2.9
United States	4.2	4.0	4.0	2.3	3.8

*Kondratiev periods are 1872-90 (Belgium, France, Germany), 1873-90 (Italy, UK), 1873-95 (USA), 1873-96 (Canada), 1874-96 (Australia), 1876-95 (Japan), and 1874-91 (Denmark, Norway, Sweden). With only a 1870 estimate available, 1870-90 is taken as the downswing phase for the Netherlands.

Taken from: Van Duijn, 1983:157

Table 4.1

Innovation theory paradigms and Kondratiev waves

	Third Kondratiev wave	**Fourth Kondratiev wave**	**Present phase (fifth Kondratiev wave)**
Explanation of innovation	Psychological	Technological	Sociological
Determinant of innovation	Entrepreneurship	Technological development	Market-orientated strategy
Agent of innovation	The Gründer ('amateur')	The technician	The professional manager
Result	↘ Economic growth and corporate development	↓	↙

Taken from: Sundbo, 1998:159

Table 4.2

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
1	**Approx. periodisation Upswing Downswing**	1770s & 1*780s to 183*0s & 1840s 'Industrial revolution' 'Hard times'	1830s & 1840s to 1880s &1890s Victorian prosperity 'Great depression'	1880s & 1890s to 1930s & 1940s '*Belle epoque*' 'Great depression'	1930s & 1940s to 1980s &1990s Golden age of growth and Keynesian full employment Crisis of structural adjustment	1980s & 1990s to?
2	**Description**	Early mechanisation Kondratieff	Steam power and railway Kondratieff	Electrical and heavy engineering Kondratieff	Fordist mass production Kondratieff	Information and communication Kondratieff
3	**Main 'carrier branches' and induced growth sectors infrastructure**	Textiles Textile chemicals Textile machinery Iron-working and iron castings Water Power Potteries Trunk canals Turnpike roads	Steam engines Steamships Machine tools Iron Railway equipment Railways World Shipping	Electrical engineering Electrical machinery Cable and wire Heavy engineering Heavy armaments Steel ships Heavy chemicals Synthetic dyestuffs Electricity supply and distribution	Automobiles Trucks Tractors Tanks Armaments for motorised warfare Aircraft Consumer durables Process plant Synthetic materials Petro-chemicals Highways Airports Airlines	Computers Electronic capital goods Software Telecommunications equipment Optical fibres Robotics FMS Ceramics Data banks Information services Digital telecommunications network Satellites
4	**Key factor industries offering abundant supply at descending price**	Cotton Pig iron	Coal Transport	Steel	Energy (especially oil)	Chips' (micro-electronics)

Table 4.2 (continues)

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
5	**Other sectors growing rapidly from small base**	Steam engines machinery	Steel Electricity Gas Synthetic dyestuffs Heavy engineering	Automobiles Aircraft Telecommunications Radio Aluminium Consumer durables Oil Plastics	Computers Radar NC machine tools Drugs Nuclear weapons and power Missiles Micro-electronics Software	Third generation' biotechnology products and processes Space activities Fine chemicals SDI
6	**Limitations of previous techno-economic paradigm and ways in which new paradigm offers some solutions**	Limitations of scale, process control and mechanisation in domestic 'putting out' system. Limitations of hand-operated tools and processes. Solutions offering prospects of greater productivity and profitability through mechanisation	Limitations of water power in terms of inflexibility of location, scale of production, reliability and range of applications, restricting further development of mechanisation and factory production to the economy as a whole. Largely overcome by steam engine and new transport system.	Limitations of iron as an engineering material in terms of strength, durability, precision, etc., partly overcome by universal availability of cheap steel and of alloys. Limitations of inflexible belts, pulleys, etc., driven by one large steam engine overcome by unit and group drive for electrical machinery, overhead cranes, power tools permitting vastly improved layout and capital saving. Standardisation facilitating worldwide operations.	Limitations of scale of batch production overcome by flow processes and assembly-line production techniques, full standardisation of components and materials and abundant cheap energy. New patterns of industrial location and urban development through speed and flexibility of automobile and air transport. Further cheapening of mass consumption products.	Diseconomies of scale and inflexibility of dedicated assembly-line and process plant partly overcome by flexible manufacturing systems, 'networking' and 'economies of scope'. Limitations of energy intensity and materials intensity partly overcome by electronic control systems and components. Limitations of hierarchical departmentalisation overcome by 'systemation', 'networking' and integration of design, production and marketing.

Table 4.2 (continues)

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
7	**Organisation of firms and forms of co-operation and competition**	Individual entrepreneurs and small firms (<100 employees) competition. Partnership structure facilitates co-operation of technical innovators and financial managers. Local capital and individual wealth	High noon of small-firm competition, but larger firms now employing thousands, rather than hundreds. As firms and markets grow, limited liability and joint stock companies permit new pattern of investment, risk-taking and ownership.	Emergence of giant firms, cartels, trusts and mergers. Monopoly and oligopoly became typical. 'Regulation' or state ownership of 'natural' monopolies and 'public utilities'. Concentration of banking and 'finance-capital'. Emergence of specialised 'middle management' in large firms.	Oligopolistic competition. Multinational corporations based on direct foreign investment and multiplant locations. Competitive subcontracting on 'arms length' basis or vertical integration. Increasing concentration, divisionalisation and hierarchical control. 'Techno-structure' in large corporations.	Networks' of large and small firms based increasingly on computer networks and close co-operation in technology, quality control, training, investment planning and production planning ('just-in-time') etc. 'Keiretsu' and similar structures offering internal capital markets.
8	**Technological leaders**	Britain France Belgium	Britain France Belgium Germany USA	Germany USA Britain France Belgium Switzerland Netherlands	USA Germany Other EEC Japan Sweden Switzerland USSR Other EFTA Canada Australia	Japan USA Germany Sweden Other EEC EFTA USSR and other Eastern European Taiwan Korea Canada Australia
9	**Other industrial and newly industrialising countries**	German states Netherlands	Italy Netherlands Switzerland Austria-Hungary	Italy Austria-Hungary Canada Sweden Denmark Japan Russia	Other Eastern European Korea Brazil Mexico Venezuela Argentina China India Taiwan	Brazil Mexico Argentina Venezuela China India Indonesia Turkey Egypt Pakistan Nigeria Algeria Tunisia Other Latin American

Table 4.2 (continues)

