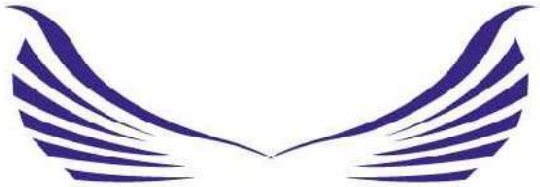

GORDON INSTITUTE
OF BUSINESS SCIENCE
University of Pretoria

MBA 2010/2011

The entrepreneurial intentions of academic researchers in an emerging knowledge economy

Joy Sixholo

A research dissertation submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration

09 November 2011

ABSTRACT

This study analysed the entrepreneurial intentions of academic researchers to create spinoffs in a country where the phenomenon of academic spinoffs is emerging. The study consisted of a quantitative analysis of entrepreneurial intentions, performed within the context of South Africa's Higher Education Institutions and Science Councils.

The study drew from psychological and entrepreneurship research on intentionality to measure the level of entrepreneurial intentions using specific determinants (*entrepreneurial self-efficacy, personal networks, perceived role models, number of years spent at the academic institution, number of patents/ copyrights/ designs, type of research, and cooperation with industry*) that characterise the emergence of academic entrepreneurial intentions that lead academics to the creation of spinoffs. The study also aimed to determine if there were differences in the entrepreneurial intentions between researchers in technical and non-technical fields of expertise.

A quantitative online survey was conducted amongst researchers in higher education institutions and science councils, followed by data analysis using a multiple linear regression to measure the entrepreneurial intentions. Thereafter a determination of factors associated with the higher levels of intention and a comparison of the level of intentions was conducted between researchers from the two study groups using an analysis of coefficients and significance tests respectively.

The study showed that the entrepreneurial intentions of researchers in South Africa were very low. It was also shown that entrepreneurial self-efficacy was the strongest predictor of academic entrepreneurial intentions. Furthermore it was found that there was no significant difference in the entrepreneurial intentions between researchers in technical and non technical fields of expertise.

Keywords: Entrepreneurial intention, academic spinoff/spinout/startup, university spinoff/spinout/startup, academic entrepreneurship, technology transfer, commercialisation, entrepreneurial self-efficacy, academic personal networks, academic cooperation with industry, academic entrepreneurial process, valorisation.

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination at any other university. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Researcher: Joy Sixholo

Date: 09 November 2011

ACKNOWLEDGEMENTS

I wish to extend my gratitude to the following people and institutions that contributed to the success of the study:

- God Almighty for always leading me to greener pastures.
- My study leader and research promoter, Mr Leon Staphorst for his guidance and valuable insights.
- My friend, Mr Sithembiso Mpungose for help with the statistics.
- Many thanks to all the respondents who participated in this study.
- My former colleagues from Onderstepoort Veterinary Institute for testing the usability of the online questionnaire.
- The Technology Innovation Agency for the financial sponsorship.
- The National Research Foundation for their generosity in providing the sample frame.
- My line manager Dr Siyabulela Ntutela for his support and for approving all my leave requests in order to attend classes during my MBA.
- My deepest gratitude goes to my parents Themba and Rosetta Sixholo for always supporting me in everything that I do, and for looking after my daughter when I had to attend classes on weekends, when I was away on the global module and during the final write up of this dissertation.
- My friends Ms Morwesi Ramonyai; Dr Mkhetwa Maluleke, Mr Phineas Thosago, Dr Emela Mochubele, Dr Muhammed Sayed; and Mr Naim Rassool, for the intellectual discussions and explaining management concepts I did not understand.
- All my classmates, especially those who have been part of my syndicate, for sharing their knowledge and experiences.

- My colleagues who supported me throughout the MBA process with special gratitude to Ms Mahlogonolo Mabula and Ms Sibongile Letuku.
- My dearest Unathi who kept me smiling.

This dissertation is dedicated to my dear husband

Akin Jenkins

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AEI	Academic Entrepreneurial Intentions
AUTM	According to the Association of University Technology Managers
DST	Department of Science and Technology
FTI	Foundation for Technological Innovation
GEM	Global Entrepreneurship Monitor
HEI	Higher Education Institutions
MIT	Massachusetts Institution of Technology
NRDS	National Research and Development Strategy
NSI	National System of Innovation
OECD	Organisation for Economic Co-operation and Development
PDF	Portable Document Format
SC	Science Councils
TIA	Technology Innovation Agency
TTO	Technology Transfer Office
TYIP	Ten Year Innovation Plan
U.S.	United States

CHAPTER 1: INTRODUCTION

1.1 Introduction to the research problem

The entrepreneurial motivations and intentions of scientists in academia have been well studied in Europe and the Americas (Landry, Amara and Rherrad, 2006; Morales-Gualdrón, Gutiérrez-Gracia and Dobón, 2009) where the phenomenon of academic spinoff is mature. The development of Silicon Valley in North California and Route 128 in Massachusetts in the vicinity of prestigious universities such Stanford, Harvard and Massachusetts Institute of Technology have highlighted the role that universities and scientists can play in entrepreneurship, economic development and job creation (Walter, Auer and Ritter, 2006). During the past three decades spinoffs originating from universities in the United States of America (U.S.) have had a significant impact on the economic growth of the U.S. (Scholten, Kemp and Omta, 2004). It is therefore because of this economic importance that it is crucial to understand the intentions of potential academic entrepreneurs since they play a critical opportunity identification role in the technology transfer process (Hoye and Pries, 2009).

University spinoffs can be described as companies which are spun out from universities through the commercialization of intellectual property (IP) and transfer of technology emanating from academic institutions (Djokovik and Souitaris, 2006). According to the Association of University Technology Managers (AUTM), the changing role of universities towards commercialization

activities, combined with government and institutional support mechanisms has resulted in an increase in the number of spinoffs in the U.S. and internationally (AUTM, 2010). In the 30 years since the U.S. Congress passed the Bayh-Dole Act, which assigned ownership of federally-funded inventions to academic institutions, university inventions have led to over 6,000 new businesses, 4,300 new products, and 153 drugs (AUTM, 2010).

Research literature in spinoff creation has been in one of the three economic levels namely macro, meso and micro (Djokovic and Souitaris, 2008). The macro level studies have their focus on the macroeconomic environment in which the spinoff exists and give a view of the role of government and industry in the spinoff process. Furthermore the impact of policies and support mechanisms are also studied including the impact of the spinoff on the local economy (Djokovic and Souitaris, 2008). Meso-level studies are those that focus on the university and the Technology Transfer Office (TTO) as the units of analysis. Meso-level based literature explores the support mechanisms that can be applied within the university context in order to facilitate and promote spinoff creation (Djokovic and Souitaris, 2008). The micro-level studies are those that analyse the firm and the individual academic entrepreneur by looking into the networks of spinoffs, their founders and human relations and interactions during the spin-out formation process (Djokovic and Souitaris, 2008).

This study specifically focuses on the micro-level analysis at the individual level where the entrepreneurial intentions of academics to create spinoffs were studied.

1.2 Background on the research context

Etzkowitz and Zhou's (2007) triple helix framework states that the role of the entrepreneurial university in societies differs according to which helix is the leading innovation actor (Göktepe-Hultén, 2008). The U.S. exemplifies a university-led triple helix as seen by the role played by MIT and Stanford University in innovation and spinoff creation. In Germany, innovation is industry led through their 107 industry clusters which are formed based on the needs of the industry. Figure 1, indicates the typical type of partners involved in a cluster. In this case the university would play the role of creating spinoffs that would act as a supplier to the cluster (zu Köcker, 2009).

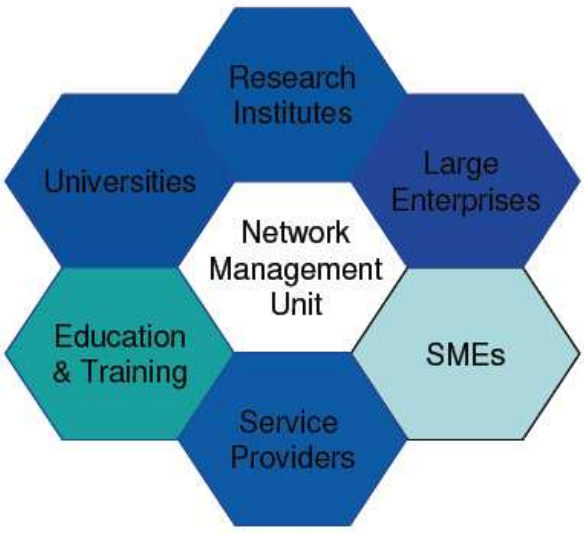

Figure 1: Main types of partners gathered in a German industry cluster (zu Köcker, 2009)

The situation in South Africa is different in that commercialization of university research outputs and academic spinoff creation is government led though the

Department of Science and Technology (DST) and the Technology Innovation Agency (TIA). TIA is an initiative of the DST which is mandated by government to provide financial and non-financial support to enhance the country's capacity to translate research and development outputs into commercially successful products and services that can stimulate the economy and improve the lives of its people (TIA Corporate Plan, 2009). The idea to create an innovation agency or Foundation for Technological Innovation (FTI) came about in the National Research and Development Strategy of 2002 (NRDS). The FTI would operate as a knowledge-based financing agency concentrating on innovation across the public and private sectors, and across the value chain from concept to market– though, with a key focus on high-cost development and market acceptance stages through commercialisation, incubation and diffusion (Figure 2).

In 2004 the DST and its agencies were established in order promote the establishment of a well-functioning National System of Innovation (NSI) as set out in the Science and technology White Paper of 1996. A review of South Africa's NSI by the Organisation for Economic Co-operation and Development (OECD) 2007 revealed that South Africa was the leading research performer on the African continent. Furthermore, the country was in the top 1% of the world's universities in fields such as ecology, social science, engineering, plant and animal sciences and clinical medicine (DST Strategic Plan, 2011). However, it was also found that there existed an innovation chasm/ valley of death of publicly funded R&D outputs; the NSI had fragmented instruments; and the innovation instruments had a narrow definition of innovation. The review thus highlighted the urgent need to extend the policy framework applicability to the

private sector in order to facilitate the flow of innovations from R&D to commercialisation (DST Strategic Plan, 2011). This formed an impetus for the TIA act of 2008, and the establishment of the TIA.

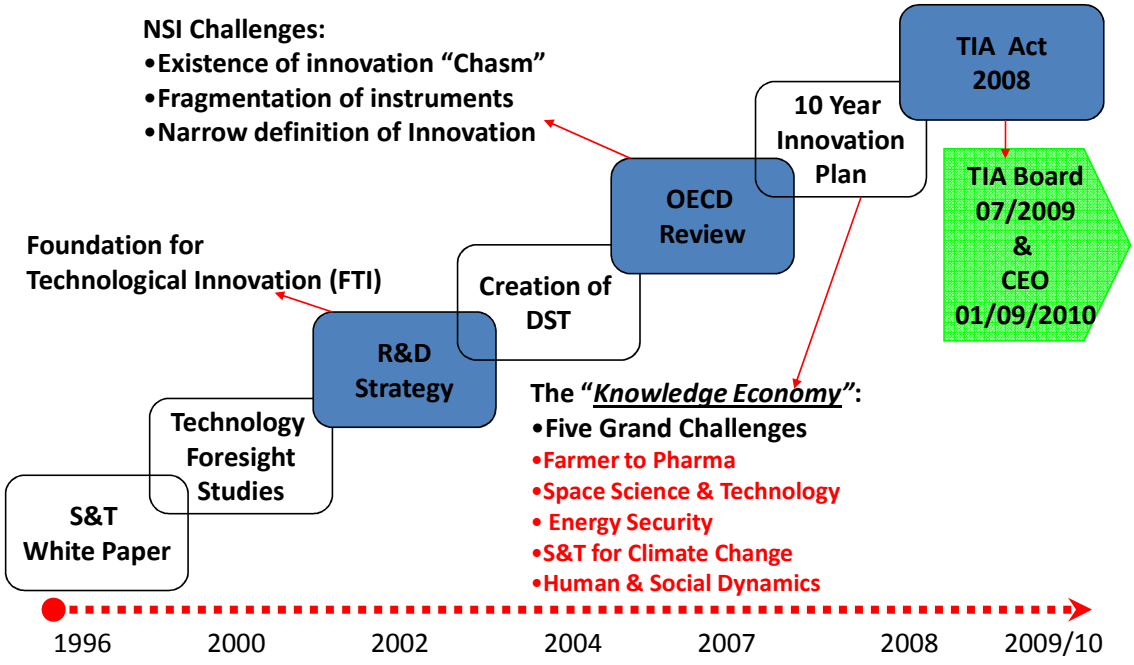

Figure 2: Innovation policy impetuses and milestones (TIA Corporate Presentation, 2011)

The major policy documents of TIA are the National Research and Development Strategy of 2002 and the Ten Year Innovation Plan (TYIP) (2008) of the DST. The former was formulated in order to exploit opportunities in areas in which South Africa has geographic advantage such as astronomy, human paleontology and biodiversity as well as in areas where South Africa has a knowledge advantage such as indigenous knowledge and deep mining (DST Strategic Plan, 2011). The TYIP builds upon the NRDS by including the five

Grand Challenges that focus on the farmer to pharma value chain in strengthening the bio-economy, space science and technology, energy security, climate change and human and social dynamics. Together with other government departments and agencies TIA is tasked with the responsibility to address these grand challenges.

