GORDON INSTITUTE
OF BUSINESS SCIENCE
University of Pretoria

MBA 2009/2010

The Impact of Intellectual Property Rights from Publicly Financed Research and Development on Governance Mode Decisions for Research Alliances

Leonard Staphorst

9415858

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

10 November 2010

Abstract

This study consisted of two distinct research phases, performed within the context of the South African Council for Science and Industrial Research (and its current and potential research alliances). The purpose of the study was to develop a decision making model that would enable strategists at publicly financed research and development organisations to analyse and predict governance mode decisions, as well as select optimal governance mode structures (ranging from quasi-market structures, such as once-off contracts, to quasi-hierarchy structures, such as research joint ventures) for research alliances.

During the qualitative first phase, the study aimed to identify impact domains within South Africa's new Bayh-Dole-like Intellectual Property Rights legislative framework that consists of the *Intellectual Property Rights from Publicly Financed Research and Development Act*, as well as the *Technology Innovation Agency Act*, which could potentially influence research alliances (based on the Transactional Cost Economics, Resource-based View and Real Options Approach perspectives) with publicly financed research and development organisations. This was followed by the quantitative second phase, which attempted to verify the validity of a value-mediated governance mode model that included the highest ranked impact domains identified during the first phase as formative indicators for the perceived Intellectual Property Rights regime strength uncertainty factor.

A qualitative online survey amongst senior managers at the Council for Science and Industrial Research, followed by Theme Extraction combined with Constant Comparative Method analysis, as well as a weighted frequency analysis, constituted the research methodology employed during the first phase's identification and ranking of impact domains within the South African legislative framework. This phase demonstrated that the highest ranked impact domains (primarily driven by the Transactional Cost Economics perspective) included the choice of Intellectual Property Rights ownership, state walk-in rights on undeclared Intellectual Property, and benefit-sharing policies for the creators of Intellectual Property.

The second phase consisted of a quantitative online survey, distributed amongst current and potential research alliance partners of the Council for Science and Industrial Research, followed by Structural Equation Modelling of a value-mediated governance model that included, amongst others, the perceived Intellectual Property Rights regime strength as an uncertainty factor. This phase revealed not only that the impact domains identified during the first phase could be used as formative indicators of the perceived Intellectual Property Rights regime strength, but also that

stronger perceived regimes are positively related to the preference for quasi-hierarchy research alliance governance modes. Furthermore, it established that the expected value of a research alliance, which was shown to be positively influenced by the strength of the perceived Intellectual Property Rights regime, acted as a mediating factor on the relationship between the perceived Intellectual Property Rights regime strength and the preferred research alliance governance mode.

Keywords: Bayh-Dole, Formative Indicators, Intellectual Property Rights, Research Alliances, Real Options Approach, Resource-based View, Quasi-Market Governance Modes, Quasi-Hierarchy Governance Modes, Structural Equation Modelling, Transactional Cost Economics, Value-mediated Governance Model

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: Leonard Staphorst

10-11-2010

Date

Acknowledgements

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

- First and foremost, my thanks go to my wife Crista, and my daughter Tessa. Their enduring love and encouragement were indispensable driving forces, especially during the gruelling times when completion of the study seemed like an insurmountable task.
- For their unwavering encouragement I wish to express my appreciation to my parents, Johannes and Marietjie, my aunt, Joey, my sister, Ronell, and my mother-in-law, Barbara.
- I am particularly grateful for the continued latitude and guidance provided by my study leader and research promoter, Mike Holland. His insights were invaluable.
- Credit is due to the Council for Science and Industrial Research for their financial sponsorship, as well as allowing access to the populations used in the sampling plans selected for the study.
- I wish to give special recognition to the following colleagues and friends for their respective contributions that assisted in bringing the study to fruition:

    - *Jayson Janneker:* For his assistance in providing the contact details of potential respondents during the qualitative phase of the study.
    - *Pieter Goosen:* For his assistance in providing the contact details of potential respondents during the quantitative phase of the study.
    - *Johan Strydom:* For his assistance in having the study sanctioned by the Council for Science and Industrial Research.
    - *Andre le Roux:* For giving me the leeway to work on the study during work hours.
    - *Erlank Pienaar:* For remaining resolute in his belief of the potential value of the study, and my abilities to successfully complete it within the given time constraints.
    - *Willie Nel:* For providing access to all information gathered during the study performed by Baloyi, *et al.* (2009).
    - *Fellow Master of Business Administration Students:* For their invaluable camaraderie during the last two arduous years of postgraduate studies.
    - *Pieter de Villiers:* For his critical evaluation of the research methodology and results of the study during numerous informal discussion sessions.

This dissertation is dedicated to:

God Almighty, for blessing me with many talents, and granting me countless opportunities to use them;
My loving family and friends, whose continuous support and encouragement carried me through the arduous times.

"The next best thing to a good education, is a pushy mother."
(Source: M.P. Staphorst)

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

ACIIESE	Asymptotic Confidence Intervals for Indirect Effects in Structural Equations
ARC	Agricultural Research Council
AVE	Average Variance Extracted
BBBEE	Broad Based Black Economic Empowerment
CAM	Competency Area Manager
CEO	Chief Executive Officer
CRADA	Cooperative Research and Development Agreement
CSIR	Council for Science and Industrial Research
CSTP	Committee for Science and Technology Policy
DST	Department of Science and Technology
EAV	Expected Alliance Value
FDI	Foreign Direct Investment
GIBS	Gordon Institute of Business Science
GRA	Global Research Alliance
ICT	Information and Communication Technology
IP	Intellectual Property
IPPM	Intellectual Property Protection Mechanism
IPR	Intellectual Property Right
IPRPFRD	Intellectual Property Rights from Publicly Financed Research and Development
KACST	King Abdulaziz City for Science & Technology
LISREL	Linear Structural Relations
MBA	Master of Business Administration
MoA	Memoranda of Agreement
NEPAD	New Partnership for Africa's Development
NIPALS	Non-linear Iterative Partial Least Squares
NIPMO	National Intellectual Property Management Office
NPV	Net Present Value
NSI	National System of Innovation
OECD	Organisation for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PLS	Partial Least Squares
PPP	Public Private Partnership
R&D	Research and Development
RBV	Resource-Based View

RJV	Research Joint Venture
ROA	Real Options Approach
ROI	Return on Investment
RRA	Regional Research Alliance
S&T	Science and Technology
SEM	Structural Equation Modelling
SET	Science, Engineering and Technology
SME	Small or Medium Enterprise
SRP	Strategic Research Partnership
TCE	Transaction Cost Economics
TEI	Tertiary Education Institution
TIA	Technology Innovation Agency
TTO	Technology Transfer Office
US	United States
VC	Venture Capital
VMG	Value-Mediation Governance
WIPO	World Intellectual Property Organisation

Chapter 1 - Introduction

1.1. Introduction to the Research Problem

Research alliances involving universities, government agencies/institutes and private firms have been growing in prevalence and in significance in most industrial nations (Hertzfeld, Link & Vonortas, 2006). This growth phenomenon is the result of a number of factors, including the complexity and speed of technological advancement and the globalisation of the world economy (Hertzfeld, *et al.*, 2006). Over the last two decades there has been a global shift in public policy from discouraging such relationships on antitrust grounds, to encouraging new research collaboration in order to ensure increased international competitiveness (Hertzfeld, *et al.*, 2006). Pateli (2009) argued that, with the emergence of knowledge and network intensive economies, the decision for technology-based firms between "going it alone" or "collaborating" is influenced by several internal and external factors related to resource scarcity (Howarth, 1994), the complexity of the product and/or service offerings, risks associated with innovation in the macro environment and the need to pre-empt potential competitors (Kotabe & Swan, 1995). Pateli (2009) postulated that the inherent uncertainty prevailing in technology-based industries may significantly affect the expectations of firms in terms of the future value of their alliances. This, in turn, may have a significant impact on their governance choice (ranging from joint ventures and minority equity alliances, to non-equity alliances, such as contractual arrangements) for alliances (Pateli, 2009).

Intellectual Property Rights (IPRs), amongst which patents, industrial designs, copyrights and trademarks are among the most prolific, reward investment in Research and Development (R&D) by granting inventors and innovators market power over competitors (OECD, 2003). During the past two decades, many countries have become more aware of the value of the Intellectual Property (IP) created by publicly financed research organisations (OECD, 2003). This awareness reflects the recognition by governments that, in many cases, placing the outputs of government financed research in the public domain is not sufficient to generate social and economic benefits (OECD, 2003). As such, demands to generate more economic benefits from publicly financed R&D have focused policy makers' attention on the legislative systems governing the ownership and exploitation of IP at public research organisations (OECD, 2003). The United States (US) was first to create a legislative "solution" for this conundrum by enacting the Bayh-Dole Act in 1980 (Mowery & Sampat, 2005). This Act encourages US universities to acquire patents on inventions resulting from government financed research, followed by issuing exclusive licenses to private firms (So, *et al.*, 2008). Several countries followed suit by enacting similar legislation, with the latest followers being China, Brazil, Malaysia and South Africa (So, *et al.*, 2008). Within the South African context,

this has led to the 24 November 2008 enactment of the Technology Innovation Agency (TIA) Act (Republic of South Africa, 2008b) and the 22 December 2008 enactment of the Intellectual Property Rights from Publicly Financed Research and Development (IPRPFRD) Act (Republic of South Africa, 2008a).

It is now widely accepted that strong IPRs regimes promote the formation of inter-firm alliances (Oxley, 1999). Oxley (1999) also showed that the difference in the perceived strength of the IPRs regimes of local and foreign firms venturing into a new alliance is correlated with the preferred alliance governance mode. Within the drive to both strengthen IPRs for publicly financed R&D and incentivise the formation of research alliances, an unintended dilemma has emerged (OECD, 2003): Although strengthening IPRs for publicly financed R&D ensures that research organisations maximise the full national value of the IP that they generate, negative spill over effects that the legislation could incur on the perceived value of a research alliance might deter an existing alliance partner from continued collaboration, or a potential alliance partner from future collaboration. Hence, the perceived strength of such IPRs legislation can be viewed as a factor external to a research alliance and needs to be considered during the decision making process of strategically selecting an optimal research alliance governance model in order to maximise the perceived value of such a research alliance (Pateli, 2009).

The following two questions encapsulate the research problem considered by the study: Firstly, which impact domains of Bayh-Dole-like IPRs legislative frameworks influence the perceived strength of an IPRs regime, and therefore alliance governance mode decisions? Secondly, how can these impact domains be included into a governance mode decision making framework that could assist publicly financed R&D organisations in making rational and effective governance mode decisions for their current and future research alliances? Such a framework needs to encompass cost saving, resource sharing and managerial flexibility decision drivers. Furthermore, it should also consider other classic internal alliance uncertainty factors, such as alliance history, and external alliance uncertainty factors, such as IPRs regime strength. The study attempted to address these questions using Pateli's Value-Mediation Governance (VMG) model (Pateli, 2009) within the context of the current and future research alliances at the South African Council for Science and Industrial Research (CSIR). The original VMG model was modified to include the most pertinent impact domains from the new South African legislative framework for IPR from publicly financed R&D (consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts) as indicators for the perceived IPRs regime strength that the study included in the VMG model as an additional external uncertainty factor that drives research alliance governance mode decision making.

1.2. Background on the Research Context

The following subsections present a succinct overview of the context within which the study was performed, as described above. Firstly, an overview of the CSIR and its existing research alliance network is given. This is followed by a discussion on the history, motivation and goals of the TIA (Republic of South Africa, 2008b) and the IPRPFRD (Republic of South Africa, 2008a) Acts.

1.2.1. The CSIR and its Research Alliance Network

1.2.1.1. Overview of the CSIR

On 5 October 1945 the South African CSIR, which receives funding via public and private sources, was established. Scientific Research Council Act (Act 46 of 1988, as amended by Act 71 of 1990) mandates the CSIR. This Act states that the objectives of the CSIR are as follows (CSIR, 2010a):

> *"The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."*

In order to fulfil its mandate, the CSIR undertakes directed and multidisciplinary research, technological innovation, as well as industrial and scientific development to improve the quality of life of South African citizens (CSIR, 2010a). The generation and application of knowledge, constituting the core competence of the CSIR, occurs in the following domains (CSIR, 2010a): Biosciences; The Built Environment; Defence, Peace, Safety and Security; Materials Science and Manufacturing; Natural Resources and the Environment. The CSIR's focus on innovation targets the improvement of South Africa's competitiveness in the global economy (CSIR, 2010a). As critical outputs, the CSIR provides science and technology services and solutions in support of various stakeholders (CSIR, 2010a). Moreover, the CSIR identifies opportunities where new technologies can be further developed and exploited in the public and private sectors for commercial and social capital building (CSIR, 2010a). The CSIR's sole shareholder is the South African Parliament, held in proxy by the Minister of Science and Technology (CSIR, 2010a). South Africa's national imperatives and global challenges provide the macro-strategic framework within which the CSIR conducts its business (CSIR, 2010a). As such, in an attempt to contribute to putting South Africa, and Africa as a whole, on a path of sustainable growth and development, the CSIR participates in New Partnership for Africa's Development (NEPAD) by (CSIR, 2010a):

- Building and transforming human capital.
- Strengthening the Science and Technology (S&T) base of South Africa.
- Performing knowledge-generating research with local relevance.
- Transferring technology and skilled human capital.

The CSIR, which has clients in both the private sector (micro, small, medium and large enterprises) and in the public sector (national, provincial and local governmental agencies), fosters a network of partner organisations as part of its intention to create a local and global sphere of influence on all matters related to technology (CSIR, 2010a). For example, in 2008, the value of contract R&D formally recognised as supporting national technology and development strategies amounted to approximately R450 million (CSIR, 2010b).