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
10	**Some features of national regimes of regulation**	Breakdown and dissolution of feudal and medieval monopolies, guilds, tolls, privileges and restrictions on trade, industry and competition. Repression of unions. Laissez-faire established as dominant principle.	High noon of laissez faire. 'Nightwatchman state' with minimal regulatory functions except protection of property and legal framework for production and trade. Acceptance of craft unions. Early social legislation and pollution control.	Nationalist and imperialist state regulation or state ownership of basic infrastructure (public utilities). Arms race. Much social legislation. Rapid growth of state bureaucracy.	Welfare state' and 'warfare state'. Attempted state regulation of investment, growth and employment by Keynesian techniques. High levels of state expenditure and involvement. 'Social partnership' with unions after collapse of fascism. 'Roll-back' of welfare state deregulation and privatisation during crisis of adjustment.	Regulation' of strategic ICT infrastructure. 'Big brother' or 'Big Sister' state. Deregulation and reregulation of national financial institutions and capital markets. Possible emergence of new-style participatory decentralised welfare state based on ICT and red-green alliance.
11	**Aspects of the international regulatory regime**	Emergence of British supremacy in trade and international finance with the defeat of Napoleon.	Pax Britannica'. British naval, financial and trade dominance. International free trade. Gold standard.	Imperialism and colonisation. 'Pax Britannica' comes to an end with First World War. Destabilisation of international financial and trade system leading to world crisis and Second World War.	Pax Americana' US economic and military dominance. Decolonisation. Arms race and cold war with USSR. US-dominated international financial and trade regime (GATT, IMF, World Bank) Destabilisation of Bretton Woods regime in 1970s.	Multi-polarity'. Regional blocs. Problems of developing appropriate international institutions capable of regulating global finance, capital, ICT and transnational companies.

Table 4.2 (continues)

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
12	**Main features of the national system of innovation**	Encouragement of science through National Academies, Royal Society, etc. Engineer and inventor-entrepreneurs and partnerships. Local scientific and engineering societies. Part-time training and on-the-job training. Reform and strengthening of national patent systems. Transfer of technology by migration of skilled workers. British Institution of Civil Engineers. Learning by doing, using and interacting.	Establishment of Institution of Mechanical Engineers and development of UK Mechanics' Institutes. More rapid development of professional education and training of engineers and skilled workers elsewhere in Europe. Growing specialisation. Internationalisation of patent system. Learning by doing, using and interacting.	In-house' R&D departments established in German and US chemical and electrical engineering industries. Recruitment of university scientists and engineers and graduates of the new Technische Hochschulen and equivalent Institutes of Technology. National Standard Institutions and national laboratories. Universal elementary education. Learning by doing, using and interacting.	Spread of specialised R&D departments to most industries. Large-scale state involvement in military R&D through contracts and national laboratories. Increasing state involvement in civil science and technology. Rapid expansion of secondary and higher education and of industrial training. Transfer of technology through extensive licensing and know-how agreements and investment by multinational corporations. Learning by doing, using and interacting.	Horizontal integration of R&D, design, production and process engineering and marketing. Integration of process design with multi-skill training. Computer networking and collaborative research. State support for generic technologies and university-industry collaboration. New types of proprietary regime for software and biotechnology 'Factory as laboratory'.

Table 4.2 (continues)

A tentative sketch of some of the main characteristics of successive long waves (modes of growth)

	Number	First	Second	Third	Fourth	Fifth*
13	**Some features of tertiary sector development**	Rapid expansion of retail and wholesale trade in new urban centres. Very small state apparatus. Merchants as source of capital.	Rapid growth of domestic service for new middle class to largest service occupation. Continued rapid growth of transport and distribution. Universal postal and communication services. Growth of financial services.	Peak of domestic service industry. Rapid growth of state and local bureaucracies. Department stores and chain stores. Education, tourism and entertainment expanding rapidly. Corresponding take-off of white-collar employment pyramid. London as centre for major world commodity markets.	Sharp decline of domestic service. Self-service fast food and growth of supermarkets and hypermarkets, petrol service stations. Continued growth of state bureaucracy, armed forces and social services. Rapid growth of research and professions and financial services, packaged tourism and air travel on very large scale.	Rapid growth of new information services, data banks and software industries Integration of services and manufacturing in such industries as printing and publishing. Rapid growth of professional consultancy. New forms of craft production linked to distribution.
14	**Representative innovative entrepreneurs and engineers**	Arkwright Boulton Wedgwood Owen Bramah Maudslay	Stephenson Whitworth Brunel Armstrong Whitney Singer	Siemens Carnegie Nobel Edison Krupp Bosch	Sloan McNamara Ford Agnelli Nordhoff Matsushita	Kobayashi Uenohara Barron Benneton Noyce
15	**Political economists and philosophers**	Smith Say Owen	Ricardo List Marx	Marshall Pareto Lenin Veblen	Keynes Schumpeter Kalecki	Schumacher Aoki Bertalanffy

Note: * All columns dealing with the 'fifth Kondratieff' are necessarily speculative.

Taken from: Freeman & Perez, 2008:50-62

Table 7.1

The district municipalities and local municipalities of Mpumalanga

District municipalities	**Gert Sibande District Municipality**	**Nkangala District Municipality**	**Ehlanzeni District Municipality**
Local municipalities	Albert Luthuli	Delmas	Thaba Chweu
	Msukaligwa	Emalahleni	Mbombela
	Mkhonto	Emakhazeni	Umjindi
	Pixley Ka Seme	Dr, J.S. Moroka	Nkomazi
	Lekwa	Thembisile Hani	Buschbuckridge
	Dipaseng	Steve Tshwete	
	Govan Mbeki		

Source: Department of Economic Development and Planning, 2008

Table 7.2

Annual income by population group in Mpumalanga, 2002

Population group	**Annual per capita income (Rand)**	**Annual per household income (Rand)**
Asian	28 973	129 219
Black	9 193	37 534
Coloured	21 973	72 055
White	47 191	153 782

Source: DBSA, 2004:21

Table 7.3

Gini-coefficients for the population groups of Mpumalanga

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Black	0,56	0,57	0,58	0,59	0,59	0.60	0,60	0,60	0,60	0,60	0,60
White	0,47	0,47	0,46	0,48	0,47	0,48	0,47	0,46	0,47	0,47	0,47
Coloured	0,59	0,61	0,62	0,63	0,63	0,64	0,64	0,63	0,63	0,64	0,63
Asian	0,51	0,52	0,52	0,53	0,53	0,54	0,53	0,53	0,54	0,54	0,54
Total	**0,63**	**0,64**	**0,65**	**0,66**	**0,66**	**0,67**	**0,67**	**0,66**	**0,67**	**0,67**	**0,66**