1.3 Research aims and scope

This study aims to contribute to the emerging body of research in academic entrepreneurial intentions by addressing two questions:

- Do researchers in South Africa have intention to create spinoffs in a country where the phenomenon is incipient and the rate of creation of new ventures is so low?
- Which factors play a dominant role in predicting entrepreneurial intention? And how do these intentions compare between researchers in technical and non-technical fields of expertise?

This work was motivated by recent studies on entrepreneurial intentions and the study began in April 2011 and ended in October of the same year. The unit of analysis was the academic researcher based in a South African Higher Education Institution (HEI) or Science Council where research is funded mainly by government. The entrepreneurial intentions of researchers in both technical (science and engineering) and non-technical (social and behavioural) fields of expertise were measured using an online survey questionnaire (Appendix E). Data analysis was conducted using linear regression.

1.4 Research motivation

According to Prodan and Drnovsek (2010) the most important gap in the literature on academic spinoffs concerns empirical studies on entrepreneurial intention at the individual level. The same authors claim that there is little empirical data on the intentions of academics from non-scientific research areas such as social and behavioural sciences (Prodan and Drnovsek, 2010). This is despite the fact that business creation emanating from universities and research institutes is not limited to the technical disciplines (Arvanitis, Sydow and Woerter, 2008; Bekkers and Bodas Freitas, 2008; Fini, Lacetera and Shane, 2002).

Finding ways to stimulate entrepreneurship in South Africa has become the country's Gordian knot[1] (The Entrepreneurial Dialogues, 2010, p.6). South Africa is an emerging economy where respect and recognition for the contribution of entrepreneurs on job creation and economic development is not sufficient (The Entrepreneurial Dialogues, 2010). Furthermore, the country's financial, operating, and regulatory & policy environment is not supportive of entrepreneurs (The Entrepreneurial Dialogues, 2010). The banking system remains the main source of capital to start and grow businesses and entrepreneurial skills are severely lacking (The Entrepreneurial Dialogues, 2010). According to the 2010 Global Entrepreneurship Monitor (GEM), an international comparative research project that aims to benchmark the level of

[1] The term is often used as a metaphor for a complicated and intricate problem. Pertaining to Gordius in 1561, ancient king of Phrygia, who tied a knot (Gordian knot) that according to prophecy was to be undone only by the person who was to rule Asia, and that was cut, rather than untied, by Alexander the Great.

entrepreneurial activities across countries, South Africa scored below average for all indicators of entrepreneurial attitudes and perceptions. In 2009 South Africa ranked 27th (23rd previous year) out of 59 countries on the level of entrepreneurial propensity. South Africa's total entrepreneurship activity[2] (TEA) rate of 8.9% was below the average for all efficiency-driven economies (11.7%) as well as significantly below the average for all middle- to low-income countries (15.6%).

South African policy makers have long known of the "innovation chasm" that has been preventing research outputs in South Africa from being commercialised (Du Toit, 2006; Pouris, 2008). There is an urgent need to transfer local research outputs into local industrial products. The introduction of the Intellectual Property Rights Act, 2008 and the Technology Innovation Agency, 2009; are examples of how policy makers though creating the appropriate intellectual property rights regime, financial incentives and knowledge transfer can influence the commercial outputs of academic research. These and other macro factors such as access to funding, government policies, government programmes, education and training, research and development (R&D) transfer, legal infrastructure, internal market openness, incubator support, access to physical infrastructure, culture and social norms have been shown to be motivators towards the creation of spinoffs in South Africa (Herrington, Kew. P and Kew, J., 2009). What has been largely missing in South African studies are factors that influence entrepreneurship at the individual level. The missing link is the knowledge behind whether the

[2] The TEA rate measures the proportion of working-age adults in the population who are either involved in the process of starting-up a business or are active as owner-managers of enterprises less than 42 months old.

researchers have any desire to be entrepreneurs in the first place, and if so, what individual motivational factors influenced the decision to create spinoffs in an emerging knowledge economy such as South Africa. Armed with this information the Government, universities and science councils can formulate policies and programmes geared at promoting the entrepreneurial culture in post graduate students and researchers. The findings herein could also provide a light as to what needs to be instituted in order to support the researchers towards creating spinoff companies.

1.5 Novel contributions emanating from the study

The purpose of this study is to specifically identify the levels of entrepreneurial intention among academic researchers in an emerging knowledge economy. This is because results based on studies from developed knowledge economies such as the U.S., Canada, Finland and Germany might not be generalisable to countries whose universities have lower resource endowments. Furthermore, if the valorisation[3] of research results is to be considered as an engine for growth and job creation in South Africa, it then becomes imperative on policy makers to understand the key individuals that are involved in the creation of spinoffs.

This study contributes to the existing body of knowledge on entrepreneurial intentions it that:

1) The entrepreneurial intentions of both technical and non technical researchers were measured in a country where the creation of spinoffs is in its

[3] The OECD defines valorisation the testing and dissemination of the results of the most innovative training and education projects, but also the exploitation of these results and their development in new contexts and environments.

infancy. Furthermore the study not only focuses on researchers from a large variety of research fields, but also across universities of different status.

2) It has been said that individuals with intention to start a business can be identified and studied as they progress through the entrepreneurial process (Krueger and Carsrud, 1993). Therefore this study sets the basis for measuring intentions over a period of time from a starting point of very low intentions in a country attempting to build a knowledge economy.

1.6 Organisation of the dissertation

The layout of this dissertation is as follows:

Chapter 1 begins with a description of the research problem addressed by the study, followed by an overview of the context within which the study was performed. It outlines the aims and scope of the research, as well as the motivation of the study.

Chapter 2 presents a literature study and theory review that span the concepts and constructs applicable to the study. Firstly, the broad field of intentionality and its determinants, with particular focus on the three main models of intentionality are discussed. This is followed by topics discussing academic entrepreneurship, the concept and formulation of a spinoff and academic entrepreneurship specifically within the South African context.

Chapter 3 then presents an overview of the two research objectives that defined the focus of the study and related hypothesis.

Chapter 4 describes the methodologies used during the study in order to address the research objectives defined in Chapter 3. This includes descriptions of the populations, units of analysis, sampling plans, data collection processes and instruments, as well as the data analysis methods for each of the two research phases. A discussion on potential research limitations inherent in the study brings this chapter to a close.

Chapter 5 then presents the results obtained during the study which includes the appropriate descriptive statistics, as well as reliability and validity tests for the data collected, but also the outputs yielded by the multiple linear regression model.

Chapter 6 critically discusses the results presented in Chapter 5 against pertinent literature and other studies that focus on the topic of academic entrepreneurial intentions.

Chapter 7 constitutes concluding remarks on the core findings of the study, as well as suggestions for future research.

CHAPTER 2: LITERATURE AND THEORY REVIEW

2.1 Intentionality and its determinants

Intention has been conceptualised as being a function of beliefs that provide a link between those beliefs and subsequent behaviour (Boyd and Vozikis, 1994). This means that people form attitudes towards performing a given behaviour based on their beliefs that performing that behaviour will result in certain consequences. Therefore it goes without saying then that there should be a strong relationship between the intention to perform certain behaviour and the actual performance of that behaviour (Boyd and Vozikis, 1994).

Previous research on entrepreneurial behaviour has been based on psychological and non-psychological factors to explain who starts a new firm and why (Scholten et al, 2004). The psychological view states that entrepreneurship stems from need for achievement, desire for independence, internal locus of control and self-efficacy (Scholten et al, 2004). The non-psychological factors are based on events that happen in the individual's life and therefore determine behaviour. Three entrepreneurial intention based models based on social cognitive theory have dominated literature. Shapero's (1975) model of entrepreneurial event argues that entrepreneurial intention is based on perceptions of personal desirability, feasibility and propensity to act. Shapero's model states that a person's behaviour is affected by events that occur in the person's life. The events change the behaviour, norms and values in which decisions are made. Shapero's model assumes that the individual inherently possesses the potential to be an entrepreneur, but a displacing event is necessary for the potential to surface (Scholten et al, 2004).

In contrast, Azjen's theory of planned behaviour states that intentions are dependent on perceptions of personal attractiveness, social norms and feasibility (Fishbein and Azjen, 1975). This model argues that entrepreneurial intention is based on an individual's perceived ability to execute the intended behaviour of entering entrepreneurship, the individual's attitudes towards the desirability of an entrepreneurial career and subjective norms.

Intentions are said to be the single best predictor of any planned behaviour (Fishbein and Azjen, 1975), and since venture creation takes time and involves considerable planning and effort, entrepreneurship is also a type of planned behaviour (Bird, 1988). In this context, intention is defined as the search for information that can help fulfil the goal of venture creation (Katz and Gartner, 1988). The relationship between entrepreneurial intention and entrepreneurial behaviour has been studied and supported by other authors (Arenius and Minniti, 2005, Kolvereid and Isaksen, 2006).

The resource based theory of the firm (Krueger and Carsrud, 1993) is less popular and stipulates that that the likelihood of spinoff creation by researchers depends on the researcher's knowledge and skills to utilise the resources available to them better than others. The entrepreneurial intention model by Krueger and Carsrud (1993) and; Krueger, Reilly and Carsrud (2000) recognises that starting a business is an intentional act in accordance with Azjen's theory of planned behaviour and acknowledges that the entrepreneurial event is as a result of interaction with the environment (Prodan and Drnovsek, 2010).

This study proceeds with a model based on Azjen's theory of planned behaviour as it aims to analyse the intention before the actual entrepreneurial event takes place. Accordingly this theory postulates that personal and situational variables have an indirect influence on entrepreneurship by influencing key attitudes and general motivation to act (Krueger et al, 2000).

As mentioned previously, formation of entrepreneurial intention is dependent on (1) an individual's perceived ability to execute the intended behaviour of entering entrepreneurship. This is expressed through *entrepreneurial self-efficacy*; (2) attitudes toward the desirability of an entrepreneurial career which is expressed through *perceived role models*, and (3) subjective norms that are formed through interactions in one's *personal networks*. In addition to these three determinants of entrepreneurial intention, prior studies have highlighted importance of prior academic experience (herein expressed as *the number of years spent in the academic institution*), experience with patenting activity (expressed as *number of patents/ copyrights/ designs* taking into account other means of IP protection such as trademarks, copyrights and plant breeder's rights). Furthermore, interaction with industry (expressed as *industry cooperation*) and overall research focus (*type of research*) have also been identified as important determinants in the emergence of academic entrepreneurial intentions. In what follows, a brief theory review of the determinants highlighted above and used in the study is provided.

2.1.1 Entrepreneurial self-efficacy

Entrepreneurial self-efficacy is positively related to the intention to set up one's own business and it refers to the strength of a person's belief that he or she is capable of successfully performing the various roles and tasks of entrepreneurship such as marketing, innovation, management, risk taking and financial control (Chen, Greene and Crick, 1998, p295). Thus identification of key efficacy perceptions may be useful in determining the future performance levels of individuals engaged in the process of new venture creation since a person's conviction that he or she can master new situations may affect future performance (Boyd and Vozikis, 1994, p.73). In a various studies that measured entrepreneurial intention in school children (Peterman and Kennedy, 2003) and university students (Chen et al, 1998) it was found that exposure to enterprise or entrepreneurial education lead to increased self-efficacy which was positively related to the intention to set up one's own business.

2.1.2 Perceived role models

Role models *positively* affect entrepreneurial intentions because they affect attitudes and beliefs such as perceived self-efficacy (Krueger et al, 2000). It has been said that academic-peer role models who have started their own companies may significantly affect other academic's entrepreneurial activities (Prodan & Drnovsek, 2010). In a study conducted by Davidsson (1995) it was found that 40 % (N^4 = 1500) of small business owner-managers had a self-employed parent, compared with about 15 % whose parents were employed

[4] N denotes the sample size

elsewhere. In another study by Bosma, Hessels, Schutjens, Praag and Verheul (2011) which measured the impact of the presence of role models before and shortly after firm start-up, the function of these role models and the relationship and similarity of characteristics between the entrepreneur and his/her role model it was found that role models matter for pursuing an entrepreneurial career. The authours found that the great majority of entrepreneurs had a role model in the pre- and/or post-start-up phase of their ventures. They also found that role models are viewed as influential people by a significant proportion of the entrepreneurs who use them in the start-up phase of their venture. Furthermore, one third of the entrepreneurs with a role model at the time of start-up claimed that they would not have started up their venture had they not had a role model. These findings suggest that role models play an important role for entrepreneurs in young firms (Bosma et al, 2011). Therefore it is postulated that role models *positively* influence entrepreneurial intentions and, ultimately, entrepreneurial activity (Krueger et al., 2000).

2.1.3 Personal networks

Interpersonal and interorganisational networks are viewed as the media through which an entrepreneur can gain access to a variety of resources held by others such as financial and physical resources, information and advice (Hoang and Antoncic, 2003). It has been established that networks and peer groups influence the decision to become an entrepreneur while it is assumed that networks and peer groups may provide role models (Bosma et al, 2011). In a study that analysed the extent to which an entrepreneur interacts with the

networks in his or her local environment during the process of starting a new firm, it was found that these interactions would positively influence the eventual creation and the nature of the firm (Birley, 1985). The premise of this postulation is that during the start-up process, the entrepreneur will seek resources such as space, money, information as well as advice from both formal networks (banks, lawyers, etc) and informal networks (family, friends and business contacts) (Nicolaou and Birley, 2003a, 2003b). In a study that investigated the effects of three social sources of opportunity-related information (mentors, informal industry networks, participation in professional forums) on opportunity recognition, it was found that all three sources had direct, positive effects on opportunity recognition by entrepreneurs (Ozgen and Baron, 2007). In addition informal industry networks were found to be an important predictor of entrepreneurial self-efficacy.