1.2.1.2. Research Alliances at the CSIR

During its 65 year history as world-class technology R&D institute, the CSIR has spearheaded the formation of several research relationships with Tertiary Education Institutions (TEIs) and other research organisations in South Africa, as well as in other countries (CSIR, 2010b, 2010c). For example, in 2008 the total number of collaborative R&D activities with a value exceeding R1 million amounted to an impressive 79 projects (CSIR, 2010b).

With these research alliances the CSIR intends to build national, regional, and global networks that will provide opportunities to develop and access Science, Engineering and Technology (SET) expertise and knowledge, thereby growing the institute's overall impact (CSIR, 2010b, 2010c). According to the CSIR (2010c) its priorities with regards to these relationships are to implement collaborative projects in order to increase research and human capital outputs, monitor the effectiveness of collaboration and establish new partnerships of mutual benefit.

At the beginning of 2008 the CSIR had research collaboration Memoranda of Agreements (MoAs) in place with five TEIs, namely the universities of Cape Town, Stellenbosch, Johannesburg, Pretoria and the Witwatersrand (CSIR, 2010b). Four additional agreements were concluded with previously disadvantaged TEIs, namely the Walter Sisulu University, Tshwane University of Technology, University of Western Cape and the University of Fort Hare (CSIR, 2010b). During 2008 a total of 18 projects from the pool of 120 research projects with TEIs were implemented through seed funding from the CSIR's Cooperation Fund, with 12 of these projects in collaboration with previously disadvantaged TEIs (CSIR, 2010b). Past experience using the Cooperation Fund as support vehicle had not only strengthened relationships with TEIs, but also produced useful joint outputs and provided opportunities for the involvement of students in research (CSIR, 2010c). Monitoring of the impact created through these relationships with TEIs in certain instances use

indicators and dashboards that were jointly developed between the CSIR and its TEI partners (CSIR, 2010c).

With regards to regional and international collaboration, the CSIR is actively initiating new research activities with its Global Research Alliance (GRA) (CSIR, 2010c, 2010d; GRA, 2010) and Regional Research Alliance (RRA) (CSIR, 2010c, 2010e; RRA, 2010) partners. Since 2008 the CSIR, which is a founding member of both GRA and RRA, had shown considerable success in implementing several collaborative research activities in fields such as water, energy and Information and Communication Technology (ICT) (CSIR, 2010b).

All of the CSIR's activities related to its research alliances fall under the responsibility of the Strategic Research Alliances sub-portfolio, within the larger R&D portfolio, which is part of the R&D Core executive group in the CSIR (CSIR, 2010a). According to CSIR (2010c), the mission of this sub-portfolio is to:

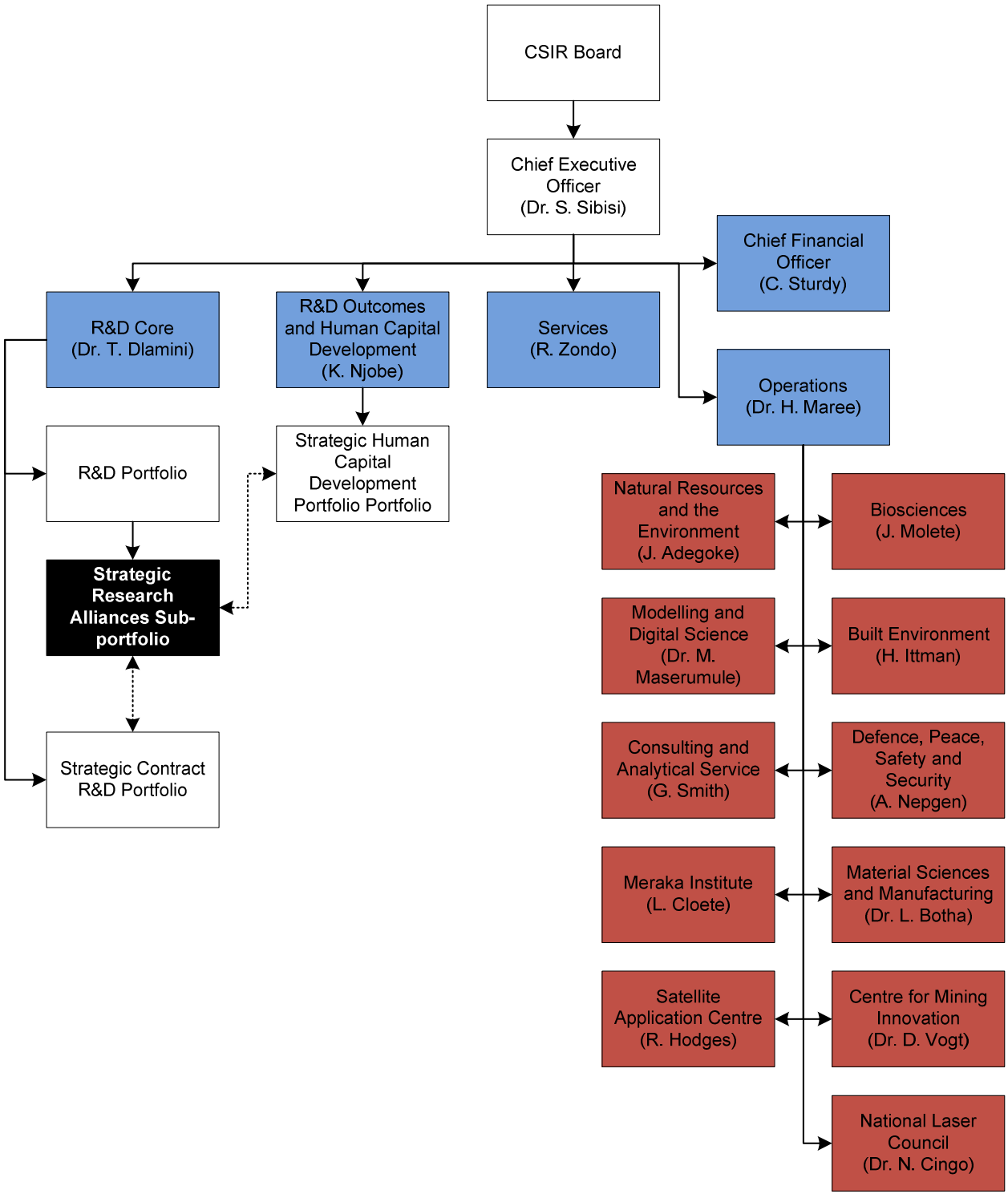
- Catalyse and manage research relationships with TEIs and research organisations in South Africa and internationally.
- Contribute to advancing the CSIR human capacity development programme, with a focus aimed at complementing and enhancing CSIR expertise in established research areas, and to build and strengthen competence in emerging research areas.

Achievement of this mission is accomplished through close collaboration with other CSIR portfolios, but primarily with the R&D portfolio (which is responsible for developing and directing the organisation's S&T strategy), the Strategic Contract R&D portfolio whose primary purpose is to oversee the development and management of the CSIR contract R&D activities, as well as the Strategic Human Capital Development portfolio (CSIR, 2010c). Within this collaborative framework intrinsic to the CSIR, various committees, such as the Human Capital Development Forum and Strategic Research Managers Forum, provide support on various issues as required (CSIR, 2010c). Figure 1 depicts the CSIR organisational structure, with the Strategic Alliances sub-portfolio indicated in black. Executive groups, such as the R&D Core group, are shown in blue, while operational units that fall specifically within the Operations executive group are shown in maroon (CSIR, 2010a).

The strategic objectives for the Strategic Research Alliance sub-portfolio is to continue its contribution to building and enhancing competence in priority research areas, advancing the human capital development objectives of CSIR and communicating the CSIR mandate and sub-portfolio role and activities to research partners (CSIR, 2010c). Hence, as is clear from Section

1.2.1.1, this sub-portfolio is fully aligned with efforts to fulfil the CSIR mandate, which emphasises partnerships and alliances (CSIR, 2010a, 2010c). Furthermore, it also supports the CSIR's strategic objectives by particularly strengthening the S&T base of the organisation and building and transforming human capital.

Figure 1: CSIR organisational structure (adapted from CSIR (2010a))



1.2.2. South African Legislative Framework for Publicly Financed R&D

1.2.2.1. Overview of the South African TIA Act

The notion of a South African TIA originated in 1996 as a suggestion during the Science and Technology White Paper development process (Ratsatsi, 2009). A more concrete definition of such an agency then found its way into the National Research and Development Strategy of 2002 (Ratsatsi, 2009). After a period of public and private sector consultation, which followed the May 2007 publication of the bill that preceded the TIA Act, final enactment occurred on 24 November 2008 (Ratsatsi, 2009; Republic of South Africa, 2008b).

The identification of suboptimal performance by the South African National System of Innovation (NSI) (CSIR, 2010f) motivated the development of the TIA. In particular, the successes of the NSI in establishing several enabling policies and strategies, such as the White Paper on Science and Technology in 1996 and the National R&D Strategy in 2002, unfortunately also resulted in the proliferation of many unsynchronised implementation agencies and structures (Ratsatsi, 2009). Hence, it came as no surprise that monitoring efforts that investigated NSI outputs for the period 2002 to 2007, such as the "Lost Opportunities Survey" conducted by the Department of Science and Technology (DST) in early 2007, indicated that the NSI was operating sub-optimally (Ratsatsi, 2009). The DST identified that, as a potential solution would be the creation of a single catalyst institution in order to (Ratsatsi, 2009):

- Support the establishment of pilot versions of new technologies, e.g. through demonstrators, in order to enhance private sector take-up.
- Support research entrepreneurs with risk capital to fund new ventures.
- Attract Foreign Direct Investment (FDI) that could introduce new technology to the country.
- Promote R&D linkages across government, higher education and industry.
- Provide R&D consultancy services in project evaluation, business planning, risk assessment and portfolio investment management.

The DST predicted the TIA as a vehicle through which it could bridge the gap from R&D to commercialisation, which it eloquently refers to as the "Innovation Chasm", by enhancing the country's capacity for translating a greater proportion of local R&D into commercial products and services (TIA, 2010). Moreover, the TIA was promoted as a driver to accomplish the DST's Technology 10 Year Innovation Plan (from 2008 to 2018), which quintessentially advocates the transformation of South Africa's resource driven economy to a knowledge driven economy (Ratsatsi, 2009). According to the TIA Act, officially filed as South African Act No. 26 of 2008, the TIA's objective is as follows (Republic of South Africa, 2008b):

> *"The object of the Agency is to support the State in stimulating and intensifying technological innovation in order to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations"*

The TIA's vision statement is as follows (Republic of South Africa, 2008b):

> *"A world class innovation agency that supports and enables technological innovation to achieve socio-economic benefits for South Africa through leveraging strategic partnerships"*

The TIA Act defines the mission of the agency to be the enhancement of South Africa's global competitiveness, as well as the delivery of socio-economic value through technological innovation across all sectors (Republic of South Africa, 2008b). It plans to accomplish this as follows (Republic of South Africa, 2008b):

- By delivering appropriately structured financial and non-financial interventions.
- Through the development and maintenance of human capacity for innovation.
- By building a culture of innovation in South Africa.
- By leveraging local and international partnerships in both the public and private sectors.

1.2.2.2. Overview of the South African IPRPFRD Act

The IPRPFRD Act (Republic of South Africa, 2008a) originated from the DST's 2006 policy framework on IPR from publicly financed R&D (DST, 2006). This policy framework document, which was created in response to the DST's observations at the Organisation for Economic Cooperation and Development (OECD) Committee for Science and Technology Policy (CSTP), had the following scope (DST, 2006):

- South African IP legislation that existed at that time, such as Patents Act 57 of 1978, and treaties, such as the Patent Cooperation Treaty (PCT), was briefly summarised.
- It presented a review of existing South African initiatives related to increasing the patenting of inventions arising from publicly financed R&D, such as capacity building and policy interventions.
- It investigated international practices, as well as South Africa's relative performance to these practices.
- It considered possible drivers of the need for new legislation.
- A structure that forms the foundation of the IPRPFRD Act was proposed.

Justification for the DST's proposed policy framework was based heavily on the findings of the OECD report "Turning science into business: Patenting and licensing at public research organisations" (DST, 2006). Furthermore, the drivers for the legislation that it proposed included (DST, 2006):

- The need for benefit sharing mechanisms for successfully commercialised IP from publicly financed R&D.
- The need to create an obligation with inventors and researchers using public financing to declare potential inventions.
- The need to grant rights to research institutes and universities to secure income from successfully commercialised IP that was generated from public financing.
- The need to create an institutional obligation to centrally manage IP creation and commercialisation through their respective Technology Transfer Offices (TTOs).
- The need to establish government walk-in rights for IP generated from public financing.
- The need to allow preferential licensing of patents to South African Small or Medium Enterprises (SMEs) and Broad Based Black Economic Empowerment (BBBEE) accredited firms.
- The need for a framework to manage IP that were jointly funded through the public and private sectors.
- The need for the TIA to record declarations of inventions and to track the registration of patents and licences derived from publicly financed R&D.

The South African government published the IPRPFRD bill in May 2007, allowing opportunity for public and private sector scrutiny. On 22 December 2008 the final legislation was enacted to produce Act No. 51 of 2008. The main goals of this legislation are to (Republic of South Africa, 2008a):

- Ensure the effective utilisation of IP emanating from publicly financed R&D.
- Establish the Intellectual Property Fund.
- Establish the National Intellectual Property Management Office (NIPMO), an administrative agency within the DST. Its functions are as follows:
    - Facilitating, co-ordinating and capacity building.
    - Provide guidelines on IP transactions and related matters.
    - Intellectual Property Fund management.