Taken from: Department of Economic Development, Environment and Tourism, 2009:6

Table 7.4

The Human Development Index for 23 selected countries, 2004

Country	HDI
Low Human Development	
Niger	0,311
Ethiopia	0,371
Malawi	0,400
Tanzania	0,430
Angola	0,439
Guinea	0,445
Nigeria	0,448
Medium Human Development	
Bangladesh	0,530
Pakistan	0,539
India	0,611
South Africa	0,653
Turkey	0,757
Peru	0,767
China	0,768
Saudi Arabia	0,777
Brazil	0,792
High Human Development	
Malaysia	0,805
Costa Rica	0,841
Qatar	0,844
Chile	0,859
United Kingdom	0,940
United States	0,948
Canada	0,950
Norway	0,965

Source: Todaro & Smith, 2009:53

Table 7.5a

Human Development Index by province for 1991 and 1996

	1991(a)	**1996(a)**	**2008(b)**
Western Cape	0,83	0,76	
Eastern Cape	0,51	0,64	
Northern Cape	0,70	0,68	
Free State	0,66	0,67	
KwaZulu Natal	0,60	0,66	
North West	0,54	0,61	
Gauteng	0,82	0,77	
Mpumalanga	0,69	0,66	0,52
Northern Province	0,47	0,63	
Total	**0,68**	**0,69**	**0,58**

Sources:

(a) Statistics South Africa, 2001:2;

(b) Department of Economic Development, Environment and Tourism, 2009:5

Table 7.5b

Human Development Index of population groups in Mpumalanga

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Black	0,43	0,45	0,45	0,46	0,46	0,46	0,47	0,47	0,47	0,47	0,47
White	0,85	0,86	0,86	0,87	0,87	0,87	0,87	0,87	0,87	0,87	0,87
Coloured	0,61	0,62	0,62	0,64	0,64	0,64	0,64	0,64	0,65	0,65	0,65
Asian	0,73	0,73	0,73	0,75	0,76	0,76	0,76	0,77	0,77	0,77	0,76
Total	**0,50**	**0,51**	**0,50**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**	**0,52**

Taken from: Department of Economic Development, Environment and Tourism, 2009:5

Table 7.6

Mpumalanga Poverty Rate (%) by districts, 2007

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
South Africa	45,54	46,7	46,4	47,7	47,8	47,1	47,5	46,6	43,7	42,2	40,7
Mpumalanga	54,3	54,8	54,9	56,3	57,9	58,0	59,1	57,0	53,7	52,3	50,5
Gert Sibande	49,2	51,0	51,2	52,0	52,4	52,2	53,5	52,0	48,7	46,9	45,4
Nkangala	51,3	51,9	52,0	54,6	57,3	57,9	57,5	54,8	52,1	50,8	49,2
Ehlanzeni	59,5	59,2	59,2	60,2	61,9	61,6	63,7	61,7	58,0	56,6	54,5

Taken from: Department of Economic Development, Environment and Tourism, 2009:7

Table 7.7

Unemployment in the world – some examples

Country	Unemployment female (% of female labour force), 2009	Unemployment male (% of male labour force), 2009
Argentina	9,8	7,8
Australia	5,4	5,7
Belgium	8,1	7,7
Brazil	11,0	6,1
Bulgaria	6,6	7,0
Canada	7.0	9,4
Chile	10,7	9,1
Denmark	5,4	6,5
Egypt, Arab Rep.	22,9	5,2
Ethiopia	29,9	12,1
France	9,3	8,9
Germany	7,3	8,1
Greece	13,1	6,9
Hong Kong SAR, China	4,3	6,0
Hungary	9,7	10,3
Israel	7,6	7,6
Italy	9,3	6,8
Japan	4,7	5,3
Korea, Rep.	3,0	4,1
Macao SAR, China	2,8	4,3
Mexico	4,8	5,4
Morocco	10,5	9,8
Netherlands	3,5	3,4
New Zealand	6,1	6,1
Portugal	10,1	8,9
Romania	5,8	7,7
Russian Federation	7,9	8,4
Saudi Arabia	15,9	3,5
South Africa	25,9	22,0
Switzerland	4,5	3,7
Turkey	14,3	13,9
United Kingdom	6,4	8,8
United States	8,1	10,3

Source: The World Bank, 2010a

Table 7.8

Percentage Gross Value Added by Mpumalanga's local municipalities, 1996 and 2002

Local municipality	**% GVA 1996**	**% GVA 2002**
Emalahleni	19,2	18,3
Middelburg	18,2	19,3
Govan Mbeki	19,5	21,3
Mbombela	12,0	12,7
Lekwa	5,6	4,2
Thaba Chweu	2,9	3,1
Msukaligwa	3,5	3,1
Nkomazi	2,5	2,3
Other	16,5	15,9

Note: Municipal boundaries changed in 2005 and Middelburg is now called Steve Tshwete. Bushbuckridge only became part of Mpumalanga after 2005.

Source: DBSA, 2004:40

Table 7.9

Population distribution of Mpumalanga by municipality – Census 2001 and Community Survey (CS) 2007

Municipality	Population		% change	% distribution	
	Census 2001	CS 2007		Census 2001	CS 2007
Gert Sibande	**900 007**	**890 699**	**-1,0**	**26,7**	**24,4**
Albert Luthuli Local Municipality	187 936	194 083	3,3	5,6	5,3
Msukaligwa Local Municipality	124 812	126 268	1,2	3,7	3,5
Mkhondo Local Municipality	142 892	106 452	-25,5	4,2	2,9
Seme Local Municipality	80 737	65 932	-18,3	2,4	1,8
Lekwa Local Municipality	103 265	91 136	-11,7	3,1	2,5
Dipaleseng Local Municipality	38 618	37 873	-1,9	1,1	1,0
Govan Mbeki Local Municipality	221 747	268 954	21,3	6,6	7,4
Nkangala	**1 018 826**	**1 226 500**	**20,4**	**30,3**	**33,7**
Delmas Local Municipality	56 208	50 455	-10,2	1,7	1,4
Emalahleni Local Municipality	276 413	435 217	57,5	8,2	11,9
Steve Tshwete Local Municipality	142 772	182 503	27,8	4,2	5,0
Emakhazeni Local Municipality	43 007	32 840	-23,6	1,3	0,9
Thembisile Local Municipality	257 113	278 517	8,3	7,6	7,6
Dr JS Moroka Local Municipality	243 313	246 969	1,5	7,2	6,8
Ehlanzeni	**1 447 053**	**1 526 236**	**5,5**	**43,0**	**41,9**
Thaba Chweu Local Municipality	81 681	87 545	7,2	2,4	2,4
Mbombela Local Municipality	476 593	527 203	10,6	14,2	14,5
Umjindi Local Municipality	53 744	60 475	12,5	1,6	1,7
Nkomazi Local Municipality	334 420	338 095	1,1	9,9	9,3
Bushbuckridge Local Municipality	497 958	509 970	2,4	14,8	14,0
Mpumalanga	**3 365 885**	**3 643 435**	**8,2**	**100,0**	**100,0**
South Africa	**44 819 778**	**48 502 063**	**8,2**		