2.1.4 Number of years spent at the academic institution

According to Prodan and Drnovsek (2010) the job stability and reputation of academics is normally dependent on teaching and publications. However entrepreneurship involves a high amount of risk, which may compromise the academic's career path by creating spinoffs at the expense of other research responsibilities. Other authours have also observed that as people get older, they become less likely to engage in risky activities (Lavesque and Minniti, 2006). Hence following on this logic, Prodan and Drnovsek predict that the number of years spent at the academic institution (which correlates with age) should have a negative effect on academic entrepreneurial intentions.

2.1.5 Intellectual Property

While patents are considered the indicator that is the most frequently used to reflect entrepreneurial activities of university researchers (Landry et al, 2006), this study also takes into account other means of IP protection such as trademarks, copyrights and plant breeder's rights as patents might not be the most appropriate protection of IP from non-technical fields of research. Landry et al (2006) found that the greater the effort made by researchers in activities related to the protection of intellectual property (such as filling out patent applications, registrations of copyrights for computer software or educational material, registration of process designs etc) the higher was their likelihood to create spinoffs compared to those of researchers who had not carried out such activities. Also it has been shown that the higher the value of the patent in terms of its coverage (domestic and international) and patent citations, which in turn increases the probability that technology transfer will occur via the formation of a start-up (Shane, 2001a). In a study conducted in MIT over a period of 16 years, it was shown that the number of patents applied for or granted was found to be positively related to entrepreneurial intentions (Prodan and Drnovsek, 2010; Shane 2001b).

2.1.6 Industry cooperation and type of research

Historically relations between universities and industrial partners, has been viewed primarily from the point of view that universities served as a source of human capital and knowledge useful to the firm (Etzkowitz, 1998). A vast literature has emerged on the type and impact of university-industry cooperation with specific focus on understanding the forms of university-industry interactions, co-patenting and co-publication, and the optimal conditions for creating spinoffs (Kruss, 2009). Various authours have found that in universities where researchers have industry links through funding, consulting or project related work, these researchers where more likely to spend most of their time conducting applied research and exhibited more entrepreneurial activity such as patenting, introducing products to markets and creating start up companies (Bluementhal, Campbell, Causino and Louis; Landry et al, 2006; Prodan and Drnovsek, 2010). Furthermore, it has also been shown that researchers who spent the majority of their time performing applied research rather than basic research generally paid more attention to industry requirements and understanding the potential market applications of their research outputs (Grandi and Grimaldi, 2005). It is on this premise that it is formulated that cooperation with industry is positively related to the number of patents, the type of research (specifically applied research) and to academic entrepreneurial intentions.

2.2 Academic entrepreneurship

Universities and science councils as producers of innovation have had to evolve in the way they see research outputs (Ndonzuau, Pirnay and Surlemont, 2002). There has been a transformation from discipline based, pure science which is curiosity driven to an emphasis on application and commercialisation of research outputs (Duberly, Cohen, and Leeson, 2007). New university policies, national policies and funding instruments offered by government have meant that researchers must now look at their research outputs from a dual perspective. Firstly from the traditional research perspective in which research outputs are published in peer reviewed journals where the reward is respect and recognition. Secondly from an entrepreneurial perspective in which research outputs are evaluated for their intellectual potential (patentability) as well as commercial potential where rewards could be financial (Duberly et al, 2007). Academic engagement now means that there has to be collaboration across disciplines and partnerships with the community in order to produce solutions to society's most important and urgent problems (Hildebrand, 2005).

Academic entrepreneurs have the possibility of three different types of career transition options available to them, i.e. transition to government-sponsored entrepreneurship programs, to young entrepreneurial companies and to R&D departments in established organisations (Duberly et al, 2007). This paper measures entrepreneurial intentions at a priori to the establishment of a firm regardless of the final career choice of the academic entrepreneur.

The academic entrepreneurial intentions have been previously studied on final year students (Kroll and Liefner, 2008; Ochaeta, 2007) as this group was considered to be a sample that possesses a broad spectrum of intentions and attitudes towards entrepreneurship. At this stage of the student's lives details of a business may not have yet coalesced in their minds, but global career intentions should have (Krueger et al, 2000). It will be interesting to see how the model performs in a sample made up of academics, as these people have already made a career decision, as it has previously been found that the more a researcher is entrenched and deeply anchored in the institution in which they work, the more difficult it will be for them to launch an entrepreneurial project (Udell, 1990).

2.3 The spinoff

A university spinoff refers to the creation of a new company established in order to commercially exploit research knowledge created by university researchers (Landry et al, 2006, p.1603). Geenhuizen and Soetanto (2009) define the academic spinoff as a venture created for the purpose of commercially exploiting a new technology or research results developed within a university, whereby the transfer of knowledge from university to company is direct; and the firm founders have their origin in the university. Due to the definitional inconsistencies in the definition of the spinoff, Nicolaou and Birley (2003a) proposed a trichotomous categorisation of spinoffs based on three categories; (1) *orthodox* in which the academic forms a new company outside the university; (2) *hybrid* where the academic maintains employment within the

university but the new company is formed outside the university and the academic holds a directorship role within the spinoff company; and (3) *technology* where the spinoff occurs outside the university and the academic having no connection with the newly established firm.

The commercialisation of knowledge emanating from research can be through consulting services, research contracts with industry, patenting and new venture creation through spinoffs. The latter is the most visible form of commercialisation of university research (Landry et al, 2006). University spinoffs differ from industrial firms (corporate spinoffs), in that the former encourages the transfer of knowledge to be used outside the university and the latter often tries to keep research and technology within the firm (Péréz Péréz and Sánchez, 2003).

According to Ndonzuau et al, (2002) the transformation of research results into a spinoff occurs in four successive stages interacting in a sequential manner where;

- Stage 1: involves generating business ideas from research.
- Stage 2: involves finalising of new venture projects out of ideas.
- Stage 3: entails launching spinoff firms from projects.
- Stage 4: is aimed at strengthening the creation of economic value by spinoff firms.

In a paper that examined the influence of network structures in the generation of the university spinoffs (Walter et al, 2006) it was found that the type of exoinstitutional and endoinstitutional network ties formed by the academics

influences the type of spinout initiated as described previously by Nicolaou and Birley (2003b).

In Canada and the US it was found that the competitive advantage of spinoffs was likely to be based on the entrepreneurial intentions of the researchers (Landry et al, 2006). The same study showed that those researchers who were determined to create enterprises were more likely to create successful spinoffs than those who created spinoffs as a funding requirement. However, Autio and Kauranen (1994) in their study of Finnish academic entrepreneurs found that while intentions were responsible for new venture creation, they did not play a role in the success of a spinoff firm.

2.4 Research fields

Literature has shown that business creation emanating from universities and research institutes is not limited to the technical disciplines (Arvanitis, Sydow and Woerter, 2008; Bekkers and Bodas Freitas, 2008; Fini, Lacetera and Shane, 2002). Previous studies on spinoff creation have shown that the research field in which the academic is involved influences the propensity towards spinoff creation (Landry, Amara and Ouimet, 2007). The age of the technical field within which the patent is registered was also found to influence the likelihood of a new technology being exploited through firm formation (Prodan & Drnovsek, 2010; Shane, 2001b).

2.5 The South African context

While the notion of an entrepreneurial university came to the fore in the 1990s in South Africa (Kruss, 2009) most universities adopted a narrow view of entrepreneurship in terms of short term, market driven goals to raise income for the university in the face of declining funding from the government (Kruss, 2009). Furthermore in South Africa the focus has been less on creating academic spinoffs and more on technology diffusion (Phaho, 2007) where basic understanding, information and innovations move from universities or research councils to individuals or firms in the private sector (Phaho, 2007). In Canada, this type of industry-university partnerships were found to have a negative impact on spinoff creation as it encouraged the researchers to transfer knowledge directly to their industry partner rather than to independently create a spinoff (Landry et al, 2006). In addition to these challenges, the fragmented and unequal higher education system in South Africa means that very few universities have the capabilities required for launching successful high technology start-ups and commercial ventures (Kruss, 2009, p19).

CHAPTER 3: RESEARCH OBJECTIVES AND HYPOTHESIS

3.1 Introduction

The following sections detail the study's research objectives, with associated research hypothesis.

3.2 Research objectives

The study was quantitative in nature as it aimed to measure the level of known predictors of entrepreneurial intentionality amongst academics. Intention indicators described by Prodan & Drnovsek (2010) were measured in a South African context, and the entrepreneurial intentions of researchers from technical fields were compared to those from non-technical fields. This model was chosen as it has been tested across different cultures and showed that individual cultural differences have no impact on the results (Prodan & Drnovsek, 2010). Furthermore the model tests both psychological (traits perspective) and non-psychological (event based & behavioural) factors to explain who starts and new firm and why.

- *Research objective 1*: To measure entrepreneurial intentions among academics in HEIs and SCs
- *Research objective 2*: To compare intentions between researchers in technical and non-technical fields of expertise and;
- *Research objective 3*: To explore the underlying reasons should there be significant differences between the two groups.

3.3 Research hypothesis

The literature sources, data collection tools and methods of analysis relating to the hypothesis below are summarised in the consistency matrix (Appendix A).

Part 1: To measure entrepreneurial intentions among academics in HEIs and SCs

H1: The entrepreneurial intentions of South African researchers are low.

The model for measuring entrepreneurial intentions of academics (Prodan & Drnovsek, 2010) was used to measure the entrepreneurial intentions of the researchers. The model is based on the following hypothesis:

H1.1: Entrepreneurial self-efficacy is positively related to academic entrepreneurial intentions.

H1.2: Academic's personal networks are positively related to the academic entrepreneurial self-efficacy and academic entrepreneurial intentions.

H1.3: The extent of perceived role models is positively related to the extent of entrepreneurial self-efficacy and the intensity of academic entrepreneurial intentions

H1.4: The number of years spent at the academic institution is negatively related to academic-entrepreneurial intentions

H1.5: The number of patents/copyrights/ designs (applied/granted) is positively related to academic-entrepreneurial intentions

H1.6: The prevalence of applied research (type of research) is positively related to academic entrepreneurial intentions

H1.7: Cooperation with industry is positively related to the number of patents/ copyrights/ designs (applied/granted) and type of research and to academic-entrepreneurial intentions

Part 2: *To determine if the entrepreneurial intentions of researchers in technical fields differ from those of researchers in social fields of discipline.*

H2: There is a significant difference between the entrepreneurial intention level of academics in technical fields and academic in social fields. If this hypothesis proved to be true then Part 3 of the study would be conducted as described below.

Part 3: *To determine the underlying determinants for observed differences in the data through exploratory research.*

Research Question 1: What are the underlying reasons for the observed differences between entrepreneurial intentions in social and technical fields?

Note: The initial plan was to conduct this part of the study only if the results obtained for Part 2 showed that there was a statistically significant difference in the intentions between the two groups. The results of part 2 revealed that there

was no statistical difference in intentions of the two groups (Section 5.2.9), therefore Part 3 was not performed. However, below is a description of the methodology and analysis that would have been followed had the results been otherwise.

A qualitative approach would have been pursued in order to explore the underlying determinants behind the differences in intentions between the two groups. According to Marshall (1996) a qualitative approach is best suited when a study aims to provide illumination and understanding of complex psychosocial issues and is most useful for answering humanistic 'why?' and 'how?' questions. A convenience sampling technique would have been used involving the selection of the most accessible subjects. Convenience sampling in this case would have been the most appropriate as the issue under investigation was intentionality at the individual level and all respondents were considered sufficiently qualified to give expect opinion as they were experts within their research fields. Furthermore this sampling method is the least costly method to the researcher, in terms of time, effort and money (Marshall, 1996) since the method of interview will be face to face.

A sample size of 10 respondents (five from each group) selected from Science Councils and Universities in Gauteng would have been used for in-depth analysis. A review of literature by Staphorst, 2010 has shown that, according to the consistency theory, when interviewing experts a sample size of as small as four respondents can be adequate (Staphorst, 2010). However there are other factors that influence the choice of sample size such as the number of theme definitions, size and complexity of the data, researcher experience and level of

fatigue and the number of researchers processing the data. The data would have been collected until a point of data saturation is reached. Data saturation occurs when there is no longer new information or themes observed in the data (Guest, Bunce & Johnson, 2006). This would require constant analysis of the data throughout the data collection phase without waiting for all the data to be collected before analysis could proceed. Just like any other technique this methodology does have its disadvantages (Mason, 2010).

Three questions would have been posed to the respondents during the in-depth analysis using an open ended questionnaire (Leedy, 2001) (Table 1). The informed consent (Appendix 3 A) and Screening questions would be the same as those used in Part 1 of the study.

Table 1: Open ended questionnaire to discover underlying determinants of differences between researches in social and technical fields

Research Question	**Open ended questions**
1. What are the underlying determinants observed to explain the differences between the entrepreneurial intentionality between academia in social and technical fields of discipline	1. What are your thoughts on academic spinoffs? 2. In your opinion what is the general feeling towards creating spinoffs in your current environment? 3. What support mechanisms do you think needs to be in place to promote the creation of spinoffs?