- Establish TTOs at research institutions and universities, based on research intensity. It also allows for regional TTOs in future.

As is the case with the TIA Act (Republic of South Africa, 2008b), the IPRPFRD Act (Republic of South Africa, 2008a) attempts to address both the need to bridge the "Innovation Chasm", as well as the goal of the DST's 10 Year Innovation Plan for South Africa to evolve into a knowledge economy (DST, 2006).

1.3. Research Aims and Scope

This study aimed to identify and verify potential domains with IPRs legislative frameworks for publicly financed R&D that could potentially impact the perceived strength of the IPRs regime and, hence, research alliance governance mode decisions, for example, choosing an equity arrangement, such as a Research Joint Venture (RJV), over a purely contractual relationship. Cognisance of such potential impact domains will greatly enhance the decision making frameworks employed by senior managers to achieve governance mode decisions, which are more effective and rational, during the creation or alteration of research alliance structures.

The scope of the study's exploratory component was limited to a qualitative identification of potential impact domains within the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts through an investigation amongst senior managers employed by the publicly financed South African CSIR. The confirmatory component of the study involved the integration and quantitative verification of the identified potential impact domains as indicators for the perceived strength of the IPRs regime within the VMG model, originally proposed by Pateli (2009), within the context of existing and potential research alliances at the CSIR.

1.4. Research Motivation

Motivation for this study is based on the following grounds:

- *Business Motivation:* The 2008 enactment of the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts has created concern amongst publicly financed South African Research institutions, such as the CSIR, and universities, specifically pertaining to the governance structures of existing and future strategic research alliances (Baloyi, *et al.*, 2009). The CSIR, for example, operates using a business model that favours non-equity governance modes, such as contract research collaborations (Baloyi, *et al.*, 2009). However, if certain external uncertainty conditions prevail, such as partnering with a firm that is attracted by the high Return on Investment

(ROI) achievable during highly uncertain macro environmental conditions, equity-based governance structures, such as RJVs, are more appropriate (Pateli, 2009). Hence, the business motivation for the study was rooted in the desire of publicly financed research institutions to create, nurture and grow successful strategic research alliances through rational and effective governance mode decision making.

- *Academic Motivation:* For a detailed discussion on the academic motivation for this study, refer to Section 2.4. In essence, this section states that the academic motivation for the study was borne out of the need to understand the impact of Bayh-Dole-like legislation on strategic research alliance governance mode decisions. Section 2.4 also states that the study was further motivated by the need to verify a modified version of Pateli's VMG model (Pateli, 2009), improved to include the perceived strength of the IPRs regime as an additional external uncertainty factor, with formative indicators consisting of the impact domains identified within the South African Bayh-Dole-like IPRs legislative framework.

1.5. Novel Contributions Emanating from the Study

The most notable novel contributions stemming from the study include the following:

- The qualitative investigation into the new South African Bayh-Dole-like legislative framework, consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, uncovered several potential impact domains that could influence research alliances with publicly financed R&D organisations (see Section 5.2). Moreover, it showed that these impact domains influence the perceived strength of the IPRs regime in which such research alliances operate, thereby impacting the governance mode decision making of current and future alliance partners in research alliances with government financed R&D institutes or universities (see Section 5.3). Determining whether these governance mode decision making impact domains, identified within the South African IPRs legislative framework, are also valid for other Bayh-Dole-like IPRs legislative regimes, such as Brazil, India and China (So, *et al.*, 2008) requires further study.
- The study set out to verify and amend the potential list of business impact domains within the South African IPRs legislative framework for publicly financed R&D (consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts) identified by Baloyi, *et al.* (2009). Not only was it shown that all of the business impact domains identified by Baloyi, *et al.* (2009) (see Section 2.3.4.2) was valid, except for the IPRPFRD Act's (Republic of South Africa, 2008a) requirement to apply to the state for permission to publish papers on IP generated from public financing, an additional six potential impact domains were amended to the list created by Baloyi, *et al.* (2009). In Section 6.2.1 it was also postulated that the core driver behind the influence of these

impact domains on research alliances with publicly financed R&D organisations consist of potential cost savings, followed by the resource leveraging and managerial flexibility drivers.

- In this study Pateli's VMG model (Pateli, 2009) for alliance governance mode decision making, which includes cost saving, resource sharing and managerial flexibility decision drivers, was modified to include the perceived strength of the IPRs regime as an additional external uncertainty factor (see Section 2.2.3.1), thereby complementing other classic internal factors (such as alliance history and the strategic orientations of alliance partners) and external factors (such as industry competition).
- An investigation into the severity of the potential impact domains, which were identified within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, revealed the following three prime impact domains (see Section 6.2.2):

    - *Choice of IPRs Ownership:* This area in the legislation allocates the control of the ownership choice of IPRs for IP, generated by research alliances employing partial or full government financing, to those partners that are public sector R&D organisations.
    - *State Walk-in Rights on Undeclared IP:* This requirement in the legislative framework grants walk-in rights to the state on the IPRs from IP generated, but not declared to government, through public financing.
    - *Benefit Sharing Policies:* The legislative framework grants IP creators specific rights to a portion of the revenues that accrue to publicly financed R&D organisations from the licensing and commercialisation of the associated IPRs.

  The study established that the abovementioned three dominant impact domains can be used as formative indicators for the additional perceived IPRs regime strength uncertainty factor in the modified VMG model (see Section 5.3.3.1).
- During the quantitative verification of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), which were altered to also include the perceived IPRs regime strength as an external uncertainty factor, it was established that the expected value of a research alliance, which was shown to be positively influenced by the perceived IPRs regime strength (see Section 5.3.6.7), acted as a mediating factor on the relationship between the perceived IPRs regime strength and the preferred research alliance governance mode.
- Pateli's VMG model (Pateli, 2009) for governance mode decision making was originally empirically verified within the context of technology alliances in the Greek wireless services industry. This study extended Pateli's work (Pateli, 2009) by demonstrating the applicability of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) as governance mode

decision making analysis and prediction tool for research alliances with South African publicly financed R&D organisations.

1.6. Organisation of the Dissertation

This dissertation is organised as follows: Chapter 1 commences 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 business and academic factors that have motivated the study. Finally, the novel contributions emanating from the study are briefly highlighted.

Chapter 2 presents a literature study and theory review that span the concepts and constructs applicable to the study. Firstly, the broad field of research alliances is considered, with particular focus on governance making decision making paradigms and theories, as well as the VMG model (Pateli, 2009). Next, topics related to IPRs, such as Intellectual Property Protection Mechanisms (IPPMs) and the role of IPRs in research alliances, are discussed. The chapter concludes with an overview of the history and trends in international IPRs legislation for publicly financed R&D (grounded in the US's Bayh-Dole Act), as well as recent legislative framework developments in South Africa.

Chapter 3 presents an overview of the two research objectives that defined the focus of the study. For the first research objective, which directed the initial qualitative research phase, related research questions are defined. The research propositions related to the second research objective, which directed the subsequent quantitative research phase of the study, are then described.

The methodologies used during the first phase's quantitative research and second phase's qualitative research, performed during the study in order to address the research objectives defined in Chapter 3, are presented in Chapter 4. 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 Chapter 4 to a close.

Chapter 5 commences by presenting the results obtained during initial qualitative phase of the study, followed by the results for the subsequent quantitative research phase. These results include not only the appropriate descriptive statistics, as well as reliability and validity tests for the data collected, but also the outputs yielded by the data analyses tools selected for each research phase. Moreover, Chapter 5 attempts to answer the research questions and test the research

propositions explicitly stated in Chapter 3. Chapter 6 critically discusses the results presented in Chapter 5 against pertinent literature and other noteworthy studies that focus on the topics of research alliance governance mode decision making and the influence of IPRs regime strength.

Concluding remarks on the core findings of the study, as well as a discussion on some future research areas, constitute Chapter 7. Lastly, the following set of appendices is included in this document:

- *Appendix A:* The consistency matrix for the study, summarising the research questions and propositions with their related literature references and chosen data collection and analysis tools, is presented here.
- Appendix B: This appendix describes the open-ended question survey used as data collection tool during the initial qualitative research phase of the study.
- *Appendix C:* The operational units within the CSIR's organisational structure are listed in this appendix, as well as the allocation of Competency Area Managers (CAMs) to each of these units.
- *Appendix D:* During both research phases of the study respondents were equipped with online copies of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, as well as information brochures summarising these Acts. In this appendix the focal points include the contents of these information brochures, as well as the structure of the companion website where the online copies of the brochures and Acts were made available.
- *Appendix E:* The closed question survey, used as data collection tool during the second quantitative research phase of the study, is described in this appendix.

Chapter 2 - Literature and Theory Review

2.1. Introduction

The literature and theory reviewed in this chapter investigates the key themes related to the research problem considered in the study, thereby creating a foundation for the understanding of the academic motivation for the study. The themes considered in this chapter include:

- *Research Alliances:* This section of the literature study presents a succinct background on the concept of research alliances, as well as alliance governance mode decision making theories and paradigms. Most importantly, it presents the VMG model created by Pateli (2009), constituting this study's selected theoretical framework for alliance governance mode decision making, which the study extended to include the perceived strength of the IPRs regime as external uncertainty factor, with indicators extracted for the potential impact domains within the South African IPRs legislative framework for publicly financed R&D.
- *Intellectual Property Rights:* The literature covered in this section presents a concise overview of IPPMs, the role of IPRs in research alliances, as well as an extensive review of IPRs legislation for publicly financed R&D, including its Bayh-Dole origins, its applicability in emerging markets, and a detailed discussion on the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.
- *Academic Motivation for the Study:* A discussion on the academic justification for the study concludes the theory and literature review presented in this chapter.

2.2. Research Alliances

2.2.1. Background on Research Alliances

According to Hertzfeld, *et al.* (2006) research alliances, also commonly referred to as research partnerships, are complex organisational arrangements that can assume numerous governance forms, ranging from infrastructure sharing, the sharing of information and knowledge, to the formation of entirely new research entities with equity sharing between alliance partners, such as RJVs (Hertzfeld, *et al.*, 2006). Many arrangements include a large number of firms joining simply to define industry standards (Hertzfeld, *et al.*, 2006), for example the 3G Partnership Project (3gpp, 2010), which consists of several telecommunication providers and vendors that have joined forces to develop future generations of cellular technology. Most popular, however, are pure one-on-one research ventures (Hertzfeld, *et al.*, 2006), such as the unique joint research ventures between the CSIR and Reutech Radar, which is geared at knowledge sharing on radar and electronic warfare

technology. In addition, there exists numerous product-focused alliances between research firms, customers and/or suppliers, aimed at solving a particular product or service related problem (Hertzfeld, *et al.*, 2006), such as the joint research undertaken by telecommunication network providers and equipment suppliers within the 3G Partnership Project (3gpp, 2010). Contractual R&D partnerships, such as joint R&D pacts and joint development agreements, are characterised by common R&D activities of two or more firms, limited to a project or programme of finite duration (Hagedoorn, Cloodt & van Kranenburg, 2005)

Link, Paton and Siegel (2001) defines Strategic Research Partnerships (SRPs) as any cooperative relationship involving organisations that sponsor or conduct R&D activities. According to this definition, examples of SRPs include RJVs, strategic alliances and networks, consortia, Cooperative Research and Development Agreements (CRADAs), licensing and sponsored research agreements involving universities, government laboratories and firms, university-based entrepreneurial start-ups, and even co-authoring between academics and industry scientists (Link, *et al.*, 2001). When classifying SRPs it is important to distinguish between private–private alliances and public–private alliances (Link, *et al.*, 2001). Within the private–private alliance domain, relationships are lead by and primarily composed of private organisations. Conversely, public–private alliances receive some finite level of support, such as funding, from a public institution, or may even have a public institution as a member (Link, *et al.*, 2001). According to Link, *et al.* (2001), funding is the quintessential distinctive characteristic underscoring the “strategic” aspect of SRPs: For private–private alliances the strategic objective is profit maximisation, while public-private alliances have the strategic goal of addressing an innovation market failure (Martin & Scott, 2000), thereby eventually enabling economic growth.

2.2.2. Alliance Governance Mode Decision Making

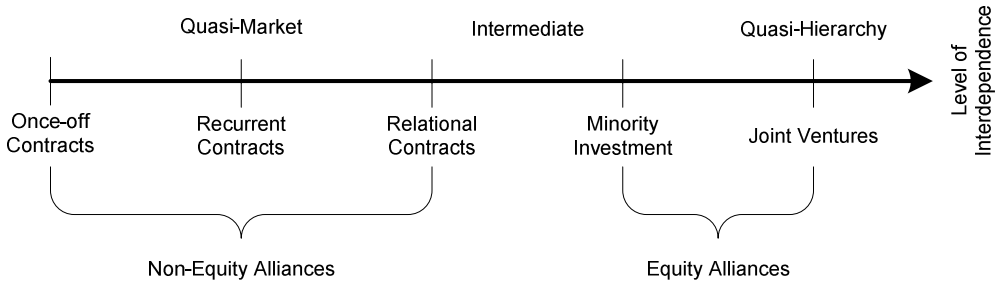
2.2.2.1. Overview of Decision Making Theories and Paradigms

Alliance governance, which is not only a crucial process during alliance creation, but also during alliance growth and evolution, primarily involves choosing between equity and non-equity structural forms on the alliance governance mode spectrum, depicted in Figure 2 (Pateli, 2009).