Source: Statistics South Africa, 2009a:7

Table 7.10

Official unemployment rates (population aged 15-64 years)

	March 2005	March 2006	March 2007
	Thousand		
Employed			
Western Cape	1 665	1 800	1 869
Eastern Cape	1 398	1 511	1 251
Northern Cape	283	315	317
Free State	786	790	818
KwaZulu-Natal	2 322	2 471	2 553
North West	830	854	860
Gauteng	3 672	3 799	3 890
Mpumalanga	837	901	904
Limpopo	798	795	864
South Africa	**12 503**	**13 237**	**13 326**
Unemployed			
Western Cape	410	385	413
Eastern Cape	509	476	509
Northern Cape	101	89	102
Free State	310	269	252
KwaZulu-Natal	734	698	745
North West	241	266	296
Gauteng	1 068	1 127	1 121
Mpumalanga	231	283	235
Limpopo	390	391	446
South Africa	**3 993**	**3 984**	**4 119**
	Percent		
Unemployment rate			
Western Cape	19,8	17,6	18,1
Eastern Cape	28,0	23,9	28,9
Northern Cape	26,3	22,0	24,2
Free State	28,3	25,4	23,6
KwaZulu-Natal	24,0	22,0	22,6
North West	22,5	23,7	25,6
Gauteng	22,5	22,9	22,4
Mpumalanga	21,6	23,9	20,6
Limpopo	32,8	33,0	34,0
South Africa	**24,2**	**23,1**	**23,6**

Source: Statistics South Africa, 2008:7

Table 7.11

Labour market indicators for Mpumalanga and South Africa (population aged 15-64 years)

Labour market indicator	**Mpumalanga**			**South Africa**		
	March 2005	**March 2006**	**March 2007**	**March 2005**	**March 2006**	**March 2007**
	Thousand					
Employed (a)	837	901	904	12 503	13 273	13 326
Unemployed (b)	231	283	235	3 993	3 984	4 119
Not economically active (c)	1 004	922	1 001	12 823	12 558	12 763
Labour force (a+b)	1 068	1 185	1 139	16 497	17 221	17 444
Working age (a+b+c)	2 073	2 107	2 140	29 319	29 779	30 208
Discouraged work-seekers	194	160	215	2 324	2 445	2 511
	Percent					
Unemployment rate	21,6	23,9	20,6	24,2	23,1	23,6
Absorption rate	40,4	42,8	42,2	42,6	44,4	44,1
Participation rate	51,5	56,2	53,2	56,3	57,8	57,7

Source: Statistics South Africa, 2008:5-29

Table 7.12

Gross Domestic Product per Region and Value Added per industry at 1996 constant prices, Mpumalanga, 1996-2004

Industry	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
	R' million								
Primary industries	**13 454**	**13 920**	**13 924**	**14 544**	**14 990**	**14 628**	**14 863**	**15 201**	**15 513**
Agriculture, forestry, And fishing	2 392	2 240	2 351	2 632	2 751	2 347	2 813	2 697	2 593
Mining and quarrying	11 062	11 680	11 573	11 912	12 239	12 281	12 050	12 504	12 919
Secondary industries	**14 091**	**14 715**	**14 641**	**14 588**	**15 526**	**15 791**	**16 585**	**16 648**	**17 260**
Manufacturing	9 605	9 873	10 069	10 279	11 240	11 575	12 144	12 059	12 616
Electricity, gas and water	3 382	3 636	3 358	3 099	3 366	3 154	3 307	3 413	3 424
Construction	1 104	1 206	1 215	1 210	920	1 061	1 135	1 176	1 220
Tertiary industries	**23 638**	**24 256**	**24 927**	**26 079**	**26 595**	**27 386**	**28 004**	**29 213**	**30 811**
Wholesale & retail trade; hotels & restaurants	5 802	5 865	5 949	6 392	6 770	6 965	7 110	7 278	7 816
Transport, storage and communication	3 766	4 095	4 373	4 664	4 927	5 118	5 458	5 990	6 230
Finance, real estate and business services	5 664	5 910	6 032	6 271	5 901	6 257	6 355	6 598	7 220
Personal services	2 697	2 697	2 876	2 985	3 127	3 196	3 274	3 401	3 439
General government services	5 709	5 689	5 696	5 767	5 870	5 850	5 807	5 946	6 105
All industries at basic prices	**51 183**	**52 891**	**53 492**	**55 211**	**57 111**	**57 804**	**59 452**	**61 063**	**63 584**
Taxes less subsidies on products	5 632	5 841	5 791	5 787	5 789	5 894	5 823	5 944	6 218
GDPR at market prices	**56 815**	**58 732**	**59 283**	**60 997**	**62 900**	**63 699**	**65 276**	**67 007**	**69 802**

Taken from: Statistics South Africa, 2006a:94

Table 7.13

Employment by industry, Mpumalanga, 2004

Industry	**Percentage employment**
Agriculture	14,4
Mining and quarrying	5,0
Manufacturing	13,4
Electricity	1,9
Construction	8,6
Trade	23,3
Transport	4,4
Financial	5,1
Communication, social and personal services	13,7
Private households	10,3

Taken from: Statistics South Africa, 2006a:66

Table 7.14

Employment in the formal and informal sectors in each province, South Africa, 2004

Province	**% employment by formal sector**	**% employment by informal sector**
Western Cape	89,4	10,5
Eastern Cape	63,4	36,3
Northern Cape	89,5	10,4
Free State	83,0	17,0
KwaZulu-Natal	74,8	24,7
North West	75,8	24,1
Gauteng	82,5	17,4
Mpumalanga	**69,3**	**30,5**
Limpopo	66,5	33,5
South Africa	**77,7**	**22,2**

Taken from: Statistics South Africa, 2006a:66

Table 7.15

Number of people running non-VAT registered businesses by province, 2005

Province	**Estimated number of non-VAT registered businesses**	**% of total non-VAT registered businesses in South Africa**
Western Cape	103 217	5,9
Eastern Cape	234 443	13,4
Northern Cape	12 471	0,7
Free State	115 687	6,6
KwaZulu-Natal	328 210	18,8
North West	139 472	8,0
Gauteng	429 515	24,6
Mpumalanga	**134 948**	**7,7**
Limpopo	249 615	14,3
South Africa	**1 747 579**	**100,0**