To analyse the results of Part 3, the obtained interview transcripts would be analysed using combination of Theme Extraction, Constant Comparative

Method and Weighted Frequency Analysis (Staphorst, 2010). The methodical triangulation approach will be used to test for the reliability and validity of the qualitative questionnaire (Staphorst, 2010). From here on, the dissertation continues with a presentation of the results obtained for Parts 1 and 2 of the study.

CHAPTER 4: RESEARCH METHODOLOGY AND DESIGN

4.1 Introduction

This chapter details the research study's two-part process that investigated the entrepreneurial intentions of researchers based on known models, including a comparison of intentions of researchers from scientific disciplines versus those from non-scientific fields. The study did not aim to find new determinants of entrepreneurial intentions, but measured those already defined by other authors; therefore the study was quantitative in nature. The intention was that should the intentions between the two groups be found to be statistically different then, a third part of the study would focus on finding the underlying reasons through unstructured interviews. Part 3 of the study was not conducted as it was found that there was no statistically significant difference between the intentions of the two groups under observation (see Chapter 5).

This chapter describes the study population, unit of analysis, sampling plan and data collection tools for the study and concludes with potential research limitations inherent in the study's methodology.

4.2 Part 1: *To measure entrepreneurial intentions among academics in HEIs and SCs*

4.2.1 Scope

Technical fields were defined as those falling within the realm of technology as defined by the Oxford dictionary (the branch of knowledge dealing with

engineering or applied sciences such as engineering, chemistry and physics. Non-technical fields were defined as those fields dealing with the scientific study of human society and social relationships such as Economics, Hospitality and Catering, Sport, Travel and Tourism (Oxford Dictionary, 2010). The research was conducted over a period of seven months (April-November 2011). For a detailed list of activities see Appendix B.

4.2.2 Population and sampling

The study population consisted of researchers from South African universities, universities of technology and SCs in technical and non-technical disciplines. Purposive sampling was conducted in order to only select those researchers who had not yet created a spinoff. This was necessary as sampling current or successful entrepreneurs introduces biases that censor data unpredictably (Krueger et al, 2000, p420). This is because human beings behave inconsistently in different times and situations and it is likely that the experience from the entrepreneurial event may affect the individual's behaviour. (Sholten et al, 2004). A sample frame of 2286 researchers was obtained from National Research Foundation's (NRF) database which contained a list of both rated and non-rated researchers. The sample frame was in the form of an Excel spreadsheet with the following fields: surname, initials, title, current affiliation (institute), rating category, specialisation, email. Appendix C contains a list of the HEIs and SCs represented in the sample. A sample of 700 researchers were selected using stratified random sampling to ensure equal representation of scientists from the two strata, with strata comprising 350 members. Stratum 1

was comprised of researchers from technical fields of expertise while stratum 2 comprised those from the non-technical fields. The entire population could not be pursued as the sample frame contained units without email addresses, units from institutions other than higher education institutes and science councils for example private companies, museums and government departments. Furthermore some units in the sample frame were retired from academia.

4.2.3 Data Collection Processes and Research Instruments

Building on the theory of planned behaviour and the findings of Bird (1988) Krueger and Carsrud (1993) the hypothesis investigated in this study were based on an academic entrepreneurial intentions model by Prodan and Drnovsek (2010). The model builds upon existing findings on characteristics of planned behaviour; and measures academic entrepreneurial intentions (AEI) as the dependent variable. The independent variables are entrepreneurial self-efficacy, personal networks, perceived role models, number of years spent at the academic institution, number of patents/ copyrights/ designs, type of research conducted and perceived role models (Prodan and Drnovsek, 2010). This test included a seventh factor, cooperation with industry, however their results showed that there is no direct influence of industry cooperation on entrepreneurial intentions. This test has been chosen for the South African context as it has been shown that the independent variables are significantly related to AEI regardless of cultural context (Prodan and Drnovsek, 2010).

The information on intentions was collected via an email questionnaire which provided a link to an online questionnaire. This approach was chosen as it was assumed that the complete population had internet access since they had an

email address. The advantage of an online questionnaire is that it allows the respondents to fill out part of the questionnaire and complete the questions later. The SurveyMonkey, a web based survey solution, was used to create the online questionnaire and for data collection (SurveyMonkey, 2011). SurveyMonkey was chosen as the preferred online survey tool over other solutions such as Google Forms (Google Forms, 2011) for the following reasons:

- It was found to be more user-friendly and easier to learn by the author.
- All responses are immediately recorded in a Microsoft Excel spreadsheet that can be easily downloaded and printed in portable document format. (PDF).
- The questionnaire can be sent via email, Twitter and Facebook.
- It also allows for the tracing of individuals that had partially completed the questionnaire so that reminders can be sent to those that have partially completed and those that have not completed the questionnaire.

The email invitation to participate in the study (Appendix D) and questionnaire (Appendix E) were prepared in English, as this is the medium of business communication in South Africa. The questionnaire was comprised of four sections; the consent form, screening questions, demographic data section and the survey questions. The purpose of the demographic data was to increase the fidelity of the collected data for future studies that might use the data as secondary information.

In order to measure AEI (Prodan & Drnovsek, 2010), six items were measured (1) the researcher's interest in setting up a business; (2) the researchers

determination in having their own company; (3) the propensity to turn identified opportunities to commercialisation of research outputs; (4) the researcher's probability that they will start a business in the next five years; (5) the researcher's probability that they will start a business within the next two years; and (6) the number of activities undertaken in the past year related to starting a business. The questionnaire was based on a five point Likert scale with the following answers for the questions above (Prodan & Drnovsek, 2010): (1) Not interested at all to very interested, (2) Not determined at all to very determined, (3) Strongly agree to strongly disagree, (4) Scale of 0-100%, (5) Scale of 0-100%, (6) See Table 2 for list of activities related to starting a business:

Table 2: List of activities related to starting a business (Prodan & Drnovsek, 2010):

	Activity
1	Gathering information on competitors
2	Gathering information on substitute products
3	Gathering information on industry and customers
4	Gathering information on potential suppliers
5	Gathering information on the cost of raw materials and labour costs
6	Gathering information on costs of rents, leases and equipment
7	Establishing a price for the product/service offering
8	Making sales/revenues projections
9	Refining/ improving the business idea
10	Seeking financing
11	Gathering information on legal requirements (permits, licences and so forth)
12	Developing goals and objectives (business plan, organisation structure, strategic plan)
13	Choosing a business name, legal status
14	Finding a location for the business

The questionnaire measured academic entrepreneurial intentions using seven predictors (Prodan & Drnovsek, 2010) and the questions thereof as shown in the table below:

Table 3: Academic entrepreneurial predictors and questions to be used in questionnaire (Prodan & Drnovsek, 2010).

Predictors	**Questions**
1. Entrepreneurial self-efficacy	
Respondents will be asked to indicate their degree of certainty in performing 11 roles/tasks on a five point Likert scale ranging from 1 (completely unsure) to 5 (completely sure) (Prodan & Drnovsek, 2010)	**Roles/tasks**
	Control costs
	Define organisational ROLESA
	Define responsibilities
	Develop new ideas
	Develop new products
	Develop new services
	Establish product's market position
	Expand business
	Set and attain profit goals
	Set and attain market share goals
	Set and attain set goals
2. Personal networks	
Personal networks will be assessed with three items (Prodan & Drnovsek, 2010)	**Measurement item**
	Number of average hours per week spent on maintaining contacts (via face to face, email, telephone) with people with whom business matters are discussed (e.g. commercialisation, marketing, finance)
	Number of average hours per week spent on developing new contacts with people to discuss business matters
	Total number of people with who business matters were discussed during the previous week
3. Type of research	
Type of research will be assessed with two items (Prodan & Drnovsek, 2010)	**Measurement item**
	Numbers of hours per week spent on applied research divided by (÷) Number of hours per week spent on basic research
	Numbers of hours per week spent on applied research

4. Number of years spent at the academic institution	
Number of years spent at the academic institution will be assessed with one item (Prodan & Drnovsek, 2010)	**Measurement item**
	Total years spent at the academic institution
5. Intellectual property (patents/ copyrights/ designs)	
Intellectual property (patents/, copyrights/ designs) will be assessed with two items (Prodan & Drnovsek, 2010)	**Measurement item**
	Number of patents/ copyrights/ designs granted to academic during the last three years
	Number of patents/ copyrights/ designs the academic applied for during the last three years
6. Cooperation with industry	
	Measurement item
Cooperation with industry be assessed with one item (Prodan & Drnovsek, 2010)	Number of hours per week spent on industry-ordered projects
7. Perceived role models	
Perceived role models will be assessed with one item (Prodan & Drnovsek, 2010)	**Measurement item**
	The number of academic entrepreneurs known by the respondents personally (has met and spoken with)

Prior to data collection the ease of use of the questionnaire was tested on ten researchers with similar characteristics to the study sample. Their feedback was used to make improvements to the questionnaire. Data collection occurred over a period of seven weeks. Three reminders were sent to remind respondents to answer the questionnaire, the first one after a week, and the others after every two weeks. Collection stopped seven weeks from the date of the first questionnaire sent.

Part 2: *To determine if the entrepreneurial intentions of researchers in technical fields differ from those of researchers in social fields of discipline**.***

See section 4.2.4c

4.2.4 Data analysis

Part 1: *To measure entrepreneurial intentions among academics in HEIs and SCs*

4.2.4a Analysis of the factors that explain whether the respondents have intentions or not

For quantitative statistics analysis Widows Microsoft Excel was used to analyse the data. A Multiple Linear Regression Model that evaluates academic entrepreneurial intentions as the target variable was used. The inputs of the model were the seven factors of academic entrepreneurial intentions described in Prodan & Drnovsek (2010). These are:

- X_1 – Entrepreneurial self-efficacy
- X_2 – Personal networks
- X_3 – Perceived role models
- X_4 – Number of years spent at the academic institution
- X_5 – Number of patents/ copyrights/ designs
- X_6 – Type of research conducted
- X_7 – Perceived role models.

The dependent variable for each respondent was then evaluated to generate *n* values of academic entrepreneurial intention. The Multiple Linear Regression Model is widely used in behavioral and social sciences to describe possible relationships between variables. What makes this the model of choice is that it is easy to setup and it allows for a simple analysis and interpretation of results

that does not require advanced statistics. The model is subject to the following basic requirements:

1. The relationship between all the variables must be linear
2. The residuals (predicted minus observed values) must follow the normal distribution

The linearity requirement was confirmed through a bivariate scatter plot between each variable and the corresponding residuals. Normality was confirmed through the Anderson-Darling normality test, which is one of the most powerful tests for normality (Razali and Wah, 2011).

The Multiple Linear Regression model was then set up as follows:

$$Y_{1j} = \beta_{1J}X_{1j} + \beta_{2J}X_{2j} + \beta_{3J}X_{3j} + \beta_{4J}X_{4J} + \beta_{5J}X_{5J} + \beta_{6J}X_{6J} + \beta_{7J}X_{7J}$$

Where:

$\beta_{1J}, \beta_{2J}\ldots \beta_{5J}$ are the regression coefficients for the predictor variables $X_{1j}, X_{2j}\ldots X_{7j}$ and Y_{1j} is the measured entrepreneurial intention for the j^{th} respondent. Where j ranges from 1 to n and where n is the sample size.

The level of significance used throughout this study was $\alpha = 0.05$. The following validity/reliability tests were conducted on the model, using 0.05 as a cutoff point:

1. *The F test for significance of regression* - this test checks the significance of the whole regression model. If this test returns a significance level greater than the preferred α value (0.05 in the case of this study), the model can be considered unreliable.

2. *The t test* - this test checks the significance of individual regression coefficients. The model calculates p values for each of the coefficients. All coefficients whose p values are greater than the preferred α value of 0.05 can be considered statistically insignificant and thus unreliable.

Once the above tests were conducted, the model was accepted as reliable and was then used to evaluate academic entrepreneurial intentions. The predicted variable was scored using the Likert scale such that the value of intention could be assessed using the following ranking: 1= no intention, 2= low intention, 3 = moderate intention, 4= high intention and 5 = very high intention.

4.2.4b Analysis of factors associated with the higher levels of intention

A regression analysis was used to assess the influence of the different factors on academic entrepreneurial intentions (Scholten et al, 2004).

4.2.4c Comparison of intentions from the two groups

Since the data sample per group was less than 30, a non parametric Mann Whitney U test (Fay and Proscan, 2010) was used to measure if there is a significant difference between the two groups.

4.3 Handling of non responses and response bias

Bouncing emails and including those where the email account holder has opted out of online surveys were considered as undelivered. Potential non-response bias and missing items were assessed using the methods described in Prodan

and Drnovsek, 2010. A single factor test was used to examine whether a significant amount of common method bias existed in the data (Prodan and Drnovsek, 2010).

4.4 Reliability and validity

Cronbach's alpha of internal consistency (Nunnally and Bernstein, 1994) was used to test the reliability of the quantitative questionnaire. An alpha value with a lower limit of 0.7 and upper limit of 0.9 was considered acceptable (Hair, Black, Babin and Anderson, 2010; Nunnally and Bernstein, 1994).

4.5 Research limitations

1. The variables used in this study are, according to prior literature, the most probable determinants of intentions and motivations. There are other variables that could be considered for inclusion (Prodan & Drnovsek, 2010).

2. The study was conducted in various universities across the country where specific corporate or social cultural determinants exist that may affect the results (Prodan & Drnovsek, 2010)

3. Since this research sample only considers scientists and engineers employed at universities and science councils, research findings cannot be generalized to academics from all research areas (Prodan & Drnovsek, 2010).