On the one end of the alliance governance mode spectrum is equity alliances (also referred to as quasi-hierarchies), which include joint ventures and minority equity alliances (Pateli, 2009; Narula & Hagedoorn, 1999). On the other end of the spectrum is non-equity alliances (also referred to as quasi-markets), which include contractual arrangements that do not involve equity exchange (Pateli, 2009; Narula & Hagedoorn, 1999). Contractual agreements are further decomposed into the following categories, adapted from Pateli (2009):

- *Once-off Contracts:* Contracts that represent collaborative relationships that only exist during a single once-off project.
- *Recurrent Contracts:* Contracts that represent collaborative relationships of short to moderate duration (Pateli, 2009).
- *Relational Contracts:* A moderate to long-term social-embedded relationship is implied by this type of collaborative contract (Wang & Wei, 2007).

Figure 2: Alliance governance mode spectrum (adapted from Pateli (2009))



From a theoretical point of view, alliance governance has been modelled in the strategic management field using several alternative perspectives, with the most prevalent perspectives, as listed by Pateli (2009), given below:

- *Cost-Based Perspective:* This perspective is embodied within the theory of Transaction Cost Economics (TCE), which proposes that governance choices are determined by the balance between efficiency and protection that each alliance partner anticipates to achieve from the alliance (Chen & Chen, 2003; Leiblein, 2003). According the TCE, alliance partners choose alliance governance structures based on minimising the sum of production and coordination costs (Leiblein, 2003). TCE assumes that, while in general quasi-market governance structures provide more efficient (lower cost) mechanisms for managing economic exchanges, quasi-hierarchies are preferred when protection from uncertainty outweighs efficiency in transactions (Hagedoorn & Narula, 1996). For a historic and conceptual overview of TCE refer to Section 2.2.2.2.
- *Resource-Based Perspective:* This perspective is grounded mainly in the Resource-based View (RBV) of firms, which dictates that governance choices depends mainly on the type, amount, heterogeneity, and complementary characteristics of the resources exchanged/shared between alliance partners (Chen & Chen, 2003). Furthermore, the RBV model supports a governance structure that maintains balance between resource exchange ease and limiting unintended leakages (Oxley & Sampson, 2004). In the event that the resource sharing between alliance partners is dominated by tacit knowledge resources (such is the case with research alliances), the RBV model will favour an equity alliance

governance structure which will enhance the flow of tacit knowledge between partners, while controlling unintended leakage of knowledge not to be shared between partners (Oxley & Sampson, 2004). For a historic and conceptual overview of RBV refer to Section 2.2.2.3.

- *Value-Based Perspective:* This more recent perspective is based on the approach that value-creation logic needs to be applied to the alliance governance mode decision (Leiblein, 2003). One theory that purports this perspective is that of Real Options Approach (ROA), which addresses environment uncertainty and its impact on the governance structure of an alliance by defining two possible value options, namely the "option to defer" and the "option to growth" (Leiblein, 2003). Under conditions of high uncertainty about the viability and the success of an alliance, firms tend make governance mode decisions through the "option to defer" and are more likely to opt for less hierarchical forms of governance, thereby assuring flexibility and avoiding investment lock-in (Santoro & McGill, 2005). However, by delaying commitment to create an alliance, firms may forgo potentially high cash flows, opportunities to learn, or even the window to pre-empt rivals through innovation (Leiblein, 2003). As such, firms motivated by the potential ROI from investments made during highly uncertain environmental conditions, could consider moving to the "option to grow", and would thus prefer quasi-market to quasi-hierarchy alliances (Leiblein, 2003). For a historic and conceptual overview of ROA refer to Section 2.2.2.4.

From a scope perspective, TCE theory emphasises the effects of internal uncertainty, due to factors internal to the alliance, on alliance governance mode decisions, while it rejects the alliance partners' ability to estimate the future value of an alliance investment (Pateli, 2009). Conversely, RBV theory stresses the importance of the current value of alliance partners, as well as the current value of the resources exchanged in the alliance (Pateli, 2009). ROA theory, unlike TCE theory and RBV theory, assumes that strategy managers are able to create alliance contracts that provide implicit or explicit claims on both the current and the future value of an alliance investment (Pateli, 2009). Furthermore, ROA theory takes into account the concept of external uncertainty, due to factors external to the alliance, allowing for the stipulation of probabilities for potential outcomes under a range of macro conditions that can be specified a-priori to a governance mode decision (Pateli, 2009). With regards to the risk of uncertainty, TCE theory focuses on the downside of the potential misappropriation of investment funds in alliances, while RBV theory and ROA theory emphasises upside profit creating opportunities emanating from uncertainty (Leiblein, 2003).

2.2.2.2. Background on Transaction Cost Economics

TCE as it is known and understood today is based extensively on the theories of Oliver Williamson (1979, 1981), with foundations in earlier work performed by fellow Nobel Prize winner Ronald

Coase (1937, 1960). Coase's seminal publication "The nature of the firm" (Coase, 1937) alluded to why free economies are populated by a number of business firms, instead of consisting exclusively of a multitude of independent, self-employed people who communicate and transact via extensive networks. His arguments were born out of the observation that that there are a number of transaction costs involved in using the market (economic theory at that stage heavily promoted outsourcing over hiring under the assumption of market efficiency), such as search and information costs, cost of good services over and above the cost of products, and bargaining costs (Coase, 1937). Hence, the concept of TCE that he proposed suggested that firms will be spawned if they can be arranged in such a fashion as to produce internally what they need, while at the same time avoiding these market related costs (Coase, 1937).

Following on Coase's earlier attempts to define the cost related driving force behind the creation of firms in the presence of market efficiency, Oliver Williamson went on to investigate the particular structure of a firm, most importantly, the extent to which it will integrate vertically, for example, through the creation of partnerships and alliances (Williamson, 1979, 1981). Hence, Williamson's work in the field of TCE embodied one of the first attempts to create economic theory that avoided treating a firm simply as a black box with a finite of inputs and outputs. Fundamental to Williamson's TCE theories were the notion that, under certain assumptions, firms are inherently driven by a purpose to maximise profits through cost minimisation (Williamson, 1979, 1981). This, in itself, was not unique to the broad body of economic theory at that time, but it was distinct in its postulation that costs incurred by firms can be split into transaction and production costs (Williamson, 1979, 1981). Williamson argued that, under certain circumstances transaction costs may be lower if a transaction takes place in an open market, while in other situations costs will be lower if managers coordinate the transaction (Williamson, 1979, 1981).

Williams (1979, 1981) defined transaction costs not only as the obvious monetary related buying and selling activities of firms, but also other non-monetary activities, such as day-to-day emotional interactions internal and external to firms. Conversely, he envisaged production costs as any costs incurred during the running of a firm that resulted from imperfect market conditions, commonly referred to as "market failures" in economic theory, such as the unavailability of perfect information to all parties active within an industry (Williamson, 1979, 1981). Williamson's (1979, 1981) contributions to TCE are embodied by a set of assumptions that define the static contextual factors which underline the theory, as well as a set of variables that determine whether a market or a hierarchy will produce the lowest transactional costs for varying conditions. Williamson's (1979, 1981) assumptions were the following:

- *Bounded Rationality:* This assumption refers to humans' limited memories and limited cognitive processing power, underlying the notions that humans can neither assimilate all information to their disposal, nor perceive all of the consequences emanating from information that they do possess.
- *Opportunism:* This assumption refers to humans' innate nature to act in self interest, thereby taking advantage of unforeseen circumstances that could be used to exploit others, whether it is humans, animals, plants or natural resources.

In terms of Williamson's defined variables, he postulated that three types of variables effectively characterise any transaction, namely the frequency of a transaction, the level of uncertainty in a transaction and the specificity of the assets involved in a transaction (Williamson, 1979, 1981). To gain a deeper understanding of these three types of variables, one needs to consider their respective impacts on transaction cost in relation to firms' decisions on whether to pursue vertical integration or not (Williamson, 1979, 1981):

- *Transaction Frequency:* This variable is based on the logic that a firm will not want to vertically integrate in order to provide a good or service that it very rarely uses or sells, such as highly specialised consultancy services. For example, the specialised radar and electronic warfare R&D consultancy services supplied by the CSIR is of such a specialised nature, that none of the CSIR's research alliance partners would consider developing this capability in-house.
- *Transaction Uncertainty:* This variable attempts to gauge the level of difficulty in foreseeing the contingencies that might occur during the course of a transaction, such as the actual duration of a transaction. For example, attaining the R&D services of a new research partner for a protracted duration of time, although attractive from a stability point of view, can add uncertainty to any transactions related in establishing such a partnership, as the continued existence of both partners over a long time duration might become questionable.
- *Asset Specificity:* Williamson (1979, 1981) based this variable on the notion that transactions that involve assets that are only valuable within the context of the transaction itself, a firm will attempt to reduce transaction costs by opting for vertical integration (Williamson, 1979, 1981). For example, if a South African firm in the defence electronics industry requires highly specialised search radar equipment as part of a once-off offering to a customer, it will rather opt to outsource the creation of this solution to the CSIR than developing it internally.

2.2.2.3. Background on the Resource Based View

The RBV, which is a dominant paradigm within strategic management theory, promotes the concept that a firm's ability to attain a competitive advantage in a certain industry can be primarily ascribed to its application and leveraging of a unique set of valuable resources, potentially a subset of its total complement of resources, that it has at its disposal (Wernerfelt, 1984; Rumelt, 1984). In order to ensure sustainability of this competitive advantage, it is of paramount importance that the firm's set of resources is heterogeneous from those available to other firms (Wernerfelt, 1984; Rumelt, 1984). A further requirement is that these resources need to be difficult to perfectly imitate or to substitute (Wernerfelt, 1984; Rumelt, 1984). Within the domain of alliance governance, RBV theory endorses the creation of alliance structures that will allow increased sustainable competitive advantage to alliance partners through access to shared resources which are rare, valuable, inimitable, non-tradable, non-substitutable, as well as alliance specific (Barney, 1991).

The history of RBV can be traced back to Penrose (1959), who proposed that resources played a pivotal role in a firm's competitive position in an industry. Furthermore, Penrose (1959) stated that the methodology employed by a firm in utilising its resources was crucial to determining the firm's success in producing both inorganic growth (for example, through the creation of alliances) and organic growth. Three decades later Wernerfelt (1984) went on to formalise the RBV in his seminal paper entitled "A resource based view of the firm". In this publication he states that the success of a firm in its product market was a result of its advantages in the factor market, or stated more simply, the income that a firm generates through its operations depends on the superiority of its resources (Wernerfelt, 1984). Wernerfelt (1984) attempted to develop his RBV theory (which postulates competitive advantage based on the resources a firm develops or acquires to implement its product market strategy), as a complement to Porter's Five Forces theory (Porter, 2008) (which considers the competitive advantage of a firm based on the firm's product market position).

Following closely on Wernerfelt's (1984) belief that a theory could be developed to explain the performance differences between firms in terms of the resources that those firms controlled, Rumelt (1984) presented a strategic theory that attempted to explain why firms exist, with the focus on firms' abilities to generate economic rents. At its most general level, Rumelt's theory suggested the conditions under which the structure of a firm, as an example of hierarchical governance (Rumelt, 1984), would be a more efficient way to create and appropriate economic rents than other forms of governance, such as markets. Hence, Rumelt (1984) defined firms as a bundle of productive resources and suggested that the economic value of these resources will vary depending on the context within which they are applied. Moreover, Rumelt (1984) also considered mechanisms which could prevent the imitation of these productive resources.

Wernerfelt and Rumelt's theories (Wernerfelt, 1984; Rumelt, 1984) that superior firm performance could be attained in product markets based on the attributes of the resources that a firm controlled, were followed by Barney's introduction of strategic factor markets and the implications of RBV within these markets (Barney, 1986). According to Barney (1986), strategic factor markets are those markets where firms acquire or develop the resources needed to sustainably compete within the product markets that they have chose to occupy. Furthermore, Barney (1986) postulates that if perfect competition is present in strategic factor markets, the acquisition of resources in those markets will dictate the performance that these resources will be able to create when used to implement product market strategies. Hence, he theorises that, within perfectly competitive strategic factor markets, any product market strategy chosen in an attempt to increase a firm's market share, will not be a sustainable source of economic rents (Barney, 1986).

Barney's notion of a strategic factor market (Barney, 1986) was extended by Dierickx and Cool (1989) by differentiating between resources the firm already controlled and those it wished to acquire. They suggested that resources that are subject to time compression diseconomies, causally ambiguous, characterised by interconnected asset stocks, or characterised by asset mass efficiencies, will suffer less from the strategic factor market competition described by Barney (1986) than other kinds of resources (Dierickx & Cool, 1989).

In 1990 Prahalad and Hamel (1990) revisited the RBV concept, aptly referring to resources of strategic importance to a firm as the firm's "core competence". They promulgated the notion that resources consisted not only of tangible and intangible assets, but also those unique capabilities the firm possessed. This RBV by Prahalad and Hamel (1994) became highly popular after publication of their book "Competing for the Future". In 1997 Teece, Pisano and Shuen extended Prahalad and Hamel's (1994) capability-based definition of resources to also include the concept of "dynamic capabilities", which they defined to be a firm's capabilities to integrate, build and reconfigure internal and external competencies in order to match rapidly changing macro environmental trends.

2.2.2.4. Background on the Real Options Approach

In 1977 Myers proposed the concept of ROA as a decision making tool for capital budgeting and the allocation of R&D resources (Myers, 1977). Myer's work on ROA (Myers, 1977) extend theory developed for financial options, which is a right, but not an obligation, to make an investment decision, such as the Black-Scholes model (Black & Scholes, 1973). Within ROA nomenclature, a real option is the right, but not the obligation, to undertake a particular business decision, such as the real option to make a capital investment (Roemer, 2005). Since traditional valuation methods, such as Net Present Value (NPV) fail to accurately capture the economic value of investments in

rapidly changing environments with high levels of uncertainty (Leiblein, 2003), ROA's ability to capture the value of managerial flexibility to adapt decision making, has resulted in it evolving into a compelling method to evaluate investment opportunities within uncertain external conditions.