Source: Statistics South Africa, 2006b:xi

Table 7.16

Field crop production in Mpumalanga

Summer cereals	maize, rain sorghum
Winter cereals	wheat, barley
Oilseed	sunflower seed, soy beans, groundnuts
Legumes	dry beans
Fodder crops	lucern, teff
Other	sugarcane, cotton, tobacco

Taken from: Department of Agriculture and Land Administration, 1999

Table 7.17

Horticultural crops in Mpumalanga

Vegetables	potatoes, tomatoes, cabbage, onion, carrots, green beans, green mealies
Citrus	oranges, lemons, grapefruit, naartjies
Sub-tropical fruit	avocados, pineapples, bananas, mangoes, paw-paws
Deciduous fruit	apples, pears, peaches, plums/prunes, table grapes
Other	nuts, coffee and tea

Taken from: Department of Agriculture and Land Administration, 1999

Table 7.18

Livestock production in Mpumalanga, 1998

Type	**Number**
Cattle	1 072 784
Sheep	1 161 503
Goats	118 553
Pigs	88 480
Horses	14 500
Donkeys & mules	4 633
Poultry	12 878 884

Taken from: Department of Agriculture and Land Administration, 1999

Table 7.19

Functional land use patterns of Mpumalanga, 1991

Land use	Percentage
Grazing land	39,6
Nature conservation	28,5
Potentially arable land	21,2
Forestry	6,7
Other	3,9

Taken from: DBSA, 2004:43

Table 7.20

Employment and remuneration in the mining industry by province, 2002

Province	% employment	% remuneration
Western Cape	22,9	0,9
Eastern Cape	5,9	0,1
Northern Cape	4,3	6,2
Free State	13,1	13,3
KwaZulu-Natal	13,6	2,5
North West	9,2	25,9
Gauteng	6,9	21,2
Mpumalanga	12,1	18,0
Limpopo	11,9	11,8

Source: DBSA, 2004:46

Table 7.21

Primary and processed mineral sales by province, 2002

Province	% Primary mineral sales	% Processed mineral sales
Western Cape	0,9	1,9
Eastern Cape	0,1	0,0
Northern Cape	8,1	0,0
Free State	9,3	0,0
KwaZulu-Natal	2,8	52,6
North West	33,4	10,8
Gauteng	15,1	9,9
Mpumalanga	20,6	20,6
Limpopo	9,8	4,1

Source: DBSA, 2004:47

Table 7.22

The Global Competitiveness Index for South Africa

INDICATOR	Rank/142	Competitive advantage/ disadvantage
INSTITUTIONS	46	
Property rights	30	A
Intellectual property protection	30	A
Diversion of public funds	81	D
Public trust of politicians	88	D
Irregular payments and bribes	48	A
Judicial independence	35	A
Favoritism in decisions of government officials	114	D
Wastefulness of government spending	69	D
Burden of government regulation	112	D
Efficiency of legal framework in settling disputes	16	A
Efficiency of legal framework in challenging regs.	19	A
Transparency of government policymaking	34	A
Business costs of terrorism	33	A
Business costs of crime and violence	136	D
Organized crime	112	D
Reliability of police service	95	D
Ethical behavior of firms	51	D
Strength of auditing and reporting standards	1	A
Efficacy of corporate boards	2	A
Protection of minority shareholders' interests	3	A
Strength of investor protection	10	A
INFRASTRUCTURE	62	
Quality of overall infrastructure	60	D
Quality of roads	43	A
Quality of railroad infrastructure	46	A
Quality of port infrastructure	50	D
Quality of air transport infrastructure	17	A
Available airline seat kms/week	24	A
Quality of electricity supply	97	D
Fixed telephone lines/100 pop.	100	D
Mobile telephone subscriptions/100 pop.	71	D
MACROECONOMIC ENVIRONMENT	55	
Government budget balance, % GDP	104	D
Gross national savings, % GDP	72	D
Inflation, annual % change	78	D
Interest rate spread, %	36	A
General government debt, % GDP	54	D
Country credit rating, 0-100	48	A
HEALTH AND PRIMARY EDUCATION	131	
Business impact of malaria	103	D
Malaria cases/100,000 pop.	90	D
Business impact of tuberculosis	135	D
Tuberculosis incidence/100,000 pop.	141	D
Business impact of HIV/AIDS	132	D
HIV prevalence, % adult pop.	139	D
Infant mortality, deaths/1,000 live births	111	D
Life expectancy, years	130	D
Quality of primary education	127	D
Primary education enrollment, net %	118	D

Table 7.22 (Continues)

The Global Competitiveness Index for South Africa

INDICATOR	Rank/142	Competitive advantage/ disadvantage
HIGHER EDUCATION AND TRAINING	73	
Secondary education enrollment, gross %	51	D
Tertiary education enrollment, gross %	97	D
Quality of education system	133	D
Quality of math and science education	138	D
Quality of management schools	13	A
Internet access in schools	100	D
Availability of research and training services	47	A
Extent of staff training	27	A
GOODS MARKET EFFICIENCY	32	
Intensity of local competition	49	A
Extent of market dominance	37	A
Effectiveness of anti-monopoly policy	7	A
Extent and effect of taxation	28	A
Total tax rate, % profits	36	A
No. of procedures required to start a business	34	A
No. of days to start a business	84	D
Agricultural policy costs	37	A
Prevalence of trade barriers	51	D
Trade tariffs, % duty	72	D
Prevalence of foreign ownership	34	A
Business impact of rules on FDI	55	D
Burden of customs procedures	62	D
Imports as a percentage of GDP	108	D
Degree of customer orientation	67	D
Buyer satisfaction	31	A
LABOUR MARKET EFFICIENCY	95	
Cooperation in labour-employer relations	138	D
Flexibility of wage determination	138	D
Rigidity of employment index, 0-100	90	D
Hiring and firing practices	139	D
Redundancy costs, weeks of salary	46	A
Pay and productivity	130	D
Reliance on professional management	18	A
Brain drain	48	A
Women in labour force, ratio to men	76	D
FINANCIAL MARKET DEVELOPMENT	4	
Availability of financial services	3	A
Affordability of financial services	39	A
Financing through local equity market	4	A
Ease of access to loans	36	A
Venture capital availability	44	A
Soundness of banks	2	A
Regulations of security exchanges	1	A
Legal rights index	8	A
TECHNOLOGICAL READINESS	76	
Availability of latest technologies	39	A
Firm-level technology absorption	30	A
FDI and technology transfer	41	A
Internet users/100 pop.	105	D
Broadband internet subscriptions/100 pop.	96	D
Internet bandwidth, kb/s/capita	112	D