4. The cross-sectional nature of this study cannot prove causality.

CHAPTER 5: RESULTS

5.1 Introduction

This chapter presents the results obtained for the methodology employed in this study. The results section starts with a presentation of sample characteristics, followed by a summary of the descriptive statistics for the data captured through the online survey questionnaire (Appendix E) and the linear regression model results. The reliability and internal consistency confirmation results are also presented here.

5.2 ***Results of Part 1****: To measure entrepreneurial intentions among academics in HEIs and SCs*

5.2.1. Sample characteristics

The questionnaire was sent to 700 respondents (350 technical, 350 non-technical) using random stratified sampling technique. There were 17 emails that bounced and one respondent had opted out of Survey Monkey surveys. These were considered as undelivered thus making the total of sent emails equal to 682. Of the 682 only 96 were completed making the response rate 14%. Two respondents answered “No” to the consent statement and were excluded from the study. Thirty-three respondents said that they had founded or were part of a business and were excluded from the study. Fifteen questionnaires with a high proportion (more than 20%) of missing data were excluded (Prodan and Drnovsek, 2010). Two questionnaires had unrealistic/unreliable answers and were also excluded. Therefore the total

number of surveyed respondents was thus 44 in total. At the end only 7 respondents were from the non-technical and 37 from the technical fields of research.

5.2.2 Biographical data

When asked to indicate the type of institution where the respondents worked, 58.4% of respondents said they were employed at the universities, 40.4% at Research Councils and 1.1% at universities of technology. An analysis of the responses revealed that 21.5% respondents were in non-technical fields of research while 78.5% were in scientific and engineering professions. On average the respondents spent 13.2 years in academia ranging from one to 40 years. The average age of the respondents was 44, ranging from 28 to 64 years old. When respondents were asked to indicate the highest qualification they had obtained 1.1% indicated a Bachelor Degree, 2.3% an Honours Degree, 23.0% Masters Degree and 73.6% indicated a PhD.

5.2.3 Test for non-response bias

An analysis of missing items (i.e. non response) was conducted to test for non response bias. A summary of the proportions of missing values is shown in Table 4 below.

Table 4: Analysis of missing items from the questionnaire

Total of excluded respondents due to missing data	**15**

	TOTAL	**% Deleted due to missing data**
No of universities (includes 1 university of technology)	53	15%
No of research institutes	36	14%
No of technical respondents deleted for missing data	16	19%
No of non-technical respondents deleted for missing data	2	17%
Total No of respondents	96	N/A
Total missing data	19	20%
No of "Unidentified" institutions	7	N/A

5.2.4 Reliability and internal consistency

Cronbach's alpha of internal consistency was used to test the reliability of the questionnaire for variables having more than one item.

Table 5: Test for Internal consistency

Variables	**Cronbach's alpha**
Entrepreneurial self-efficacy	0.95
Personal networks	0.53
Number of patents/ copyrights/ designs	0.67
Cooperation with Industry	-1.12
Academic entrepreneurial intentions	0.91

5.2.5 Linearity

The residual plots below were generated to check for linearity between the predicted variable (Y_{AEI}) and each of the predictor Variables X_1-X_6.

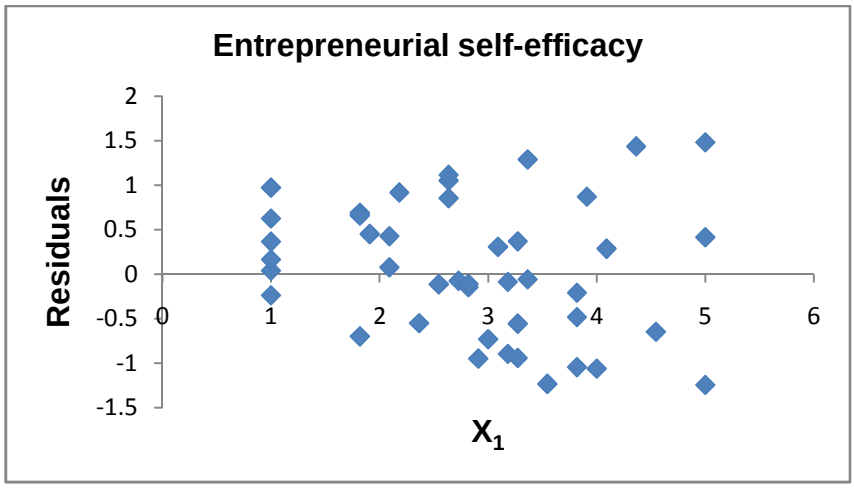

Figure 3: Residual plot for linearity between Y_{AEI} and Entrepreneurial self-efficacy (X_1)

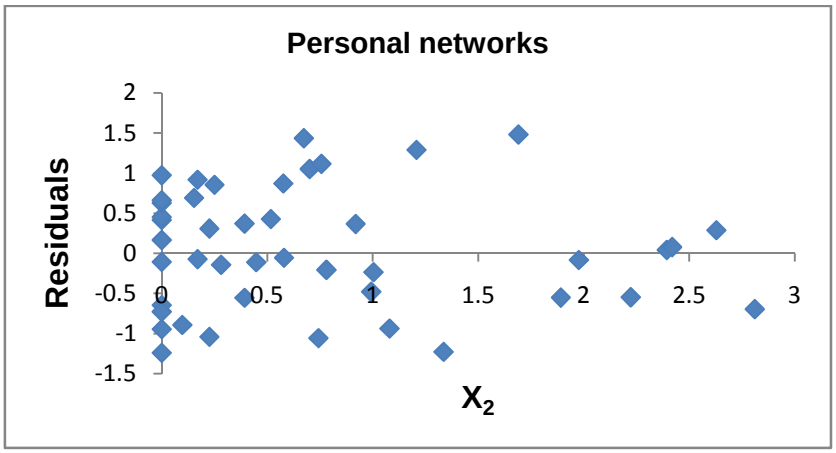

Figure 4: Residual plot for linearity between Y_{AEI} and Personal networks (X_2)

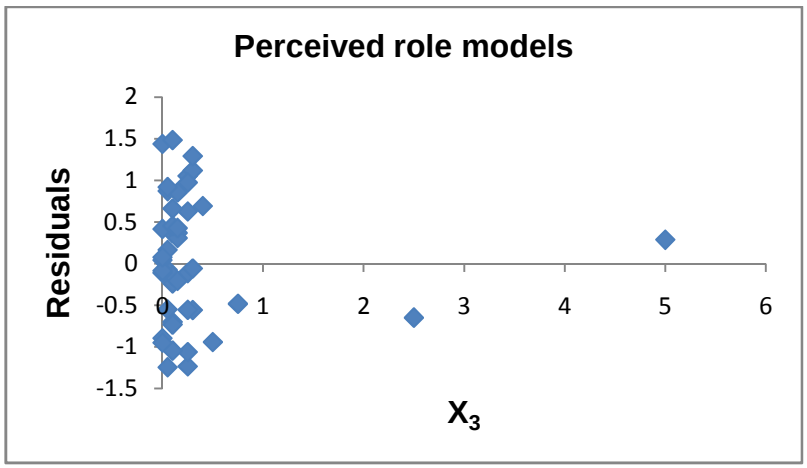

Figure 5: Residual plot for linearity between Y_{AEI} and Perceived role models (X_3)

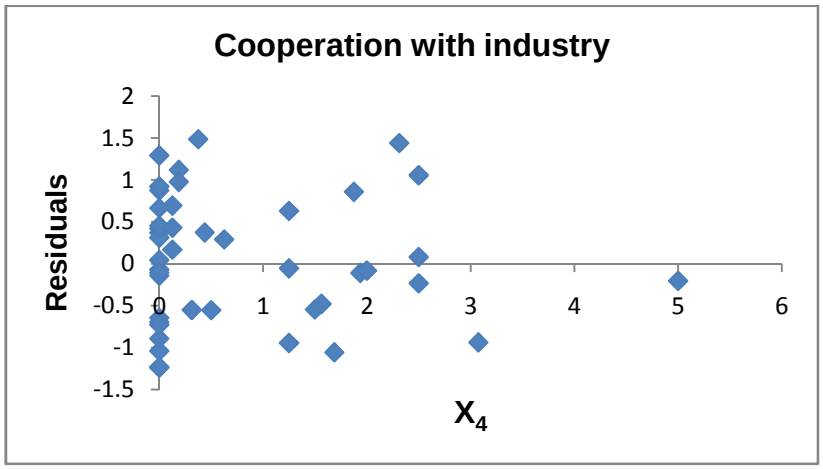

Figure 6: Residual plot for linearity between Y_{AEI} and Cooperation with industry (X_4)

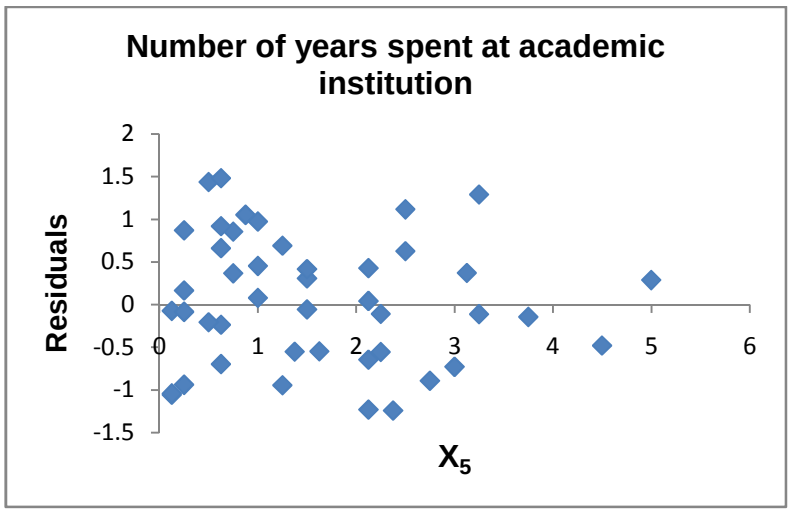

Figure 7: Residual plot for linearity between Y_{AEI} and Number of years spent at academic institution (X_5)

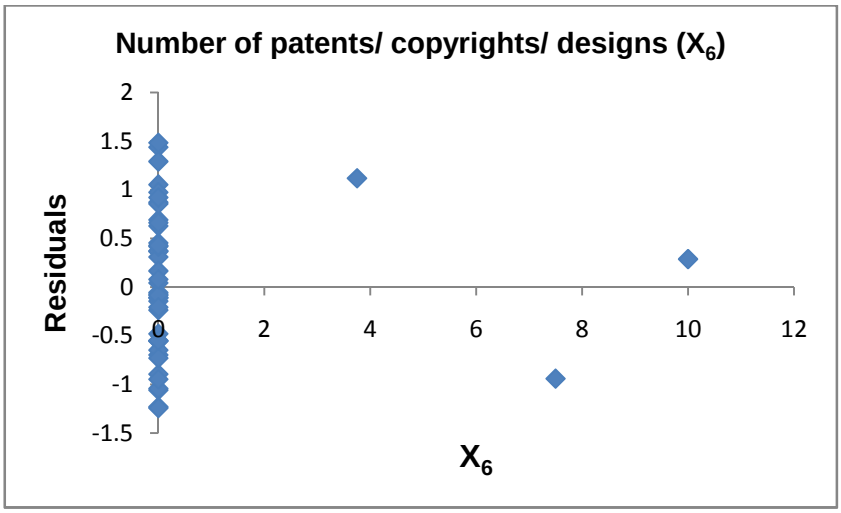

Figure 8: Residual plot for linearity between Y_{AEI} and number of patents/ copyrights/ designs (X_6)

5.2.6 Normality (Anderson-Darling test)

The Anderson-Darling normality test was conducted on the residuals as is the requirement for a linear regression model. The results of the test are summarized in the graph below (Figure 9). The test calculates the p-values of the residuals and compares it to the selected alpha value (alpha= 0.05 was used throughout the study). If the calculated p-value for the residuals is greater than alpha, then the data is considered to have come from a normally distributed sample. In this case the calculated p-value was found to be **0.813.**