Extensive research has been performed to investigate a broad variety of real options (Leiblein, 2003), such as the option to alter the firm's product mix (Majd & Pindyck, 1987; McDonald & Siegel, 1986; Trigeorgis, 1998), the option to invest in a joint venture (Folta, 1998; Folta & Leiblein, 1994; Kogut, 1991; Reuer & Leiblein, 2000), the option to enter a specific market (Miller & Folta, 2002a), and options related to organisational governance (Leiblein & Miller, 2003). However, all of these real options can be grouped into five overarching categories: Waiting-to-Invest option, Growth option, Flexibility option, Exit option and Learning option (York University, 2010).

Within the context of strategic technology alliances (such as research alliances), ROA considers the creation of such alliances as specific instances of real options (Leiblein, 2003). Moreover, Kogut (1991) argues that investment in technology alliances are real options that allow firms to expand in response to future technological and market developments. Hence, the ROA effectively augments the classic cost minimisation objective of TCE, and the resource synergy maximisation objective of RBV (Vaquero, Cruz & de la Fuente, 2008), to now also recognise the interdependencies of the strategic decisions leading to the creation and governance of such alliances (Roemer, 2005; Miller & Folta, 2002b). Particularly, technology alliances (including research alliances) represent portfolios of technology capabilities previously unavailable to one or more of the alliance partners, which provide alliance partners the right, but not the obligation) to invest in future technologies (Vaquero, *et al.*, 2008). Hence, the partners of a research alliance gain access to a growth option for future expansion in technologies embraced by the alliance, while still retaining the option to defer full R&D commitment (Vaquero, *et al.*, 2008). This option to defer immediate R&D investment into a specific technology represents a source of flexibility to R&D firms, which has considerable value as such investment could be risky and irreversible (McDonald & Siegel, 1986).

ROA theory relies heavily on the following two key assumptions (Leiblein, 2003): Firstly, it assumes that firms have the ability to implicitly or explicitly capture claims on future opportunities in contracts created and negotiated with alliance partners (Leiblein, 2003). Secondly, it assumes that a firm will be able to accurately estimate the expected returns emanating from various options to exit, defer, or increase investment in a particular alliance (Leiblein, 2003). These assumptions effectively imply that an alliance's true value consists of the combination of the present value of its existing assets, and the present value derived from the creation of discretional future opportunities within the alliance (Leiblein, 2003). Lastly, it has been found that, in instances where investment projects

exhibit high degrees of uncertainty and managers have discretion to act flexibly in response to this uncertainty, ROA do not suffer from the same value under estimation limitations of classic investment valuation techniques, such as NPV (Myers, 1977; Leiblein, 2003).

2.2.3. Value-Mediation Governance Model

2.2.3.1. Model Overview

In 2009 Pateli proposed a VMG model for governance mode decision making at technology-based alliance (Pateli, 2009). Pateli's VMG model employs the Structural Equation Modelling (SEM) with Partial Least Squares (PLS) regression to model and identify the potential interrelationship between internal uncertainty factors, external uncertainty factors, the expected value of the technology alliance and the preferred alliance governance mode selected by the alliance partners (Pateli, 2009). The study's use of Pateli's VMG model (Pateli, 2009) as base for the creation of a model to evaluate and represent alliance governance mode decision making for research alliances was motivated by the following factors:

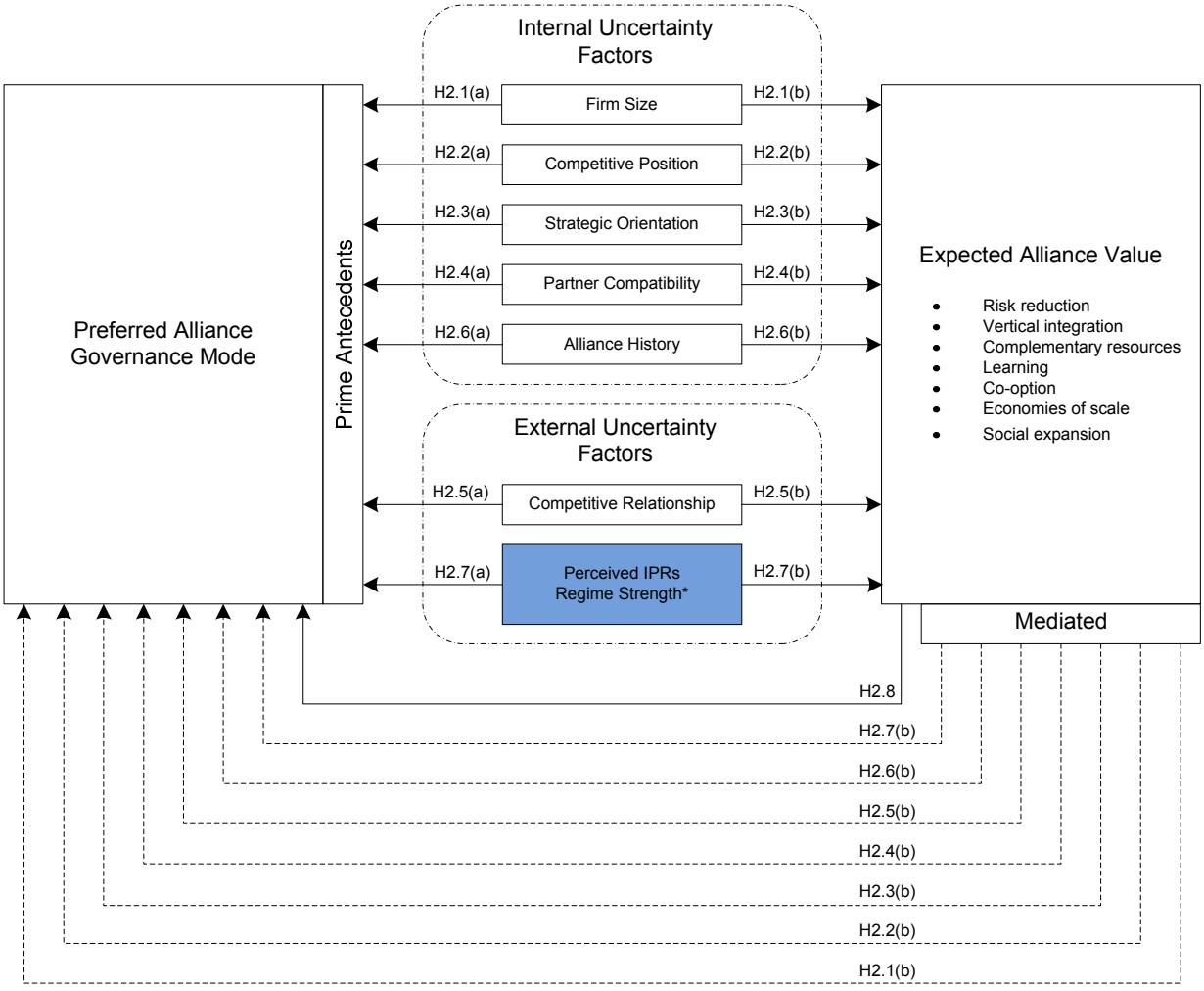
- Unlike many other popular models, such as the models by Parkhe (1993) and Leiblein (2003), developed to gain an understanding and develop an explanation of the factors that drive alliance governance mode decision making, Pateli's VMG model attempts to create a multi-dimensional view by integrating the cost-based, resource-based and value-based perspectives embodied by the TCE, RBV and ROA theories, respectively (Pateli, 2009).
- SEM with PLS regression, which is described in detail in Section 4.7.2.3 and Section 4.7.2.4, respectively, employed by Pateli's VMG model is ideally suited for instances where model building and model confirmation is the goal during research which is exploratory in nature (Vinzi, Chin, Henseler & Wang, 2010), as is the case with the study's investigation into the potential impact of Bayh-Dole-like legislation on governance mode decision making for research alliances.

In the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), which is depicted in Figure 3, internal uncertainty is estimated from alliance partner compatibility, the competitive relationship between partners, and alliance history. External uncertainty in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) consists of competition intensity and environment uncertainty. Note in Figure 3 that internal and external uncertainty factors that directly influence the preferred alliance governance mode are referred to as "Prime antecedents" (Pateli, 2009).

The VMG model also introduces the Expected Alliance Value (EAV) construct as a mediating factor on the relationships between uncertainty factors and the preferred alliance governance

mode, which allows for the mitigation of the effects of either the current firm value, or the internal uncertainty related to the governance mode decision itself (Pateli, 2009). Rooted in the ROA, the EAV construct is defined as a multi-dimensional construct that attempts to measure the expected benefits incurred by an alliance partner firm from its participation in a strategic alliance (Pateli, 2009). It is based on the key assumption that value expectations are realised when alliance partners' objectives for the alliance formation are fulfilled (Pateli, 2009). Conceptually the EAV construct spans the following seven dimensions of Contractor and Lorange's framework for the strategic contributions emanating from cooperative arrangements (Contractor & Lorange, 2002): risk reduction, vertical integration, complementary resources, learning, co-option, economies of scale and social expansion. From the VMG model shown in Figure 3 it can be seen that the perception of the EAV is driven by the sets of internal and external uncertainty factors that also act as "Primary antecedents" on the preferred alliance governance mode decision (Pateli, 2009).

Figure 3: Modified VMG model (adapted from Pateli (2009))



* External Uncertainty Factor Added by this Study

It is based on the key assumption that value expectations are realised when alliance partners' objectives for the alliance formation are fulfilled (Pateli, 2009). Conceptually the EAV construct spans the following seven dimensions of Contractor and Lorange's framework for the strategic contributions emanating from cooperative arrangements (Contractor & Lorange, 2002): risk reduction, vertical integration, complementary resources, learning, co-option, economies of scale and social expansion. From the VMG model shown in Figure 3 it can be seen that the perception of the EAV is driven by the sets of internal and external uncertainty factors that also act as "Primary antecedents" on the preferred alliance governance mode decision (Pateli, 2009).

In Pateli's original VMG model (Pateli, 2009) the Preferred Alliance Governance Mode and EAV constructs were defined as endogenous constructs, while the internal uncertainty factors, such as Firm Size, Strategic Orientation and Alliance History, and external uncertainty factors, such as Competitive Relationship, were treated as exogenous constructs (see Section 4.7.2.3 for a discussion on the concepts of endogenous and exogenous constructs). As most of internal and external uncertainty factors were latent, and therefore not directly observable, Pateli (2009) adopted a multitude of formative and reflective indicators to measure these latent constructs (see Section 4.7.2.3 for a discussion on the concepts of formative and reflective indicators). Similarly, only the Preferred Alliance Governance Mode endogenous construct was directly observable, while the EAV construct was also latent (Pateli, 2009). Section 2.2.3.2 details the endogenous and exogenous constructs employed in the original VMG model (Pateli, 2009), as well as their associated formative and reflective indicators.

Pateli (2009) evaluated the validity of the original VMG model through a survey of 57 strategic alliances in the Greek wireless services industry. From Pateli's research it was found that, in the Greek wireless services industry, quasi-hierarchy governance modes were preferred by firms that assessed their current value as high and was devoid of fear of an alliance partner's potential opportunistic behaviour (Pateli, 2009). Furthermore, quasi-market alliances were preferred by firms that had high expectations for the future value of the alliance, while facing high internal uncertainty from the existence of a competitive relationship between alliance partners (Pateli, 2009).

Based on Oxley's notation that the preferred alliance governance mode of a strategic alliance is related to the perceived strength of the IPRs regime within which the alliance operates (Oxley, 1999), the study added Perceived IPRs Regime Strength as an additional external uncertainty factor to Pateli's original VMG model (Pateli, 2009). Furthermore, the study postulated that Perceived IPRs Regime Strength is an exogenous latent construct, with research alliance related impact domains within the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts acting as potential formative indicators. Section 2.2.3.3

discusses the Perceived IPRs Regime Strength exogenous latent construct, which was added to the VMG model (Pateli, 2009) of the study.

The study's modified VMG model, depicted in Figure 3, differed from Pateli's original VMG model (Pateli, 2009) in the following two aspects:

- The Perceived IPRs Regime Strength external uncertainty factor was added, with formative indicators extracted from the impact domains identified within the South African Bayh-Dole-like IPRs legislation during Phase One of the study.
- In the original VMG model Pateli (2009) evaluated the indirect mediating effects of the EAV construct on the relationships between the internal and external uncertainty factors and the Preferred Alliance Governance Mode construct. This was accomplished using Sobel's (1982) Asymptotic Confidence Intervals for Indirect Effects in Structural Equations (ACIIESE) to test for the significance of these effects. This study, however, opted to rather model the direct mediating effects (Baron & Kenny, 1986) of the EAV construct on the relationships between the uncertainty factors and the Preferred Alliance Governance Mode construct. This evaluation of the direct mediating effects is considerably simpler to accomplish than using Sobel's ACIIESE, although less comprehensive in its ability to reflect the full extent of the mediating effects in the SEM model (Baron & Kenny, 1986). A further advantage of this approach is that it can be directly evaluated via PLS regression SEM, without having to perform any additional statistical tests (see Section 4.7.2.5 for detail on the evaluation approach proposed by Baron and Kenny (1986)).