Table 7.22 (Continues)

The Global Competitiveness Index for South Africa

INDICATOR	Rank/142	Competitive advantage/ disadvantage
MARKET SIZE	25	
Domestic market size index	24	A
Foreign market size index	38	A
BUSINESS SOPHISTICATION	38	
Local supplier quantity	47	A
Local supplier quality	31	A
State of cluster development	46	A
Nature of competitive advantage	97	D
Value chain breadth	100	D
Control of international distribution	26	A
Production process sophistication	41	A
Extent of marketing	31	A
Willingness to delegate authority	32	A
INNOVATION	41	
Capacity for innovation	46	A
Quality of scientific research institutions	30	A
Company spending on R&D	36	A
University-industry collaboration in R&D	26	A
Government procurement of advanced technological products	103	D
Availability of scientists and engineers	111	D
Utility patents granted/million pop.	42	A

Source: Schwab, 2011:322-323

Table 7.23

Highest level of education by province amongst those aged 20 and older (percentages)

Level of education	No schooling	Completed primary	Grade 12/ Std 10	Higher
Western Cape	2,1	6,5	28,1	13,8
Eastern Cape	8,5	6,5	19,7	7,6
Northern Cape	10,9	8,7	19,0	5,5
Free State	5,9	6,9	23,8	8,4
KwaZulu-Natal	8,1	5,3	27,0	8,2
North West	10,2	7,0	20,9	6,9
Gauteng	2,9	4,0	33,5	16,0
Mpumalanga	**11,3**	**5,6**	**24,4**	**9,5**
Limpopo	13,4	6,1	15,3	8,4
South Africa	**6,9**	**5,7**	**25,7**	**10,6**

Source: Statistics South Africa, 2011:51-52

Table 7.24

Percentage of persons aged 5 years and older attending educational institutions (numbers in thousands), 2010

Educational institution/ Province	**Pre-school**	**School**	**ABET**	**Literacy classes**	**Universities & Universities of Technology**	**FET**	**Other colleges**	**Home based education**	**Other**
Number									
Western Cape	59	1 161	7	1	100	20	33	2	8
Eastern Cape	68	2 156	14	2	56	20	9	0	4
Northern Cape	18	305	2	0	5	4	2	0	0
Free State	46	811	8	1	54	16	13	0	4
KwaZulu-Natal	105	3 279	15	1	124	48	16	2	2
North West	32	922	14	3	24	14	5	1	3
Gauteng	131	2 250	21	0	231	43	57	11	18
Mpumalanga	**38**	**1 150**	**13**	**0**	**39**	**17**	**23**	**0**	**4**
Limpopo	30	2 000	20	4	46	21	10	0	5
South Africa	526	14 034	113	11	679	202	169	17	48
%									
Western Cape	4,3	83,5	0,5	0,0	7,2	1,4	2,4	0,2	0,6
Eastern Cape	2,9	92,6	0,6	0,1	2,4	0,9	0,4	0,0	0,2
Northern Cape	5,3	90,6	0,7	0,1	1,4	1,1	0,7	0,0	0,1
Free State	4,8	85,2	0,8	0,1	5,7	1,7	1,4	0,0	0,4
KwaZulu-Natal	2,9	91,3	0,4	0,0	3,5	1,3	0,4	0,1	0,1
North West	3,1	90,6	1,4	0,3	2,4	1,4	0,5	0,1	0,3
Gauteng	4,7	81,5	0,8	0,0	8,4	1,6	2,1	0,4	0,7
Mpumalanga	**3,0**	**89,6**	**1,0**	**0,0**	**3,1**	**1,3**	**1,8**	**0,0**	**0,3**
Limpopo	1,4	93,7	0,9	0,2	2,2	1,0	0,5	0,0	0,2
South Africa	**3,3**	**88,8**	**0,7**	**0,1**	**4,3**	**1,3**	**1,1**	**0,1**	**0,3**

Source: Statistics South Africa, 2011:9

Table 7.25

Number of matric passes and pass rates, 2006-2008

	2006		**2007**		**2008**		**2009**		**2010**	
	No. of learn-ers who passed	**% pass rate**	**No. of learn-ers who passed**	**% pass rate**	**No. of learn-ers who passed**	**% pass rate**	**No. of learn-ers who passed**	**% pass rate**	**No. of learn-ers who passed**	**% pass rate**
WC	33 316	83,7	33 787	80,6	34 393	62,2	34 017	75,7	35 124	76,8
EC	41 268	59,3	39 358	57,1	30 525	50,6	34 731	51,0	37 364	58,3
NC	5 753	76,8	7 141	70,3	7 251	72,7	6 356	61,3	7 366	72,3
FS	21 582	72,2	21 522	70,5	21 644	71,6	20 680	69,4	19 499	70,7
KZN	82 460	65,7	94 421	63,8	80 301	57,2	80 733	61,1	86 556	70,7
NW	25 440	67,0	21 372	67,2	22 470	67,9	20 700	67,5	21 876	75,7
GP	57 355	78,3	63 287	74,6	71 797	76,3	70 871	71,8	72 537	78,6
MP	**25 479**	**65,3**	**31 449**	**60,7**	**27 883**	**51,7**	**25 854**	**47,9**	**29 382**	**56,8**
LP	58 850	55,7	55 880	58,0	48 530	52,7	40 776	48,9	54 809	57,9
Total	351 503	66,6	368 217	65,2	344 794	62,2	334 718	60,6	364 513	67,8

Abbreviations: WC = Western Cape, MP = Mpumalanga, LP = Limpopo, GP = Gauteng, NW = North West, KZN = KwaZulu-Natal, FS = Free State, NC = Northern Cape, EC = Eastern Cape

Sources: National Treasury, 2009:39; Department of Basic Education, 2010:40-41; Department of Basic Education, 2011:46

Table 7.26

Public ordinary school statistics by province, 2008

	Number			Ratio	
	Learners	**Educators**	**Schools**	**Learner : Educator**	**Learner : School**
Western Cape	937 887	31 214	1 451	30	646
Eastern Cape	2 037 777	64 371	5 686	32	358
Northern Cape	263 086	8 835	602	30	437
Free State	656 074	22 696	1 614	29	406
KwaZulu-Natal	2 725 855	83 760	5 783	33	471
North West	765 762	25 736	1 730	30	443
Gauteng	1 716 196	53 017	1 989	32	863
Mpumalanga	**1 034 719**	**32 784**	**1 873**	**32**	**552**
Limpopo	1 735 806	55 647	4 023	31	431
Total	**11 873 162**	**378 060**	**24 751**	**31**	**480**
	Percentage of national total				
Western Cape	7,9	8,3	5,9		
Eastern Cape	17,2	17,0	23,0		
Northern Cape	2,2	2,3	2,4		
Free State	5,5	6,0	6,5		
KwaZulu-Natal	23,0	22,2	23,4		
North West	6,4	6,8	7,0		
Gauteng	14,5	14,0	8,0		
Mpumalanga	**8,7**	**8,7**	**7,6**		
Limpopo	14,6	14,7	16,3		
Total	**100,0**	**100,0**	**100,0**		