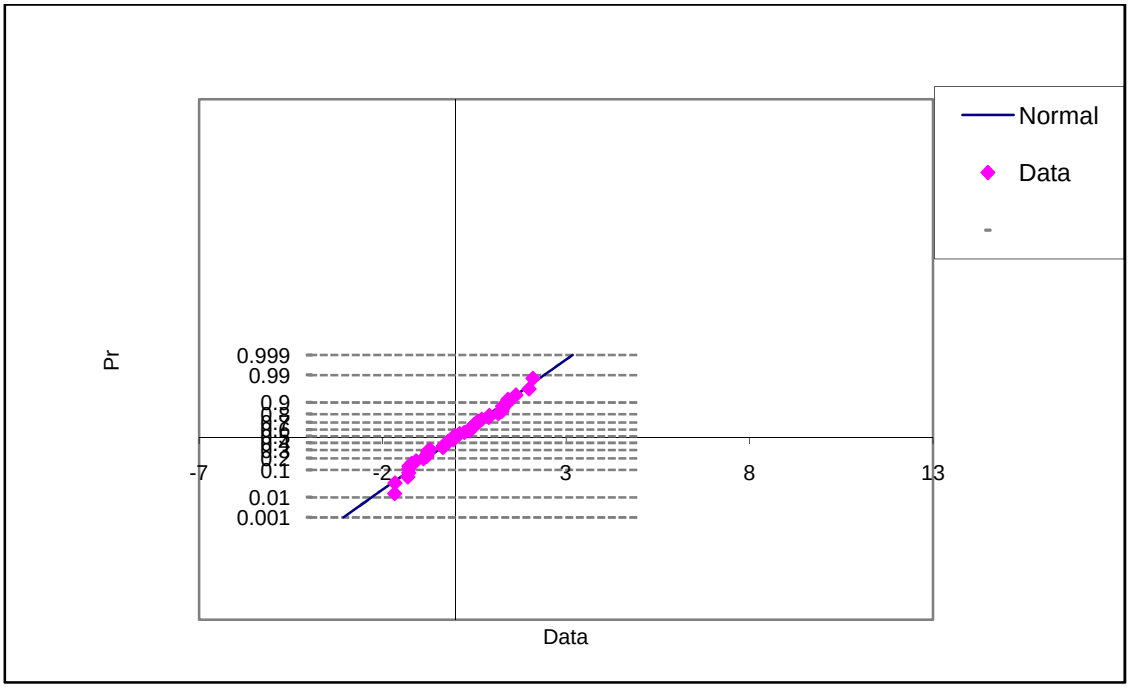

Figure 9: Normal Probability Plot

5.2.7 Analysis of the factors that explain whether the respondents have intentions or not

A multiple linear regression model was used to predict entrepreneurial intention using the seven predictor variables namely (1) Entrepreneurial efficacy, (2) Personal networks, (3) Type of research, (4) Number of years spent at academic institution, (5) Number of patents/ copyrights/ designs, (6) Cooperation with industry and (7) Perceived role models. The variable "type of research" was omitted from the analysis due to an error which was detected in the survey instrument after the data was collected. Those variables whose coefficients were statistically insignificant ($p>0.05$) were deleted in a step by step iteration (Scholten et al, 2004) where those whose coefficients had the greatest p-value were deleted first, keeping an eye on the effect of the deletion on the adjusted R^2 value to make sure there was improvement each time a variable was deleted. According to Scholten et al (2004) when using the linear regression model, the less variables one has, the better as too many variables could make the model unstable. This process was repeated until further deletion of variables led to the deterioration of the adjusted R^2 value. Table 6 below shows the first results obtained before the deletion where X_1 = Entrepreneurial efficacy, X_2 = Personal Networks, X_3 = Perceived role models, X_4 = Cooperation with industry, X_5 = Number of years spent at academic institution, X_6 = Number of patents/ copyrights/ designs. The deletion of the variables was X_5 and X_2 resulted in an improvement in the adjusted R^2 value from 0.810 to 0.815 (Table 7). Further deletion of subsequent variables led to the deterioration of the R^2 value hence the deletions were stopped. From this model the average predicted

Y_{AEI} = 1.65 and average observed Y_{AIE} = 1.69. The 95% confidence interval was found to be (1.45, 1.85).

Table 6: Linear regression results for all six variables X_1- X_6

Regression Statistics	
Multiple R	0.925145769
R Square	0.855894693
Adjusted R^2	**0.810617679**
Standard Error	0.788276253
Observations	44

ANOVA

	Df	SS	MS	F	**Significance F**
Regression	6	140.242887	23.37381449	37.61600811	**2.67941E-14**
Residual	38	23.61241917	0.621379452		
Total	44	163.8553061			

	Coefficients	Standard Error	t Stat	**P-value**	Lower 95%
Intercept	**0**	#N/A	#N/A	**#N/A**	#N/A
Efficacy (X_1)	**0.538377846**	0.072086294	7.468518864	**5.76489E-09**	0.392446775
Networks (X_2)	**0.148976425**	0.151476195	0.983497275	**0.331583552**	-0.157671097
Rmodels (X_3)	**-0.401027342**	0.229097034	-1.750469373	**0.088108215**	-0.864810038
IndCo-op (X_4)	**0.12768067**	0.113155115	1.128368521	**0.266238105**	-0.101389883
Yrs at isnt (X_5)	**-0.046757625**	0.104849063	-0.445951766	**0.658162799**	-0.259013453
IP (X_6)	**0.393753374**	0.183804264	2.142242874	**0.038643511**	0.021661099

Table 7: Linear regression results for five variables X_1, X_3, X_4 and X_6

Regression Statistics	
Multiple R	0.922946191
R Square	0.851829672
Adjusted R^2	**0.815716897**
Standard Error	0.779077892
Observations	44

ANOVA

	Df	*SS*	*MS*	*F*	***Significance F***
Regression	4	139.5768117	34.89420292	57.48989584	**7.83717E-16**
Residual	40	24.27849445	0.606962361		
Total	44	163.8553061			

	Coefficients	*Standard Error*	*t Stat*	***P-value***	*Lower 95%*
Intercept	**0**	#N/A	#N/A	**#N/A**	#N/A
Efficacy (X_1)	**0.538874214**	0.050608056	10.64799286	**3.06248E-13**	0.43659152
Rmodels (X_3)	**-0.415177417**	0.214993866	-1.93111285	**0.06057736**	-0.849696223
IndCo-op (X_4)	**0.16356685**	0.106387858	1.537457878	**0.132054848**	-0.051451029
IP (X_6)	**0.421252**	0.179752729	2.343508231	**0.024160472**	0.057958187

5.2.8. Analysis of factors associated with the higher levels of intention

Table 8: Coefficients of X_1-X_6

Predictor Variables	Coefficients
X_1	0.510354343
X_2	0.16207025
X_3	-0.42689292
X_4	0.121120946
X_6	0.199086966

5.2.9 Comparison of intentions from the two groups

A Mann Whitney U-test was used to determine the difference between the two groups (non-technical and technical researchers) and the results showed that there was no significant difference between the two groups.

5.2.10 Handling of non responses and response bias

Of the study sample 18 questionnaires were found to have less than 20% missing data. However, the 18 missing data was distributed almost evenly across all groups (between universities & research councils and also between technical and non technical respondents. Since no pattern was observed in missing values, this suggests that the missing data is missing at random and should therefore not introduce any missing data bias.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

In this chapter the results of the study are discussed in more detail.

6.2 Handling of non responses and response bias

Since no pattern was observed in missing values, this suggests that the missing data is missing at random and should therefore not introduce any missing data bias.

6.3 Reliability and internal consistency

Reliability was assessed using Cronbach's alpha for internal consistency for predictor variables with more than a single item. Cronbach's alpha values obtained were: 0.95 for Entrepreneurial self-efficacy, 0.67 for Number of patents/ copyrights/ designs and 0.91 for Academic entrepreneurial intention. The alpha values for Entrepreneurial self-efficacy and Academic entrepreneurial intentions were greater than the lower limit of 0.7 (Hair et al, 1998). The alpha value of 0.67 for Number of patents/ copyrights/ designs is slightly below 0.7 and thus may be considered questionable. However, Cronbach's alpha value above 0.6 although questionable, may still be considered acceptable (Gliem and Gliem, 2003). For the variables Personal networks and Cooperation with industry the alpha-values returned were 0.54 and -1.12 respectively. Although an alpha value above 0.5 may still be considered acceptable, all alpha values below 0.5 are unacceptable (Gliem and Gliem, 2003; George and Mallery, 2003). This therefore means that there is poor intercorrelation amongst the test items for the variable Personal Networks. For the variable Cooperation with industry, a negative Cronbach's alpha was found which could indicate

inconsistent coding or a mixture of items measuring different dimensions, leading to negative inter-item correlations. According to Yu (2011), a low or negative alpha may result from random guessing by respondents when they have not been exposed to the items of the test. In this case the questions for personal networks asked for three items namely; (1) the number of hours per week the respondents spent maintaining contacts with people whom business matters were discussed, (2) the number of hours per week the respondents spent developing new contacts with people to discuss business matters and (3) the total number of people with whom the respondents discussed business matters during the previous week. An analysis of the questions show that they demanded exact figures on average hours spent and on number of people communicated with. It is quite plausible that in the South African academic context researchers are not used to or required to keep a time sheet on hours spent on personal networking and hence when they were posed with the question they simply gave a guess, or gave the actual number of hours spent rather than the average per week. The negative alpha for Cooperation with industry might be explained by the fact that Prodan & Drnovsek (2010) found in their empirical results that Cooperation with industry is not directly, significantly related to the academic entrepreneurial intentions. However it was included in this study as it is related to academic entrepreneurial intentions indirectly, through Number of patents/ copyrights/ designs and Type of research.

6.4 Linearity

Before proceeding with the linear regression, linearity of the predictor variables X_1 to X_6 was assessed and the results are depicted in the residual plots in section 5.2.5 of the results. In all cases the scatter plots show symmetry about the x-axis, although not perfect. There is no evidence that the relationships are not linear in all the plots therefore the data satisfies first requirement of the multiple linear regression model.

6.5 Normality

The second requirement of the linear regression model is that the residuals must be normally distributed. To test for normality we used the Anderson Darling normality test. The test calculates the p value for the data and compares it to the significance level α (α = 0.05 in this case). If the p value is greater than the α value, the data may be considered to be from a normal distribution. The p value was found to be 0.81 which is a value greater than α of 0.05. This means that the sample follows a normal distribution and therefore it was appropriate to use linear regression to predict Y_{AEI}. Furthermore from hereon inferences to the study's target population can be made from the results and the findings can be generalised to reflect the South African situation.

6.6 Analysis of the factors that explain whether the respondents have intentions or not

The results obtained where the average predicted Y_{AEI} = 1.64 and average for the observed Y_{AEI} = 1.69. Using the Likert scale ranking where 1= No intention, 2= low intention, 3 = moderate Intention, 4= high intention and 5 = Very high intention, the results of the study show that the academic entrepreneurial

intentions of researchers in South Africa's HEIs and SCs are none to low or very low.

6.7 Analysis of factors associated with the higher levels of intention

Since intentions are the single best predictor of any planned behavior, including entrepreneurship, then understanding the antecedents of intentions increases the understanding of the intended behaviour of spinoff creation. The variable entrepreneurial self-efficacy (X_1) was found to be the strongest predictor of AEI. This is in line with findings of other authours in a different cultural context to that of South Africa (Prodan and Drnovsek, 2010). From this result important implications can be drawn on entrepreneurial assessment, education and support intervention. According to Chen et al (1998) entrepreneurial self-efficacy can be used to identify reasons for entrepreneurial avoidance since there may be individuals who avoid entrepreneurial activity not because they actually lack the necessary skills but because they believe that they do. Furthermore the same authours believe that through systematic and continuous efforts, entrepreneurial self-efficacy of individuals can be improved thus enabling the entrepreneur to be actively engaged in entrepreneurial tasks, more persistent and confident in the face of difficulty and setbacks (Chen et al, 1998).

Scholten et al (2004) using a measuring tool based on the theory of planned behavior albeit with different predictors found "attitude" as the most important factor to explain academic's entrepreneurial intentions. Although the results of the regression model seemed to suggest that Number of patents/ copyrights/ designs (X_6) is the second strongest predictor of AEI, this result is viewed with caution. The reason for this is that only seven respondents from the entire

sample answered that they had patents or filed for patents or other form of intellectual property in the past three years. Furthermore in South Africa, unlike in Europe and the United States, the Companies and Intellectual Property Commission (CIPC) formerly known as Companies and Intellectual Properly Registration Office (CIPRO) is not a patent examining body (Dell, 2011) which means that whilst patents may be registered and granted, they may be of no commercial value due lack of novelty and freedom to operate. On the other hand the fact that the great majority of the respondents reported that they had zero patents filed or registered, supports the findings that the academic entrepreneurial intentions are indeed low.

6.8 Suggestion for future research

- A study that determines the underlying reasons for the low intensions observed in this research by identifying the sources of entrepreneurial avoidance
- A cross sectional study that needs to ultimately examine the relationship between the entrepreneurial attitudes, intentions and entrepreneurial behaviours over time

CHAPTER 7: CONCLUSION

The intentions model used in this study asserts that in that order to encourage economic development in the form of new enterprises, then the perceptions of feasibility and desirability (self-efficacy) thereof must be increased. This means that interventions aimed at promoting spinoff creation will only increase business formation if those initiatives positively influence intentions. Policy makers, university authorities and entrepreneurship support programmes could benefit from identifying sources of entrepreneurial avoidance by offering interventions in entrepreneurial education that are aimed at enhancing the entrepreneurial self-efficacy of academic researchers.

The role of researchers as the actual initiators of entrepreneurial activities within universities is well understood. Entrepreneurial activities have resulted from researcher's interactions with their role models and personal networks with industry partners and other's with whom they wish to do business. Currently in order to have high rankings as a researcher and to be promoted to the university's upper echelons researchers have to publish in prestigious publications and present their work in international conferences. Those that do, become role models for others to follow in their footsteps. Appendix F gives a summary of the NRF's ranking requirements. As can be envisaged, these incentives for high rating by encouraging researchers to publish research results extensively have adverse effects from the standpoint of economical exploitation of those results. This is because a single publication is known as "a disclosure in the public domain" and is sufficient to remove all the originality

value of the results hence there can be no benefit from legal protection such as patents which are usually key in spinoff creation.

From this study one can deduce that until interventions that trigger the intent to enter into entrepreneurial activity are put in place as a support mechanism for researchers then the prospects for creating a knowledge economy in South Africa are very bleak.