2.2.3.2. Constructs in Pateli's Original VMG Model

Table 1 presents a succinct overview of the first-order constructs (defined as those constructs with directly related measurement indicators and, in some instances, directly related first-order constructs) employed in Pateli's original VMG model (Pateli, 2009). The second-order constructs, defined as those constructs that only have directly related first-order constructs (taken from Table 1), with no directly related measurement indicators, employed in Pateli's original VMG model (Pateli, 2009) are presented in Table 2. The survey items used to operationalise each first-order construct (see Table 29 in Appendix E for the questions and statements contained in the online survey employed to validate the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) during the quantitative phase of the study), which can either be directly observable or latent, are briefly described in Table 1. For each of the survey items the number of measurable indicators is also listed, along with each indicator's type (formative or reflective, as described in detail in Section 4.7.2.3). Pertinent publications that can be reviewed for detailed descriptions and argumentation for each construct and related indicators are additionally listed in Table 1.

Table 1: First-order constructs in the original VMG model (adapted from Pateli (2009))

First-order Construct	Construct Type	Operationalised Survey Items (with Assigned Variable Names)	Number of Indicators	Indicator Type	Related References
Firm Size	Observable	Size of the current or potential partner firm (SIZE1)	1	Reflective	European Commission (2003); Pateli (2009)
Preferred Alliance Governance Mode	Observable	Degree of interdependence between partners, based on the alliance governance mode spectrum of Figure 2 (GOV1)	1	Reflective	Gulati & Singh (1998); Pateli (2009)
Strategic Orientation	Latent	Growth strategy that the current potential partner firm plans to implement (STRAT_OR1 to STRAT_OR4)	4	Reflective	Ansoff (1965); Kotler (2000); Pateli (2009)
Competitive Relationship	Latent	1. Market overlap between partner firms (MARK_OVER1) 2. Physical location overlap between partner firms (LOC_OVER1)	1 1	Formative	Oxley & Sampson (2004); Pateli (2009)
Alliance History	Latent	1. Number of previous alliances between partners (PREV_NUM1) 2. Number of years of collaboration (PREV_DUR1) 3. Predominant governance type of previous collaborations (PREV_GOV1)	1 1 1	Formative	Parkhe (1993); Pateli (2009)
Resource Position	Latent	Resource position advantages (RES_POS1 to RES_POS9)	9	Reflective	Day & Wensley (1988); Das & Teng (2000); Pateli (2009)
Market Position	Latent	Market position advantages in terms of customer value and costs (MARK_POS1 to	8	Reflective	Day & Wensley (1988); Das & Teng (2000);

		MARK_POS8)			Pateli (2009)
Performance Position	Latent	Performance advantages in terms of market share and profitability (PERF_POS1 to PERF_POS4)	4	Reflective	Day & Wensley (1988); Das & Teng (2000); Pateli (2009)
Resource Complement-arity	Latent	Resource complementarity between partners (RES_COMP1 to RES_COMP3)	3	Reflective	Parkhe (1991); Anderson & Narus (1990); Sarkar, Echambadi, Cavusgil & Aulakh (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995); Pateli (2009)
Cultural Compatibility	Latent	Cultural compatibility between partners (CULT_COMP1 and CULT_COMP3)	3	Reflective	Parkhe (1991); Anderson & Narus (1990); Sarkar, *et al.* (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995); Pateli (2009)
Operational Compatibility	Latent	Operational compatibility between partners (OPER_COMP1 to OPER_COMP3)	3	Reflective	Parkhe (1991); Anderson & Narus (1990); Sarkar, *et al.* (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995); Pateli (2009)
Risk Reduction	Latent	Risk reduction (RISK_RED1 to RISK_RED3)	3	Reflective	Contractor & Lorange (2002); Pateli (2009)

Vertical Integration	Latent	Vertical integration (VERT_INT1 to VERT_INT5)	5	Reflective	Contractor & Lorange (2002); Pateli (2009)
Complement-arity	Latent	Complementarity (COMPLEM1 and COMPLEM2)	2	Reflective	Contractor & Lorange (2002); Pateli (2009)
Learning	Latent	Learning (LEARN1 to LEARN4)	4	Reflective	Contractor & Lorange (2002); Pateli (2009)
Co-option	Latent	Co-option (CO_OPTION1 and CO_OPTION2)	2	Reflective	Contractor & Lorange (2002); Pateli (2009)
Economies	Latent	Economies (ECONOM1 to ECONOM3)	3	Reflective	Contractor & Lorange (2002); Pateli (2009)
Social Expansion	Observable	Social expansion (EXPANSION1)	1	Reflective	Contractor & Lorange (2002); Pateli (2009)

Table 2's description of the second-order constructs not only indicates the associated first-order constructs, but also the type of relationship that these first-order constructs have with the second-order constructs, which was chosen as reflective for the study.

Table 2: Second-order constructs in the original VMG model (adapted from Pateli (2009))

Second-order Constructs	Construct Type	Related First-order Constructs (with Assigned Variable Names)
Competitive Position	Reflective	1. Resource Position 2. Market Position 3. Performance Position
Partner Compatibility	Reflective	1. Resource Complementarity 2. Cultural Compatibility 3. Operational Compatibility
EAV	Reflective	1. Risk Reduction 2. Vertical Integration 3. Complementarity 4. Learning 5. Co-option 6. Economies 7. Social Expansion

For a visualised representation of the interrelationships between measurement indicators, first-order constructs and second-order constructs, refer to the modified VMG model's SEM path diagram depicted in Figure 4.

2.2.3.3. Amending the Perceived IPRs Regime Strength Latent Construct

The study incorporated Perceived IPRs Regime Strength as an additional external uncertainty factor in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) depicted in Figure 3. Justification for the inclusion of this latent construct as driver for the preferred alliance governance mode is as follows: According to Kim (2009), viewed through the TCE lens, the level of knowledge appropriation concerns, which are defined as the concerns that technology buyers will use information related to ideas/innovation disclosed by technology sellers without offering any payment, is directly related to the governance structures employed by technology alliances. More specifically, knowledge appropriation concerns, which are caused by uncertainty and contracting issues within weak IPRs regimes, can seriously hamper inter-firm technology transactions (Williamson, 1979, 1981). Thus, strengthening the IPRs regime within which a technology alliance operates could lower knowledge appropriation concerns by reducing imitation risks, uncertainty, and the transaction costs involved in technology licensing, including the cost of monitoring and enforcement contracts (Kim, 2009).

Oxley revisited the TCE paradigm by examining how the institutional environment and project characteristics influence governance mode decisions of research alliance partners, specifically considering the choice between equity and contractual alliance forms under differing IPRs regimes and other national institutional characteristics (Oxley, 1999). Although Oxley's research showed that transaction-level characteristics, such as the internal factors in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) are the primary drivers in governance mode decision making, it did highlight the importance of IPRs regime strength as an external driving factor (Oxley, 1999). More specifically, Oxley (1999) showed that alliance partners adopt more hierarchical governance modes when the perceived IPRs regime strength is low.

An ongoing challenge in performing quantitative research into IPRs (such as the quantitative research phase of the study), is defining measures that adequately reflect the level of IPR protection and the IPRs regime strength. Rapp and Rozek (1990), for example, used the prevalence of patent laws (measured on a 6-point scale) as a proxy for IPR protection. Seyoum (1996) proposed a 4-point scale to measure the levels of the following set of indicators: patents, copyrights, trademarks and trade secrets. The IPR protection scoring system devised by Sherwood (1997) consisted of a weighted sum of the scorings for each of the following 4 indicators:

enforceability, administration, substantive law (with separate scorings for copyrights, patents, trademarks, trade secrets and life forms) and treaties.

During the qualitative phase of the study several impact domains within the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts were identified which could potentially influence governance mode decisions for R&D alliances (see Section 5.2.2.1). From the list of impact domains identified the following three were determined to be the most significant (see Section 5.2.2.2):

- *Choice of IPRs Ownership:* A public sector R&D organisation can choose the ownership of the IPRs obtained for Intellectual Property (IP) it had generated, with the potential assistance of funding, resources and services of other R&D organisations, from partial or full government funding.
- *State Walk-in Rights on Undeclared IP:* The state is granted walk-in rights on the IPRs for IP that was generated through public financing, but not properly declared to government.
- *Benefit Sharing Policies:* IP creators at publicly financed R&D organisations are granted a specific right to a portion of the revenues that accrue to the organisation from the IPRs.

These three impact domains were then used as formative indicators (see Section 4.7.2.3) of the Perceived IPRs Regime Strength latent construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1). Justification for defining these indicators as formative indicators, instead of reflective indicators, is based on each indicator's limited ability to act as full proxy for the perceived strength of the IPRs regime. Arguably, each indicator is only able to reflect a portion of the perceived strength of the IPRs regime. Hence, a linear weighted combination of these indicators is required to attain a full reflection of the Perceived IPRs Regime Strength uncertainty factor, which is a defining characteristic of formative indicators (see Section 4.7.2.3).

2.3. Intellectual Property Rights

2.3.1. Intellectual Property Protection Mechanisms

IPPMs encompasses the protection instruments provided by patents, trademarks, plant breeders rights, copyright, trade secrets and other types of rights that legislation provides for the protection of investment in creative effort and knowledge creation (Maredia, 2001). Core to the notion of a knowledge economy is the belief that the greatest level of economic efficiency occurs with the widest possible dissemination of new knowledge (Maredia, 2001). However, if everybody is free to access new knowledge, inventors and innovators have little incentive to commit resources, such as funding, human capital and production resources, to commercialise it. Hence, IPRs effectively

transform knowledge from a public good into a private good, albeit for a limited time frame (Maredia, 2001). One can therefore argue that the enhanced market power conferred to the owners of IPRs not only enable them to recoup their expenditure in creating this new knowledge, but also creates incentive to engage in further invention and innovation. The World Bank (1999) eloquently states that IPRs are a "...compromise between preserving the incentive to create knowledge and the desirability of disseminating knowledge at little or no cost".

2.3.2. Role of Intellectual Property Rights in Research Alliances

Hertzfeld, Link and Vonortas (2001) claim that the use of IPPMs in research alliances depends on various factors, including the type of knowledge to be protected, the kind of competition in the specific industry, the organisational characteristics and culture of the owner of the knowledge, the governance structure of the alliance, the objectives of the partnership and the position of the alliance in the continuum from the early planning stage to termination. In Hertzfeld, *et al.* (2006) findings are presented from a substantial set of large, diversified US firms that were investigated with regards to their assessment of the role and effectiveness of IPPMs in the formation and implementation of research alliances. Their research confirms that resolving issues related to IPR protection is a fundamental consideration for all research alliance partners involved (Hertzfeld, *et al.* 2006). Furthermore, Hertzfeld, *et al.* (2006) found that patents are the most frequently used IPPM to protect research alliance partners' existing IP (referred to as background knowledge) when entering into a research alliance and new IP (referred to as foreground knowledge) created by the research alliance, while other IPPMs (especially trade secrets) are used extensively to protect know-how and tacit knowledge in the early negotiation stages of creating a new alliance.

2.3.3. IPRs Legislation for Publicly Financed R&D

2.3.3.1. Origins and Success of the Bayh-Dole Act

The Bayh-Dole Act (Mowery & Sampat, 2005) was implemented in 1980 in the US with the primary intent to promote the growth of technology-based small businesses by allowing them to own the patents that were produced out of federally sponsored research. Although not through original design, universities and other non-profit recipients of federal funding were also included in the definition of "small entities" benefiting from the Bayh-Dole Act (Mowery & Sampat, 2005). The Act defined that universities and other small entities would not develop their patented technologies themselves, but would license the patents to industry for development and commercialisation. Furthermore, a provision of the Act allowed for the university retention of royalties, to be reinvested into its research and educational activities) as well as specifying that a fraction of the royalties received need to be allocated as personal income to the inventors (So, *et al.*, 2008).

Enactment of Bayh-Dole Act in 1980 paralleled a sharp increase in patenting and licensing at US universities (So, *et al.*, 2008). For instance, the number of patents issued to the 100 leading US research universities increased by more than 100% for the period for 1979 to 1984, and doubled again between 1984 and 1989 (So, *et al.*, 2008). The share of US patents attributable to universities increased from less than 1% in 1975, to a figure of nearly 2.5% in 1990 (So, *et al.*, 2008). So, *et al.* (2008) also states that the ratio of patents to R&D spending within the US university arena nearly doubled during the period 1975 to 1990, with a 1975 figure of 57 patents per $1 billion in R&D spend to a figure of 96 patents per $1 billion in R&D spend in 1990. As this ratio for non-university US patenting showed a sharp decline (decreasing from 780 patents in 1975 to 429 patents in 1990 for $1 billion in R&D spend), it is clear that universities increased their patenting per US Dollar spent on R&D for a period in which overall patenting per US Dollar spent on R&D was declining (So, *et al.*, 2008). Accompanying the increased patenting activity at US universities during the last three decades, these universities also expanded their efforts to license their registered patents (Cohen, Florida, Randazzese & Walsh, 1998). According to reports by the Association of University Technology Managers, the number of universities with technology transfer offices increased from 25 in 1980 to 200 in 1990, and licensing revenues increased from $183 million to $318 million for the period 1991 to 1994 (Cohen, *et al.*, 1998). The question, however, still remains whether these increases in patenting and licensing are attributable to the Bayh-Dole Act (So, *et al.*, 2008), or to other external factors.

2.3.3.2. Application of Bayh-Dole-like Legislation in Emerging Markets

Recent imitators that have created legislation emulating the US Bayh-Dole Act include countries such as China, Brazil, Malaysia, India and South Africa (So, *et al.*, 2008). Although all of these countries, most with emerging economies, created Bayh-Dole-like IPRs legislation to promote the patenting of publicly financed R&D, and incentivises the commercialisation of these patents through exclusive licensing agreements, some of the emulation initiatives also aim to generate revenues for public sector research institutions (So, *et al.*, 2008). Emulation of the Bayh-Dole Act is spurred by increases in patenting and licensing that many believe are attributable to the Bayh-Dole Act (So, *et al.*, 2008).