Taken from: National Treasury, 2009:24

Table 7.27

Mpumalanga - Facilities in public ordinary schools

Facilities	**2005/2006 Actual**	**2006/2007 Actual**	**2007/2008 Estimate**
Number of public ordinary schools with a water supply	1 514	1 558	1 768
Number of public ordinary schools with electricity	1 382	1 412	1 451
Number of schools with adequate number of functional toilets	388	417	512
Number of schools with more than 40 learners per class	446	432	312
Number of schools with section 21 status	1 876	1 824	1 910

Source: Department of Education, 2008:30

Table 7.28

Number and percentage of candidates who obtained university endorsement per province, 2006 -2008

	2006		**2007**		**2008**	
	Number of learners with endorse-ments	**Endorse-ments percentage rate**	**Number of learners with endorse-ments**	**Endorse-ments percentage rate**	**Number of learners with endorse-ments**	**Endorse-ments percentage rate**
Western Cape	10 589	26,6	10 300	24,6	14 167	32,4
Eastern Cape	7 002	10,1	6 466	9,4	8 447	14,0
Northern Cape	1 163	15,5	1 208	11,9	1 937	19,4
Free State	5 901	19,7	5 776	18,9	6 293	20,8
KwaZulu-Natal	19 116	15,2	21 443	14,5	23 846	17,0
North West	5 537	14,6	5 060	15,9	6 213	18,8
Gauteng	17 012	23,2	17 307	20,4	27 608	29,3
Mpumalanga	**5 481**	**14,0**	**6 561**	**12,7**	**6 493**	**12,0**
Limpopo	14 029	13,3	11 333	11,8	11 043	12,4
Total	85 830	16,3	85 454	15,1	106 047	19,1

Taken from: National Treasury, 2009:40

Table 7.29

Deaths per 1 000 population per province, 2007

	< 10	**10 - 12**	**13 - 15**	**> 16**
Western Cape	X			
Eastern Cape			X	
Northern Cape			X	
Free State				X
KwaZulu-Natal			X	
North West		X		
Gauteng		X		
Mpumalanga			X	
Limpopo		X		

Source: Statistics South Africa, 2009b:18

Table 7.30

The ten leading underlying natural causes of death per province, 2007

	Mpumalanga		**South Africa**	
	Number	**%**	**Number**	**%**
Tuberculosis	6 806	14,1	76 761	12,8
Influenza and pneumonia	5 230	10,9	49 722	8,3
Intestinal infectious diseases	4 779	9,9	37 398	6,2
Cerebrovascular diseases	2 278	4,7	25 321	4,2
Certain disorders involving the immune mechanism	1 985	4,1	15 253	2,5
Other forms of heart disease	1 946	4,0	26 030	4,3
Diabetes mellitus	1 414	2,9	20 139	3,4
Hypertensive diseases	1 128	2,3	13 381	2,2
Chronic lower respiratory diseases	981	2,0	15 313	2,5
Human immunodeficiency virus (HIV) diseases	943	2,0	13 521	2,2
Other natural causes	16 767	34,9	254 078	42,3
Non-natural causes	3 853	8,0	54 216	9,0
All causes	**48 110**	**100,0**	**601 133**	**100,0**

Source: Statistics South Africa, 2009b:31

Table 7.31

Malaria cases in South Africa, 2004 – 2006

	2004		**2005**		**2006**	
	Cases	**Deaths**	**Cases**	**Deaths**	**Cases**	**Deaths**
Limpopo	4 899	50	3 458	31	6 369	57
Mpumalanga	**4 064**	**17**	**3 077**	**16**	**4 558**	**21**
KwaZulu-Natal	4 417	22	1 220	17	1 211	11
Rest of SA	19	0				
Total	**13 399**	**89**	**7 755**	**63**	**12 098**	**87**

Source: Department of Health, S.a.

Table 7.32

HIV prevalence among antenatal women by province, South Africa, 2006-2008

Province	**2006**	**2007**	**2008**
	% HIV prevalence	**% HIV prevalence**	**% HIV prevalence**
Western Cape	15,1	15,3	16,1
Eastern Cape	28,6	28,8	27,6
Northern Cape	15,6	16,5	16,2
Free State	31,1	31,5	32,9
KwaZulu-Natal	39,1	38,7	38,7
North West	29,0	30,6	31,0
Gauteng	30,8	30,5	29,9
Mpumalanga	**32,1**	**34,6**	**35,5**
Limpopo	20,6	20,4	20,7
National Average	29,1	29,4	29,3

Source: Department of Health, 2009:10

Table 7.33

HIV prevalence by province (excluding antenatal), 2008/09

	HIV prevalence among clients tested (excluding antenatal)	**HIV testing rate (excluding antenatal)**
Western Cape	12,8	96,0
Eastern Cape	22,7	84,9
Northern Cape	18,5	94,1
Free State	36,1	76,2
KwaZulu-Natal	35,2	92,1
North West	20,8	79,1
Gauteng	37,0	93,2
Mpumalanga	**40,0**	**78,7**
Limpopo	20,8	79,1
National Average	28,3	85,2

Taken from: National Treasury, 2009:55

Table 7.34

Number of deaths by age, 2007

Age	Mpumalanga		South Africa	
	Number	**%**	**Number**	**%**
0	3 933	8,2	46 546	7,7
1-4	1 510	3,1	14 782	2,5
5-14	922	1,9	9474	1,6
15-49	24 633	51,2	278 589	46,3
50-64	7 851	16,3	105 102	17,5
65+	9 173	19,1	145 425	24,2
Unspecified	88	0,2	1 215	0,2
Total	**48 110**	**100,0**	**601 133**	**100,0**

Source: Statistics South Africa, 2009b:51-52

Table 7.35

Health services by province, 2001

	Number of people per public doctor	Number of people per nurse	Hospital beds per thousand people	
			Public hospital	**Private hospital**
Western Cape	1 745	169	3,5	4,0
Eastern Cape	6 788	319	3,1	1,7
Northern Cape	4 054	260	2,3	2,1
Free State	3 386	237	2,6	3,2
KwaZulu-Natal	3 724	269	3,4	2,9
North West	7 992	300	2,1	2,6
Gauteng	2 439	173	3,5	3,4
Mpumalanga	**7 377**	**405**	**1,8**	**1,6**
Limpopo	7 954	470	2,0	0,6
South Africa	**3 749**	**255**	**2,9**	**2,9**