A concerted effort by government, their funding agencies, university authorities, and private organisations will be key in strengthening university industry relationships since the role of cooperation with industry has been shown to induce entrepreneurial activity and improve entrepreneurial self-efficacy. The government has a role to play through policy frameworks that promote a industry-led or university-led type of triple helix as seen with their success U.S. and Germany. Funding Agencies also have a responsibility in promoting a culture of entrepreneurship. The NFR and the universities should consider revising incentives for rating and performance so that they are aligned to the National goal of creating a knowledge economy by 2018 as planned in the DST's NRDS and TYIP. The universities and science councils will need to have skills in opportunity identification, so that they can be able to differentiate those research results that would hold commercial value and whose IP is worth protecting from those that promote the dissemination of knowledge through publications.

The major contribution of this research is that it has predicted that the level of spinoff creation from South African HEIs and SCs is very low based on empirical findings. From this base, cross sectional studies can be conducted to measure the intentionality of researchers over time. The results and insights gained in this study will guide policymakers, university authorities and funding agencies to formulate spinoff policies, financial and non-financial support structures that are aimed at improving intentionality and take into account the fact that academic entrepreneurial intentions are low.

Appendix A: Consistency matrix

Title: The entrepreneurial intentions of researchers in academia in an emerging knowledge economy

Hypothesis	Literature review	Data Collection tool	Analysis	Validity and Reliability
H1 The entrepreneurial intentions of South African researchers are low. .	• Entrepreneurial Dialogues, 2010 • Global Entrepreneurship Monitor, 2010 • Kruss, 2009 • Phaho, 2007	Questionnaire 1 (**A1-5; B1-14**).	Linear Model to measure academic entrepreneurial intentions Regression Analysis to determine which of the seven predictors is highest contributor to academic entrepreneurial intentions	Cronbach's Alpha
H1.1 Entrepreneurial self efficacy is positively related to academic – entrepreneurial intentions	• Boyd et al, 1994 • Chen et al, 1998 • Peterman & Kennedy, 2000 • Prodan & Drnovsek, 2010	Questionnaire 1 (**C1-11**)	Same as above	Same as above
H1.2 Academic's personal networks are positively related to the academic-	• Birley, 1985 • Bosma et al, 2011 • Hoang and Antoncic, 2003	Questionnaire 1 (**D1-3**)	Same as above	Same as above

entrepreneurial self-efficacy and academic-entrepreneurial intentions	• Nicolaou and Birley, 2003a • Nicolaou and Birley, 2003b • Ozgen & Baron, 2007 • Prodan & Drnovsek, 2010			
H1.3 The extent of perceived role models is positively related to the extent of entrepreneurial self efficacy and the intensity of academic entrepreneurial intentions ,	• Bosma et al, 2011 • Davidsson, 1995 • Krueger et al, 2000 • Prodan & Drnovsek, 2010	Questionnaire 1 (**E1**)	Same as above	Same as above
H1.4 The number of years spent at the academic institution is negatively related to academic-entrepreneurial intentions	• Lavesque and Minniti, 2006 • Prodan & Drnovsek, 2010	Questionnaire 1 (**F1**)	Same as above	Same as above
H1.5 The number of patents (applied for/granted) is	• Landry et al, 2006 • Prodan &	Questionnaire 1 (**G1-2**)	Same as above	Same as above

positively related to academic-entrepreneurial intentions	Drnovsek, 2010 • Shane, 2001a • Shane, 2001b			
H1.6 The prevalence of applied research (type of research) is positively related to academic-entrepreneurial intentions	• Bluemental et al, 2006 • Etzkowitz, 1998 • Grandi & Grimaldi, 2005 • Kruss, 2009 • Prodan & Drnovsek, 2010	Questionnaire 1 (**H1-2**)	Same as above	Same as above
H1.7 Cooperation with the industry is positively related to the number of patents/ copyrights/ designs (applied for/granted) type of research) and academic entrepreneurial intentions	• Bluemental et al, 2006 • Etzkowitz, 1998 • Grandi & Grimaldi, 2005 • Kruss, 2009 • Prodan & Drnovsek, 2010	Questionnaire 1 (**I 1**)	Same as above	Same as above
H2 There is a significant difference between the entrepreneurial intention	• Arvanitis et al, 2008 • Bekkers & Bodas Freitas,	Complete data obtained from **all sections of Questionnaire 1** be compared for	A Mann-Whitney U-test to measure if there is a significant difference between the two	Not applicable

level of academics in technical fields and academic in social fields	2008 • Fini et al, 2008 • Landry, 2001b • Landry, 2007 • Shane, 2002 • Prodan & Drnovsek, 2010	differences between the two groups	groups.	
Research question 1 What are the underlying determinants observed to explain the differences between the entrepreneurial intentionality between academia in social and technical fields of discipline	Guest et al, 2006 Marshal, 1996 Mason, 2010	Questionnaire 2 (**1-3**)	Theme Extraction, Constant Comparative Method and Weighted Frequency Analysis (Staphorst, 2010)	Methodical triangulation (Staphorst, 2010)

Appendix B: Timeline

Date	Activity
07 January	Project topic submitted
23 February	7 Page research proposal submitted
10 April	Workshop in preparation of Research Proposal hand-in
21 April	Submit draft proposal to supervisor
27 April	*Submit 20 page research proposal*
May: Chapters 1-4	
01 May-31May	Chapters 1-4
3 May	*Supervisor completes marking of proposal*
31 May	Submit chapter 1-4 to supervisor for review
June: Correction of Proposal and Questionnaire design	
01June -30 June	Improvements on Proposal after feedback from supervisor
01June-15June	Questionnaire design
July: Application for ethical Clearance	
02 July	Submit questionnaire to supervisor for review
08 July	Application for ethical clearance
11 July	1st Research workshop: Chapters 1-4
25 July	*Latest date for Supervisors to sign off on chapters 1-4*
25 July	*Ethical clearance ends*
August: Chapter 5, Data collection and analysis	
01-31 August	Data collection and analysis
22 August	2nd Research Workshop - Chapters 4 and 5
September: Chapter 6&7, Discussion of results	
01 September -30 September	Data analysis and Chapter 6 and 7
22 September	3rd Research Workshop - Chapters 5, 6 and 7
October: Final draft and corrections	
30 October	Submit research draft to supervisor for review
31 October	4th Research Workshop – recap and wrap up of entire project
November: Submission	
09 November	*Research Project Submission Date*
December: Blissful existence	

Note: GIBS deadlines in italics

Appendix C: List of HEIs and SCs represented in the sample frame

Universities	Science Councils
University of the Witwatersrand	Agricultural Research Council (ARC)
University of Cape Town	South African National Biodiversity Institute (SANBI)
Nelson Mandela Metropolitan University	Nuclear Energy Cooperation of South Africa (NECSA)
University of Johannesburg	Council for Geosciences
University of South Africa	Council for Scientific and Industrial Research (CSIR)
Fort Hare University	Medical Research Council (MRC)
University of Pretoria	South African Institute for Aquatic Biodiversity (SAIB)
University of the Western Cape	National Institute for Communicable Diseases
Stellenbosch University	National Institute for Occupational Health
Vaal University of Technology	iThemba Laboratory for Accelerated Based Sciences
University of Kwazulu Natal	South African Environmental Observation Network
Rhodes University	Hermanus Magnetic Observatory
Tshwane University of Technology	Mintek
North West University	South African Astronomical observatory (SAAO)
Cape Peninsula University of Technology	Human Sciences Research Council (HSRC)
Durban University of Technology	National Health Laboratory Services (NHLS)
University of Venda	Oceanographic Research Institute
Central University of Technology, Free State	National Metrology Institute of South Africa

Appendix D: Survey email invitation

June 2011

Dear Sir / Madam

I am a final year student at the Gordon Institute of Business Science (GIBS). As part of the research component of my MBA, I am conducting research aimed at measuring the entrepreneurial intentions of researchers in South African Universities, Universities of technology and Science Councils.

The entrepreneurial motivations and intentions of scientists in academia have been well studied in Europe and the USA where the phenomenon of academic spinoff is mature. The development of Silicon Valley in North California and Route 128 in Massachusetts in the vicinity of prestigious universities such Stanford, Harvard and Massachusetts Institute of Technology have highlighted the role that universities and scientists can play in entrepreneurship, economic development and job creation. It is therefore because of this economic importance that it is important to understand the intentions of academic entrepreneurs since they play a critical opportunity identification role in the technology transfer process.

As a valued survey participant, you are assured of confidentiality and at no point will your personal information be collected. To participate in the survey, please click on the following link:

https://www.surveymonkey.com/s.aspx?sm=GSnlsmIKPU5_2bsMeyVpFJJA_3d_3d

The survey should not take more than 10 minutes to complete. The closing date for responses is 15 July 2011.

Thank you for taking time to assist in the study. Should you have any questions please do not hesitate to contact me.

Regards,

Joy Sixholo

GIBS MBA 2010/11

Tel: +27 12 472 2734

Mobile: +27 74 337 8500

E-mail: sixholoj@tia.org.za

Leon Staphorst (Pr.Eng, M.Eng, MBA, SMIEEE, SMSAIEE)

Study Leader

Tel: +27 12 841 3236

Mobile: +27 82 857 1135

Email: leon.staphorst@gmail.com

Appendix E: Questionnaire

A. Informed Consent

As a valued survey participant, you are assured of confidentiality and at no point will your personal information be collected. Kindly confirm by ticking the appropriate box below that your participation in the survey is voluntary and should you wish not to take part in the study you will suffer no penalties

I am aware that participation in the survey is voluntary and should I chose not to participate I will suffer no penalties	Yes	No

Note that the information you provide will only be used in combination with all the others respondents' information to determine the general level of entrepreneurial intention among researchers in South Africa.

B. Screening questions

Please tick the appropriate block:

Type of Institution

University	University of Technology	Research Council

Entrepreneurial status

I have founded / am part of a personal business venture/ university spinoff	I have **NOT** founded / am part of a personal business venture/ university spinoff

C. Demographical Details

Please provide the requested information:

Demographic information

Age	Highest qualification obtained	Field of research	Name of institution

D. Survey questions

In the following section some statements and questions about entrepreneurial intentions and behaviour will be presented to you. Please **answer all the questions**.

Please tick the appropriate block:

A. Entrepreneurial intentions		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1.	I am interested in setting up my own business					
2.	I am determined to have my own company					
3.	If you identified possibilities for a commercial application for one or more of your inventions, you would seriously consider becoming an entrepreneur to commercialize the opportunity					
4.	What is the probability that you will start your own business in the next two years?	**0%**	**25%**	**50%**	**75%**	**100%**
5.	What is the probability that you will start your own business in the next five years?	**0%**	**25%**	**50%**	**75%**	**100%**
B. List of activities related to starting a business		**Please indicate which of the following activities related to starting a business you have undertaken during the past year**				

1.	Gathering information on competitors					
2.	Gathering information on substitute products					
3.	Gathering information on industry and customers					
4.	Gathering information on potential suppliers					
5.	Gathering information on the cost of raw materials and labour costs					
6.	Gathering information on costs of rents, leases and equipment					
7.	Establishing a price for the product/service offering					
8.	Making sales/revenues projections					
9.	Refining/ improving the business idea					
10.	Seeking financing					
11.	Gathering information on legal requirements (permits, licences and so forth)					
12.	Developing goals and objectives (business plan, organisation structure, strategic plan)					
13.	Choosing a business name, legal status					
14.	Finding a location for the business					
C. H1.1: Self-efficacy **Please** indicate your degree of certainty in performing the following		**Completely unsure**	**Somewhat Unsure**	**Neutral**	**Somewhat sure**	**Completely sure**
1.	Control costs					
2.	Define organisational					

	roles					
3.	Define responsibilities					
4.	Develop new ideas					
5.	Develop new products					
6.	Develop new services					
7.	Establish product's market position					
8.	Expand business					
9.	Set and attain profit goals					
10.	Set and attain market share goals					
11.	Set and attain set goals					

D. H1.2: Personal networks		**Please provide the requested information:**
1.	Number of average hours per week spent on maintaining contacts (via face to face, email, telephone) with people with whom business matters are discussed (e.g. commercialisation, marketing, finance)	
2.	Number of average hours per week spent on developing new contacts with people to discuss business matters	
3.	Total number of people with who business matters were discussed during the previous week	
E. H1.3: Perceived role models		**Please provide the requested information:**
1.	Number of academic entrepreneurs you know personally (i.e. have met and spoken with)	
F. H1.4: Number of years spent at the academic institution		**Please provide the requested information:**
1.	Total years spent at the academic institution	
G. H1.5: Intellectual property (patents/copyrights/ designs)		**Please provide the requested information:**
1.	Number of patents/ copyrights/ designs granted to academic during the last three	

	years	
2.	Number of patents/ copyrights/ designs the academic applied for during the last three years	
H. H1.3: Type of research		**Please provide the requested information:**
1.	Numbers of hours per week spent on applied research divided by (÷) Number of hours per week spent on basic research	
2.	Numbers of hours per week spent on applied research	
I. H1.6: Cooperation with industry		**Please provide the requested information:**
1.	Number of hours per week spent on industry-ordered projects	

Appendix F: NRF Researcher rating requirement summary

There are broad categories (with sub-categories where applicable) based on researcher performance, within which the NRF awards rating for researchers in South Africa. In order of the lowest to highest, these ratings are:

- Late entrant into research (Y)
- Promising young researcher (P)
- Established researcher (C)
- Internationally acclaimed researcher (B)
- Leading international researcher (A)
- President's Awardee

A synopsis of each category is available on the website of The NRF's evaluation centre.