So, *et al.* (2008) and others (Jishnu, 2008; Mowery, Nelson Sampat & Ziedonis, 2004) believe that advocates of Bayh-Dole emulation in other countries overstate the impact of Bayh-Dole in the US. For example, *The Economist* claimed in 2002 that the low licensing rate for the approximate 28000 patents owned by the US government prior to Bay-Dole's enactment in 1980, was the result of a legal regime that was not conducive to commercialisation (So, *et al.*, 2008). The relevance of these figures in relation to debates about publicly financed R&D is questionable, since most of these patents were based on government-funded research conducted by private firms, not by universities

or public sector R&D institutions (So, *et al.*, 2008). So, *et al.* (2008) also notes that by focussing on licensing of patented inventions, advocates conveniently ignore the fact that most of the economic value-add produced public sector R&D institutions have historically occurred without patents, as this occurred through knowledge dissemination by means of conference presentations, journal publications and student training (So, *et al.*, 2008).

2.3.4. South African IPRs Legislation for Publicly Financed R&D

2.3.4.1. Background on the South African Legislation for IP Generated from Public Financing

According to World Intellectual Property Organisation (WIPO), universities and R&D institutions in Africa have been amateur in their relations with sponsors of R&D activities, particularly government sponsors (Maredia, 2001). This can be attributed to the fact that most universities and R&D institutions in Africa do not have proper IP policies in place with which to safeguard their interests within collaborative research activities (Maredia, 2001). As such, the South African government has recently decided to intervene through a legislative attempt to strengthen IPR protection for publicly financed R&D by means of the IPRPFRD Act (Republic of South Africa, 2008a), as well as the establishment of the TIA (Baloyi, *et al.*, 2009). In addition to the funding currently provided through public agencies, such as the Innovation Fund, the TIA seeks to mobilise Venture Capital (VC) through Public Private Partnerships (PPPs) (Baloyi, *et al.*, 2009). The TIA, through financial and non-financial support mechanisms, is designed to stimulate scientific innovation and to ensure ROI on R&D spent through the commercialisation of research outputs (Baloyi, *et al.*, 2009). The TIA was established through the TIA Act (Republic of South Africa, 2008b), which was signed into law in November 2008. According to the TIA Act (Republic of South Africa, 2008b), the role of the TIA is to (Baloyi, *et al.*, 2009):

- Stimulate the development of technology-based products and services.
- Stimulate the development of public and private sector technology-based enterprises.
- Develop a significant technology base for the South African economy.
- Facilitate the development of human capital for innovation.
- Provide the primary bridge between the formal knowledge base and the real economy.

The primary purpose of the IPRPFRD Act (Republic of South Africa, 2008a) is to provide legislative mechanisms to protect IP emanating from publicly financed R&D by requiring that it be identified, protected, utilised and commercialised for the advantage of the people of South Africa, whether it be for a social, economic, military or any other benefit (Baloyi, *et al.*, 2009). The IPRPFRD Act (Republic of South Africa, 2008a) was in essence derived from the Bayh-Dole Act (Mowery &

Sampat, 2005). According to the South African government, IPR protection for publicly financed R&D through the IPRPFRD Act (Republic of South Africa, 2008a) is required to (Baloyi, *et al.*, 2009):

- *Realise Commercial Value:* Investors might not want to commercialise IP that is not protected in some way. Hence, there needs to be a barrier to entry for potential innovation competitors.
- *Stake a Claim to IP:* The IPRPFRD Act not only provides a process by which IP creators can be identified, but also provides a fair and transparent ethos of reward and recognition.
- *Realise R&D Opportunities (by exploiting research niche areas through enhanced visibility):* The Act promotes the creation of patent lists in specific industries to increase the stature of particular research groups and could lead to more contract R&D directly due to the IP held in that area.
- *Create Opportunities to go from Invention to Innovation:* Disclosure of IP is the key to allow other people, organisations and firms to use researchers' IP to realise value, whilst allowing some form of ROI to the inventors.

The IPRPFRD Act (Republic of South Africa, 2008a) is geared at increasing the awareness of the benefits of IP protection, and ultimately, at ensuring that proper care is taken in protecting and utilising the IP created by public financing in South Africa (Baloyi, *et al.*, 2009). Moreover, the objective of the IPRPFRD Act (Republic of South Africa, 2008a) is to foster a culture which nurtures and protects IP and aims to realise the potential of inventions into innovations (Baloyi, *et al.*, 2009). Furthermore, the IPRPFRD Act (Republic of South Africa, 2008a) should create an awareness of the use of IP protection as a way to encourage innovation (Baloyi, *et al.*, 2009).

2.3.4.2. Potential Business Impact Domains within the South African IPRPFRD and TIA Acts

Prior research on the business impact of the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts on the strategic decision making processes and operations of South African research institutions is limited to a qualitative exploratory study by Baloyi, *et al.* (2009), which employed only secondary data (Zikmund, 2003). Their study, based purely on a critical evaluation of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, was aimed at identifying the potential impact domains of the Acts on the CSIR's operational processes, infrastructure and resources. The eight domains of potential business impact within the CSIR, identified by Baloyi, *et al.* (2009), include (not ranked in any specific order of potential severity of impact):

1. *IP Detection Process:* The establishment of a process required for the detection of new IP generated from research activities.

2. *IP Declaration Process:* The establishment of a process for the declaration of transfer of IP.
3. *Benefit Sharing Policies:* The creation or updating of benefit sharing policies with research alliance partners.
4. *Offshore IP Registration Process:* Complying with the requirements for international collaboration and registering offshore IP.
5. *Government Reporting Process:* Establishing a process for reporting on IPR related issues to NIPMO, twice yearly.
6. *Government Publication Approval Process:* The NIPMO approval process for the publication of papers.
7. *Government Reaction Time:* The response times to be expected from NIPMO with regards to the approval for research publications or other requests.
8. *Structural and Resource Requirements:* Improvements required to firm infrastructure and operational resources in order to support the new IPRPFRD Act (Republic of South Africa, 2008a), such as enterprise software upgrades.

Although Baloyi, *et al.* (2009) postulated that these impact domains will influence operations, infrastructure and resources at the CSIR in general, this research study elected to use this list as a baseline set of potential factors, emanating from the new legislative framework consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could significantly influence the perceived strength of the IPRs regime (Oxley, 1999), which in turn influences governance mode decisions within research alliances.

As part of the research objectives (see Section 3.3.1) the study attempted to verify and potentially extend this list of impact domains, and subsequently endeavoured to identify the three most significant domains in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that might impact research alliance governance mode decision making. These three identified impact domains were then included as formative indicators for the Perceived IPRs Regime Strength external uncertainty factor that impact the Preferred Alliance Governance Decision Mode construct within the modified VMG model (Pateli, 2009) (see Section 2.2.3.1).

2.3.4.3. Potential Negative Spill-Over Effects from South Africa's IPRPFRD Act

At the time of the writing of this dissertation, no case law had yet been generated in South Africa that involves the new IPRPFRD Act (Republic of South Africa, 2008a). As such, it is difficult to gauge the potential negative spill-over effects of this Acts. However, with reference to the potential business domains defined in the exploratory study by Baloyi, *et al.* (2009) at the CSIR, the following speculative negative spill-over effects have been suggested by Baloyi, *et al.* (2009), but to date have not been quantitatively tested:

- *Success Depends on Structural and Policy Issues at Research Organisations:* The US Bayh-Dole Act of 1980, on which South Africa's IPRPFRD Act (Republic of South Africa, 2008a) is based, essentially sought to facilitate patenting and licensing by US universities and small businesses of all inventions based on federally funded research (Mowery & Sampat, 2005). The Bayh-Dole Act was followed by significant growth in patenting and licensing by US universities. As such, many governments attempted to emulate the Bayh-Dole Act, without substantiated proof that the observed growth in patenting and licensing was the consequence of the Act, and not any other external factors. Mowery and Sampat (2005) postulates that emulation of the Bayh-Dole Act is likely to have modest success if greater attention is not given to the structural and policy characteristics of publicly financed research organisations, due to the Act's inherent history, path dependence and institutional entrenchment.
- *Negative Spill-Over Effects for Research Alliances:* The exploratory research performed by Baloyi, *et al.* (2009) on the potential impact areas of the IPRPFRD Act (Republic of South Africa, 2008a), with a specific focus on the CSIR context, suggests that negative spill-over effects may occur in both national and international research collaborations. Within international research collaborations, Baloyi, *et al.* (2009) postulates that these spill-over effects could include the following:

    - The IPRPFRD Act (Republic of South Africa, 2008a) requires the declaration of any "offshore IP transaction" to the NIPMO (Baloyi, *et al.*, 2009). To fulfil the requirements of the Act, the publicly financed research organisations will have to establish a new process whereby R&D outcomes managers will have to manage this as part of the contract approval processes (Baloyi, *et al.*, 2009). Furthermore, generation of IP through collaborative research that is in any way financed by South African funds (even through indirect contributions) falls under the regulations of the IPRPFRD Act (Republic of South Africa, 2008a), and as such, any transfer and/or sharing of IP with an international partner will have to be approved by the NIPMO (Baloyi, *et al.*, 2009). These factors will most likely have a direct impact on all existing joint international research efforts, since any new IP agreements will have to be evaluated by the NIPMO (Baloyi, *et al.*, 2009).
    - Any publicly financed South African research organisation wanting to set up an international collaboration will have to prove that there are no local partners which can either develop, or commercialise the IP locally (Baloyi, *et al.*, 2009).

  From the perspective of national research collaborations, negative spill-over effects could include the following (Baloyi, *et al.*, 2009):

- Some of the South African universities see the IPRPFRD Act (Republic of South Africa, 2008a) as restricting them from performing contract research for an industrial entity, since the indirect cost (such as infrastructure and salaries) covered by public funds, will mean that the NIPMO will gain rights to IP for which they provided very little funding (Baloyi, *et al.*, 2009). As this view might also become entrenched within the South African private sector, the result could potentially be diminished public-private contractual R&D partnerships between national firms (Baloyi, *et al.*, 2009).
- Open community initiatives, such as the OpenSource community involved in the development of the Ubuntu operating system, led by Mark Shuttleworth's Canonical (Canonical, 2010), will be stifled, specifically in the domain of software development projects, since the IPRPFRD Act (Republic of South Africa, 2008a) requires that any such projects must first be approved by the NIPMO, causing delays and interruption that could lead interested parties to look for alliance partners elsewhere (Baloyi, *et al.*, 2009).

2.4. Academic Motivation for the Study

The academic case for the study is composed of the following three arguments:

1. *Gauging the Impact of Bayh-Dole-Like Legislation on Strategic Research Alliances:* While the impact of IPRs legislation on the governance of research alliance have been considered in prior research, the focus to date has been primarily on IPRs regime mismatches between international alliance partners (Oxley, 1999). Furthermore, the impact of Bayh-Dole-like legislation on university-industry collaboration has also been a focal point of prior research (So, *et al.*, 2008). However, prior research investigating the governance mode decision impact of Bayh-Dole-like legislation on strategic research alliances seemed to be lacking in literature.
2. *Updating of the VMG Model to Include Bayh-Dole-Like IPRs Legislative Impact Domains as Indicators for the Perceived IPRs Regime Strength External Uncertainty Factor:* The VMG model proposed by Pateli (2009) presented an initial attempt at creating an integrative alliance governance mode decision model that exploits the advantages of cost-based, resource-based and value-based perspectives. Although sound in its general approach, it was lacking in terms of the internal and external uncertainty factors that it supported. Specifically in the case of strategic research alliances, the impact of the perceived strength of the IPRs regime (determined by the IPRs legislative framework) as external uncertainty needed to be included (Oxley, 1999).

3. *Verification of the VMG Model's Validity for Governance Mode Decisions in Strategic Research Alliances:* Pateli's VMG model (Pateli, 2009) was created specifically for strategic technology alliances and was only empirically tested within the Greek wireless services industry. As such, the validity of this model as a framework for governance mode decisions within strategic research alliances warranted further investigation.

Chapter 3 - Research Objectives, Questions and Propositions

3.1. Introduction

The following sections detail the study's research objectives, with associated research questions and propositions.

3.2. Research Objectives

As is discussed in more detail in Chapter 4, the study was performed in two distinct phases, each addressing a separate research objective. These two research objectives of the study were defined as follows:

- *Research Objective 1:* This research objective, which was the focus of Phase One of the study, entailed identifying the three most significant impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could potential act as formative indicators for the external uncertainty factor Perceived IPRs Regime Strength, which influence governance mode decisions for research alliances, within the context of the CSIR's current and future research alliance network. To that end, the impact domains proposed by Baloyi, *et al.* (2009) (see Section 2.3.4.2) as potential factors that could influence the general operations, infrastructure and resources of the CSIR, were selected as baseline set. Any additional impact domains identified during this quantitative research phase was then amended to this list. From the final amended set of impact domains, the three most significant impact domains were identified and included in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) as indicators for the perceived strength of the IPRs regime (Oxley, 1999). The research approach followed during this initial exploratory phase was a qualitative study (Zikmund, 2003) that employed an online survey of senior managers at the CSIR as data collection tool (for detail on this phase's data collection and data analysis approaches, refer to Section 4.6.1 and Section 4.7.1, respectively).
- *Research Objective 2:* This research objective, which was the focus of Phase Two of the study, aimed to incorporate Phase One's three identified impact domains into the VMG model (Pateli, 2009) as formative indicators for the Perceived IPRs Regime Strength external uncertainty factor. Next it aimed to empirically evaluate the validity of the modified

VMG model (Pateli, 2009) (see Section 2.2.3.1) within the context of the CSIR's current and potential research alliance network. The research approach employed during the confirmatory phase was a quantitative study (Zikmund, 2003) that used an online survey as data collection tool (for detail on this phase's data collection and data analysis approaches, refer to Section 4.6.2 and Section 4.7.2, respectively). The survey was distributed amongst CSIR research alliance partners and clients, as well as business professionals that might consider establishing such relationships with the CSIR in the future.