Source: DBSA, 2004:33

Table 7.36

Provincial expenditure of R&D, 2007/08

	Business enterprise		**Government**		**Higher education**		**Not-for-profit**		**Science councils**		**Total**	
	R '000	**%**	**R '000**	**%**	**R '000**	**%**	**R '000**	**%**	**R '000**	**%**	**R '000**	**%**
WC	1 755 404	16,3	376 550	32,6	1 044 360	28,8	39 367	17,6	441 036	15,3	3 656 717	19,6
EC	283 488	2,6	122 191	10,6	276 740	7,6	6 164	2,8	138 342	4,8	826 925	4,4
NC	7 450	0,1	66 921	5,8	48 277	1,3	2 038	0,9	45 250	1,6	169 937	0,9
FS	786 225	7,3	62 116	5,4	180 713	5,0	1 255	0,6	67 901	2,4	1 098 210	5,9
KZN	1 302 260	12,1	76 458	6,6	459 299	12,7	42 141	18,9	201 009	7,0	2 081 166	11,2
NW	193 339	1,8	42 500	3,7	166 137	4,6	2 207	1,0	49 390	1,7	453 574	2,4
GP	6 142 233	57,2	292 757	25,4	1 260 991	34,8	115 499	51,7	1 809 272	62,7	9 620 752	51,7
MP	**196 368**	**1,8**	**74 690**	**6,5**	**105 629**	**2,9**	**9 930**	**4,4**	**66 333**	**2,3**	**452 950**	**2,4**
LP	71 687	0,7	40 217	3,5	79 716	2,2	4 602	2,1	67 562	2,3	263 784	1,4
SA	**10 738 456**	**100**	**1 154 399**	**100**	**3 621 862**	**100**	**223 203**	**100**	**2 886 094**	**100**	**18 624 014**	**100**

Abbreviations: WC = Western Cape, MP = Mpumalanga, LP = Limpopo, GP = Gauteng, NW = North West, KZN = KwaZulu-Natal, FS = Free State, NC = Northern Cape, EC = Eastern Cape, and SA = South Africa

Taken from: Centre for Science, Technology and Innovation Indicators, Human Sciences Research Council, 2009b:21

Table 7.37

Total in-house R&D expenditure per sector, 2007/08

Sector	**R '000**	**%**
Business enterprise	10 738 456	57,7
Government	1 154 399	6,2
Higher education	3 621 862	19,4
Not-for-profit organisations	223 202	1,2
Science councils	2 886 094	15,5
Total Gross expenditure on R&D	**18 624 013**	**100,0**

Taken from: Centre for Science, Technology and Innovation Indicators, Human Sciences Research Council, 2009b:21

Table 7.38

Gross expenditure on R&D as a percentage of GDP 2007* (International comparison)

Country	Gross expenditure on R&D as a percentage of GDP
Sweden	3,60
Korea	3,47
Finland	3,46
Japan	3,44
United States	2,68
OECD average	2,29
France	2,08
Australia	2,01
EU-27 average	1,77
China	1,49
Spain	1,27
Russian Federation	1,12
South Africa	**0,93**
India	0,80
Argentina	0,51

*or latest year available

Source: Centre for Science, Technology and Innovation Indicators, Human Sciences Research Council, 2009a:13

Table 7.39

Number of Full Time Equivalent (FTE) researchers per 1 000 total employment in 2007* (International comparison)

Country	Number of researchers per 1 000 total employment
Japan	11,0
Sweden	10,6
Norway	9,8
Korea	9,5
Australia	8,3
France	8,3
Russian Federation	6,7
Spain	6,0
Argentina	2,9
China	1,9
South Africa	**1,5**
Mexico	1,2

*or latest year available

Source: Centre for Science, Technology and Innovation Indicators, Human Sciences Research Council, 2009a:15

Table 7.40

Grants and loans obtained by small and micro enterprises, South Africa, 2002

Total number of small & micro enterprises	**2 300 000**
Enterprises who needed money to start business	**1 400 000**
Enterprises who did not need money to start business	**900 000**
Enterprises who obtained a grants	**16 000**
Grants from Government	5 000
Grants from non-governmental organisations	3 000
Grants from other sources	8 000
Loans	**217 000**
Loans from friends/relatives	181 000
Loans from others	12 000
Loans from commercial banks	11 000
Loans from money lenders/mashonisas	10 000
Loans from credit societies	2 000
Loans from business association	2 000
Loans from (business) partners	1 000
Loans from NGO/CBO	1 000

Source: Statistics South Africa, 2002:91-92

Table 7.41

Percentage of annual disposable income (constant 2000 prices) by province, 2007

Province	**% annual disposable income**
Western Cape	15,7
Eastern Cape	9,3
Northern Cape	1,8
Free State	5,1
KwaZulu-Natal	16,3
North West	5,5
Gauteng	33,2
Mpumalanga	**5,7**
Limpopo	7,2
South Africa	100,0

Source: Department of Economic Development and Planning, 2008

Table 7.42

Mpumalanga international trade

	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Exports as a % of GDP	5,3	4,4	5,9	4,2	6,5	8,1	10,2	4,6	5,2	5,8	5,2	5,5
Total trade as % of GDP	6,9	6,2	7,3	5,5	7,8	9,6	12,4	6,2	7,0	7,5	6,2	6,9
Regional share – Exports	1,8	1,5	2,0	1,4	1,9	2,3	2,6	1,4	1,6	1,8	1,5	1,4
Regional share – Imports	0,6	0,6	0,5	0,5	0,4	0,5	0,7	0,5	0,6	0,5	0,3	0,4

Source: Department of Economic Development and Planning, 2008

Table 7.43

South Africa's international trade

	2003	2004	2005	2006	2007	2008
Real merchandise exports to GDP[1]	19,8	20,0	21,1	21,6	21,7	21,9
Real merchandise imports to GDE[2]	19,8	21,6	22,8	25,2	25,9	25,8
Exports of goods (incl. gold) and services to GDP[3]	27,9	26,4	27,4	30,0	31,3	35,5
Imports of goods and services to GDP[3]	25,5	26,7	27,9	32,5	34,2	38,5

1. Gross domestic product at constant 2005 prices

2. Gross domestic expenditure at constant 2005 prices

3. Gross domestic product at market prices

Source: South African Reserve Bank, 2010:S-146

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