The NRF's evaluation centre's Guidelines for Key Research Areas and Types of Research (KRAT) document (2011) outlines intellectual property (patents, trademarks, etc) as an expected primary output in only four fields of research out of 22 namely (1) Engineering, Information Technology and Library Services, Mathematics and Animal & Veterinary Sciences. For all others, including the four listed above, the most important research outputs are:

- Publications of original research in peer-reviewed journals and peer reviewed electronic publications;
- Reviews in recognised scientific journals;
- Peer-reviewed conference proceedings (excluding abstracts);

- Scientific monographs;
- Computational research tools; and
- Public biological databases.

REFERENCES

Arenius, P., & Minniti, M. (2005). Perceptual variables and nascent entrepreneurship. *Small Business Economics*, 24(2), 233-247.

Arvanitis, S.,Sydow, N., & Woerter, M. (2008). Do specific forms of university-industry knowledge transfer have different impacts on the performance of private enterprises? An empirical analysis based on Swiss firm data. *The Journal of Technology Transfer*, 33(5), 504-533.

Autio, E., & Kauranen, I. (1994). Technologist-entrepreneurs versus non-entrepreneurial technologists: analysis of motivational triggering factors. *Entrepreneurship y Regional Development*, 6, 315–328.

Association of University Technology Managers Licensing Survey (2010). Retrived from http://www.autm.net/Licensing_Surveys_AUTM.htm

Bekkers, R., & Bodas Freitas, I.M. (2008). Analysing knowledge transfer channels between universities and industry: to what degree do sectors also matter?. *Research Policy*, 37(10), 1837-1853.

Bird, B. (1988). Implementing entrepreneurial ideas: the case for intention. *Academy of Management Review*, 13(3), 21-29.

Birley, S. (1985). The role of networks in the entrepreneurial process. Journal of Business Venturing, 1(1), 107-117.

Bosma, N., Hessels, J., Schutjens, V., van Praag, M., & Verheul, I. (2011). Entrepreneurship and role models. *Journal of Economic Psychology*, 1(3), 1-30.

Boyd, N.G., & Vozikis, G.S. (1994). The influence of self-efficacy on the development of entrepreneurial intentions and actions. *Entrepreneurship: Theory & Practice*, 18(4), 63-77.

Chen, C.C., Greene, P.G., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing*, 13 (4), 295-316.

Davidsson, P. (1995). Determinants of entrepreneurial intentions. *Paper prepared for the RENT IX Workshop*, Piacenza, Italy, Nov. 23-24. Retrieved 09 November from http://eprints.qut.edu.au/2076/1/RENT_IX.pdf

Dell, S. (2011). South Africa: Intellectual property rights failing. Retrieved 07 November from http://www.universityworldnews.com/articlephp?story=20110715165939648&mode=print

Department of Science and Technology National Research and Development Strategy (2002). Retrieved 09 November from http://www.dst.gov.za/publications-policies/strategies-reports

Department of Science and Technology Strategic Plan for the Fiscal Years 2011-2016. (2011). Retrieved 09 November from http://www.dst.gov.za/publications-policies/strategies-reports

Department of Science and Technology Ten Year Innovation Plan. (2008, 09 November). Retrieved 09 November from http://www.dst.gov.za/publications-policies/strategies-reports

Djokovic, D., & Souitaris, V. (2008). Spinouts from academic institutions: a literature review with suggestions for further research. Journal of Technology Transfer, 33 (3), 225-247.

Druilhe, C., & Garnsey, E. (2004). Do academic spin-outs differ and does it matter? *Journal of Technology Transfer*, 29 (3-4), 269-285.

Duberley, J., Cohen, L., & Leeson, E. (2007). Entrepreneurial academics: Developing scientific careers in changing university settings. *Higher Education Quarterly,* 61(4), 479-497.

du Toit, D. (2006). Bridging the innovation chasm: Innovation policy challenges in Africa and Opportunities for Partnership with Europe. Available: http://www.africanaxis.org/Presentations/innovation%20seminar/daan%20du%20toit.pdf

Etzkowitz, H. (1998). The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. Research Policy, 27(8), 823-833.

Etzkowitz, H.,& Zhou, C. (2008). Building the entrepreneurial university: a global perspective. *Science Public Policy*, 35(9), 627-635.

Fay, M, P., &Proschan, M, A. (2010). Wilcoxon-Mann-Whitney or t-test? On assumptions for hypothesis tests and multiple interpretations of decision rules. *Statistics Surveys*, 4, 1-39.

Fini, R., Lacetera, N., & Shane, S.A. (2008). Inside or outside the IP system? Business Creation in Academia. *Research Policy*, 39(8), 1060-1069.

First National Bank Entrepreneurial Dialogues. (2010). The state of entrepreneurship in South Africa. (FNB Publication). Retrieved 18 April from http://www.endeavor.co.za/Portals/74/docs/White%20paper/FINAL_GEW_WhitePaper_18March.pdf

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, intention and behaviour: an introduction to theory and research. Addison-Wesley, Reading, MA.

George, D., & Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th ed.). Boston: Allyn & Bacon.

Göktepe-Hultén, D. (2008). Academic inventors and research groups: entrepreneurial cultures at universities. *Science and Public Policy*, 35(9), 657-667.

Grandi, A., & Grimaldi, R. (2005) Academic's organisational characteristics and the generation of successful business ideas. *Journal of Business Venturing*, 20(6), 821-845.

Guest, G., Bunce, A., & Johnson, L. (2006).How Many Interviews Are Enough? An Experiment with Data Saturation and Variability. *Field Methods*, 18(59), 59-82.

Gulbrandsen, M., & Smeby, J.C. (2005). Industry funding and University professor's research performance. *Research Policy,* 34(6), 932-950.

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010) Multivariate *data analysis*. Upper Saddle River, NJ: Pearson Education,.

Herrington, M., Kew, J. & Kew, P. (2010). *Global Entrepreneurship Monitor: 2009 South African Report.* Graduate School of Business, University of Cape Town, South Africa.

Hildebrand, D. L. (2005). Academics are intellectual entrepreneurs. Retrieved 10 October from http://www.davidhildebrand.org/research/articles-and-shorter-writings/article-academics-are-intellectual-entrepreneurs/

Hoang, H., Antoncic, B. (2003). Network-based research in entrepreneurship: a critical review. *Journal of Business Venturing*, 18(2), 165-187.

Hoye, K., & Pries, F. (2009). 'Repeat commercializers', the 'habitual entrepreneurs' of university-industry technology transfer. *Technovation*, 29(10), 682-689.

Katz, J., & Gartner, W.B. (1988). Properties of emerging organizations. *Academy of Management Review*, 13(3): 429-441.

Kolvereid, L., & Isaksen, E. (2006). New business start-up and subsequent entry into self employment. *Journal of Business Venturing*, 21(6), 866-885.

Kroll, H., & Liefner, I. (2008). Spinoff enterprises as a means of technology commercialisation in a transforming economy-evidence from three universities in China. *Technovation*, 28(5), 298-313.

Krueger, N. F., & Carsrud, A. L. (1993). Entrepreneurial intentions: applying the theory of planned behavior. *Entrepreneurship & Regional Development*, 5(4), 315-330.

Krueger, N.F., Reilly, M.D., & Carsrud, A.L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing,* 15, 411–432.

Kruss, G. Human Sciences Research Council. (2009). *Knowledge-based development: the contribution of university-firm interaction in South Africa*. (HSRC Publication). Retrieved 16 June from www.globelics2009dakar.merit.unu.edu/papers/1238484527_GK.pd

Landry, R., Amara, N., & Ouimet, M. (2007). Determinants of knowledge transfer: evidence from Canadian university researchers in natural sciences and engineering. *Journal of Technology Transfer*, 32(6), 561-592.

Landry, R., Amara, N., & Rherrad, I. (2006). Why are some university researchers more likely to create spinoffs than others? evidence from canadian universities. *Research Policy, 35*(10), 1599-1615.

Lavesque, M., & Minniti, M. (2006). The effect of aging on entrepreneurial behaviour. *Journal of Business Venturing*, 21(2), 177-194.

Marshal, N. (1996). Sampling for qualitative research. *Family Practice*, 13(6), 522-525.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. Forum: Qualitative Social Research, 11(3). Retrieved 03 May from http://nbn-resolving.de/urn:nbn:de:0114-fqs100387

Morales-Gualdrón, S.T., Gutiérrez-Gracia, A., & Dobón, S.R. (2009). The entrepreneurial motivation in academia: a multidimensional construct. *International Entrepreneurship and Management Journal*, 5(3), 301-317.

National Research Foundation' evaluation centre's Guidelines for Key Research Areas and Types of Research (KRAT) document (2011). Retrieved 09 November from http://evaluation.nrf.ac.za/index.htm

Ndonzuau, F, N., Pirnay, F., & Surlemont, B. (2002). A stage model of academic spinoff creation. Technovation, 22(5), 281-289.

Nicolaou N., & Birley, S. (2003a). Academic networks in a trichotomous categorisation of university spinouts. *Journal of Business Venturing*, 18(3), 333-359.

Nicolaou, N., & Birley, S. (2003b). Social networks in organisational emergence: the university spinout phenomenon. Management Science, 49(12), 1702-1725.

Nunnally, J.C., & Bernstein, I.H. (1994). *Psychometry theory* (3rd ed.). New York: McGraw-Hill.

Ochaeta, K. (2007). Comparison of entrepreneurial intention level between overseas scholarship recipients and local Students in Taiwan. Retrieved 06 May from 140.114.53.170:8080/.../Projects%5CMR(Special%20Topics%20in%20Marketing%20Research)%5C….

OECD (2007). Review of the South African Innovation Policy. Retrieved from http://www.oecd.org/publishing.

Ozgen, E., & Baron, R, A. (2007). Social sources of information in opportunity recognition: effects of mentors, industry networks, and professional forums. *Journal of Business Venturing*, 22(2), 174-192.

New Oxford English Dictionary (3rd ed.). (2010). Hinsdale, IL: Oxford University Press.

Péréz Péréz, M., & Sánchez, A.M. (2003). The development of university spinoffs: early dynamics of technology transfer and networking. *Technovation*, 23(10), 823-831.

Peterman, N, E., & Kennedy, J. (2003). Enterprise education: Influencing students' perceptions of entrepreneurship. *Entrepreneurship: Theory and Practice*, 28(2), 129-144

Phaho, D. (2007). *Assisting entrepreneurs through technology Intelligence and diffusion*. Poster session presented at the meeting of University of Johannesburg's FROM IDEA TO PRODUCT SEMINAR, Auckland Park, South Africa.

Pouris, A. (2008). Science-industry relations and the SA innovation chasm: searching for lost technologies.
Retrieved 06 May from http://www.docstoc.com/docs/74383191/NEPAD-OECD-Agenda---THE-2008-HIGH-LEVEL-MEETING-AND-EXPERTS-

Prodan, I., & Drnovsek, M. (2010). Conceptualizing academic-entrepreneurial intentions: An empirical test. *Technovation, 30*(5-6), 332-347.

Razali, N, M., & Wah, Y., B. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lillifors and Anderson-Darling tests. *Journal of Statistical Modelling and Analytics*, 2(1), 21-33.

Scherer, R.F., Adams, J.S., Carly, S.S., & Wiebe, F.A. (1989). Role model performance effects on development of entrepreneurial career preference. *Entrepreneurship: Theory & Practice*, 13(3), 53-71.

Scholten, V, R., Kemp, & Omta, S. (2004) Entrepreneurship for Life. Entrepreneurial intention among academics in the Life Sciences, 2nd *ESU Conference*, Enschede, September 20-22.

Shane, S.A. (2001a). Technological opportunities and new firm creation. *Management Science*, 47(2), 205-220.

Shane, S.A. (2001b). Technology regimes and new firm formation. *Management Science*, 47(9), 1173-1190.

Shane, S.A., & Stuart, T. (2002). Organisational endowments and the performance of university start-ups. *Management Science*, 48(1), 154-170.

Shapero, A. (1975). The displaced, uncomfortable entrepreneur. *Psychology Today*, 9(6), 83-88.

Staphorst, L. (2010). *The impact of intellectual property rights from publicly*

financed research and development on governance mode decisions for research alliances (Master's thesis). Available from Gordon Istitute of Business Science.

SurveyMonkey (2011). SurveyMonkey Home Page. Retrieved 15 May from http://www.surveymonkey.com/

Technology Innovation Agency Corporate Plan (2009). Retrieved 01 November from http://www.tia.org.za

Technology Innovation Agency Corporate Presentation (2011). Retrieved 01 November from http://www.tia.org.za

Udell, G. (1990). Academe and the goose that lays its goldern eggs. *Business Horizon*, 33(2), 29-37.

Walter, A., Auer, M., & Ritter, T.(2006). The impact of network capabilities and entrepreneurial orientation on university spinoff performance. *Journal of Business Venturing*, 21(4), 541-567.

Zhao, H., Seibert, S.E., & Hills, G.E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. Journal of Applied Psychology, 90(6), 1265-1272.

zu Köcker, G, M. (2009). Clusters in Germany: An empirical based insight view on emergence, financing, management and competitiveness of the most innovative clusters in Germany. Retrieved 01 November from http://www.vdivde-it.de/publications/studies/an-empirical-based-insight-view-on-emergence-financing-management-and-competitiveness-of-the-most-innovative-clusters-in-germany