3.3. Research Questions, Propositions

The following research questions and propositions were defined for the research objectives state in Section 3.2.

3.3.1. Research Questions Related to Research Objective 1

The following research questions were addressed as part of Research Objective 1:

- *Research Question 1.1*: Using the set of potential business impact factors identified by Baloyi, *et al.* (2009) (see Section 2.3.4.2) in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts as baseline, which domains within these Acts could be used as formative indicators for the perceived strength of the IPRs regime, that could, in turn, significantly impact governance mode decisions for strategic research alliances within the context of the CSIR's current and potential research alliance networks?
- *Research Question 1.2*: Which three of the impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, as identified during Research Question 1.2, could most significantly impact governance mode decisions within research alliances by acting as formative indicators for the perceived strength of the IPRs regime (within the context of the CSIR's current and potential research alliance network)?

Pertinent literature sources related to these research questions, as well as the data collection tools and analysis methods used in answering these questions, are summarised in the consistency matrix of Table 26 (see Appendix A).

3.3.2. Research Propositions Related to Research Objective 2

In order to quantitatively evaluate the validity of the modified VMG model (see Section 2.2.3.1) within context of the current and potential research alliance network of the CSIR, Research Propositions H1 through H7 in Pateli (2009) were mirrored by Research Propositions H2.1(a) through H2.6(a), as well as H2.8, in this study. Propositions H8a to H8f in Pateli (2009), which

were mirrored by Research Propositions H2.1(b) through H2.6(b) in this study, were slightly modified in order to test for the direct mediating effect of the EAV construct on the relationship between each of the uncertainty factors in the modified VMG model (see Section 2.2.3.1) and the Preferred Alliance Governance Mode construct, as opposed to replicating Pateli's approach that considered the significance of indirect mediating effects via Sobel's (1982) ACIIESE. Since the methodology used to validate the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) was based on PLS regression, defining mathematical hypotheses for these propositions were not required (Abdi, 2010; Vinzi, *et al.*, 2010).

Several researchers (Leiblein & Miller, 2003; Osborn & Baughn, 1990) believe that firm size influence the motivation of firms to enter in alliances. Tether (2002) postulates that small firms opt for less hierarchical alliances in fear of losing their autonomy, while large firms prefer more hierarchal alliances in order to exploit power over resources (in accordance with RBV). Research propositions related to the impact of the alliance partner firm's size on governance mode decisions included the following:

- *Research Proposition H2.1(a):* The preference for quasi-hierarchy governance modes is positively related to partner firm size (see research proposition H1 in Pateli (2009)).
- *Research Proposition H2.1(b):* The relationship between partner firm size and the preference for quasi-hierarchy governance modes is mediated via the EAV (modified from research proposition H8a in Pateli (2009) in order to consider direct mediating effects).

The competitive position of a firm is in part determined by its resource position (Day & Wensley, 1988). Hemphill and Vonortas (2003) argued that, from an RBV perspective, firms wishing to maintain or achieve a competitive advantage in an environment where time-to-market and timing is critical, the rate of technological change is rapid, and the nature of future competition difficult to determine, will prefer quasi-hierarchy alliances. This preference is ascribed to these firms' need to not only acquire new competitive competencies through learning, but also protect their current competitive skills and resources (Hemphill & Vonortas, 2003; Hamel & Prahalad, 1994). Research propositions related to the impact of the alliance partner's competitive position on governance mode decisions included the following:

- *Research Proposition H2.2(a):* The preference for quasi-hierarchy governance modes is positively related to strength of the alliance partner firm's competitive position (see research proposition H2 in Pateli (2009)).
- *Research Proposition H2.2(b):* The relationship between the strength of the alliance partner firm's competitive position and the preference for quasi-hierarchy governance modes is

mediated via the EAV (modified from research proposition H8b in Pateli (2009) in order to consider direct mediating effects).

According to Ansoff (1965) and Kotler (2000) alliance creation is sometimes viewed as an aggressive growth strategy, which allows for rapid service/product diversification and integration. Furthermore, as the importance of growth strategies based on increased diversification and integration increase, so also does the required resource commitment (Pateli, 2009). Moreover, the fear that alliance partners' actions could damage growth strategies also increases (Pateli, 2009). Thus, from both the RBV and TCE perspectives a focus on such growth strategies will dictate a preference for more hierarchical governance modes, which will not only allow for the safeguarding of assets, but also ensure partner commitment to growth strategies (Pateli, 2009). Research propositions related to the impact of the alliance partner's view on growth strategies on governance mode decisions included the following:

- *Research Proposition H2.3(a):* The preference for quasi-hierarchy governance modes is positively related to the increased importance of growth strategies (diversification and integration) (see research proposition H3 in Pateli (2009)).
- *Research Proposition H2.3(b):* The relationship between the increased importance of growth strategies (diversification and integration) and the preference for quasi-hierarchy governance modes is mediated via the EAV (modified from research proposition H8c in Pateli (2009) in order to consider direct mediating effects).

Parkhe (1991) conceptualised alliance partner compatibility as the complementarity of resources, together with cultural and operational compatibility. From a TCE perspective the coordination costs inherent in alliance management decreases if the compatibility in partners' cultures and operational strategies increase, thereby resulting in a preference for quasi-hierarchies (Gulati & Singh, 1998). Similarly, an RBV perspective also results in a preference for quasi-hierarchies due to the increased availability of complementary resources (Pateli, 2009). Research propositions related to the impact of the alliance partner compatibility on governance mode decisions included the following:

- *Research Proposition H2.4(a):* The preference for quasi-hierarchy governance modes is positively related to increased partner compatibility (see research proposition H4 in Pateli (2009)).
- *Research Proposition H2.4(b):* The relationship between increased partner compatibility and the preference for quasi-hierarchy governance modes is mediated via the EAV

(modified from research proposition H8d in Pateli (2009) in order to consider direct mediating effects).

According to Hamel, Doz and Prahalad (1989) potential technology alliance partners need to be screened based on converging strategic goals, but diverging competitive goals. In highly competitive alliances quasi-hierarchies are preferred, since they provide protection to induce knowledge sharing (according to the RBV perspective), while they allow partners to sustain their own core competencies (according to the TCE perspective) (Kogut, 1988). Research propositions related to the impact of the alliance partner's competitive relationship on governance mode decisions included the following:

- *Research Proposition H2.5(a):* The preference for quasi-hierarchy governance modes is positively related to intensity in the partner competitive relationship (see research proposition H5 in Pateli (2009)).
- *Research Proposition H2.5(b):* The relationship between the intensity in the partner competitive relationship and the preference for quasi-hierarchy governance modes is mediated via the EAV (modified from research proposition H8e in Pateli (2009) in order to consider direct mediating effects).

Gulati (1995) postulates that prior collaborations between firms through alliances increase trust. Moreover, as mutual experience increases, so also does the level of trust between partners (Gulati, 1995). From a TCE perspective, this increase level of trust, with an according decrease in uncertainty, leads to positive expectations about partner behaviour, thereby decreasing the need for the costly monitoring and control mechanisms available in quasi-hierarchical alliances (Santoro & McGill, 2005). From an ROA perspective the increased level of trust will enhance the preference for quasi-hierarchies, as the decrease of partner uncertainty encourages partners to commit more resources in order to opt for future growth (Pateli, 2009). Research propositions related to the impact of the alliance history on governance mode decisions included the following:

- *Research Proposition H2.6(a):* The preference for quasi-hierarchy governance modes is positively related to the alliance history between partners (see research proposition H6 in Pateli (2009)).
- *Research Proposition H2.6(b):* The relationship between the alliance history between partners and the preference for quasi-hierarchy governance modes is mediated via the EAV (modified from research proposition H8f in Pateli (2009) in order to consider direct mediating effects).

The three impact domains related to the legislative framework consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts in South Africa, identified during the research performed for of Phase One of the study, were used as formative indicators in the SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) for the Perceived IPRs Regime Strength (Oxley, 1999) external uncertainty factor. The following research propositions were derived from research proposition H1 in Oxley (1999), which postulated a negative relationship between the preference for quasi-hierarchies in research alliances between US and non-US firms, and the perceived strength in the IPRs regime:

- *Research Proposition 2.7(a):* The preference for quasi-hierarchy governance modes is positively related to the perceived strength of the IPRs regime within which the research alliance operates.
- *Research Proposition 2.7(b):* The relationship between the perceived strength of the IPRs regime within which the research alliance operates and the preference for quasi-hierarchy governance modes is mediated via the EAV.

Research Propositions H2.1(a) through H2.7(a) relate to “Prime antecedents” factors, while Research Propositions H2.1(b) through H2.7(b) relate to the “Mediated” factors in the modified VMG model (see Section 2.2.3.1). Figure 3, showing the modified VMG model, adapted from Pateli (2009), includes branch labelling indicating the relevance of each of these research propositions within the model’s structure.

ROA recognises the value that the ability to delay or defer an irreversible investment under high exogenous uncertainty can produce (Leiblein, 2003; McDonald & Siegel, 1986). Thus, under conditions of exogenous uncertainty ROA promotes the adoption of quasi-market alliances, as these structures provide more flexibility (Pateli, 2009). However, ROA also suggests that the options for growth resulting from the creation of equity alliances could bias governance mode decisions towards quasi-hierarchies (Ansoff, 1965; Kotler, 2000). The research proposition related to the impact of external uncertainty on governance mode decisions was as follows:

- *Research Proposition H2.8:* The preference for quasi-hierarchy governance modes is positively related to high expectations for EAV (adapted from research proposition H7 in Pateli (2009)).

Pertinent literature sources related to these research propositions, as well as the data collection tools and analysis methods used during the testing of these propositions are summarised in the consistency matrix of Table 26 (see Appendix A).

Chapter 4 - Research Methodology

4.1. Introduction

This chapter details the research study's two-phased research process, consisting of a qualitative phase followed by a quantitative phase. It describes the population, unit of analysis, sampling plan, data collection tools and data analysis tools for each of the research phases. PLS regression SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) receives special attention, since this modelling approach has only recently gained traction in business research and is not yet that well known (Vinzi, *et al.*, 2010). A brief overview of potential research limitations inherent in the study's methodology concludes this chapter.

4.2. Phased Research Process

This study was conducted using two distinct phases, each designed to address a specific research objective (see Section 3.2):

- *Phase One:* The initial phase addressed Research Objective 1, which intended to identify the three most significant impact domains within the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could act as indicators for the perceived strength of the IPRs regime, which has the potential to influence governance mode decisions within research alliances. At its onset it gauged the validity of the eight business impact factors identified by Baloyi, *et al.* (2009) as potential candidates, where after it attempted to amend/improve on this list. From this amended list the three most significant influencing factors were selected as formative indicators for the Perceived IPRs Regime Strength (Oxley, 1999) external uncertainty factor that was added to the VMG model (Pateli, 2009).
- *Phase Two:* This phase, which intended to address Research Objective 2, employed the three most significant IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts' impact domains identified in Phase One to the VMG model (Pateli, 2009) as formative indicators for the additional external uncertainty factor Perceived IPRs Regime Strength. Subsequently it applied this modified VMG model (Pateli, 2009) (see Section 2.2.3.1) to the current and potential research alliance network of the CSIR in order to produce a prediction tool that may assist in choosing the most optimal governance structures for current and future research alliances within this context.

4.3. Research Methodologies

4.3.1. Research Methodology for Phase One

By endeavouring to discover the three most significant impact domains within the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could potentially act as indicators for the perceived strength of the IPRs regime, which influences governance mode decisions for research alliances, the study expanded the initial exploratory research performed by Baloyi, *et al.* (2009). Expansion of the study performed by Baloyi, *et al.* (2009) was justified for the following reasons:

- Their study attempted to find business impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that influenced the CSIR's operations, infrastructure and resources. Hence, their study was not only heavily rooted in context, but also did not focus specifically on impact domains that influence governance mode decision making for research alliances (via their potential impact on the perceived strength of the IPRs regime).
- The conclusions drawn in their study were based on results consisting of a combination of the researchers' critical review of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, as well as a very limited quantitative survey amongst CSIR researchers only, without any statistical analysis whatsoever. Hence, their results suffered from researcher bias, unrepresentative sampling and low statistical confidence (Zimunk, 2003).

Hence, this phase of the present study attempted to remedy these shortcomings through a detailed qualitative study amongst South African managers, employed by publicly financed R&D institutions, whom potentially experience the direct effects of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts on research alliances within their environment.

Zikmund (2003) states that qualitative research methods emphasise the value of individual experiences and views, as encountered in real-life situations. Furthermore, Zikmund (2003) also states that the nature of qualitative enquiry implies that large amounts of rich and deep data are produced, often from a variety of sources. While the present research methodology does not seek to reduce data to statistical evidence, qualitative data nevertheless requires systematic analysis through methods such as Narrative Inquiry and Constant Comparative Method (Zikmund, 2003) to ensure rigor and validity in the derived conclusions. Since the first phase of the study required this deep, but rigorously analysed perspective on the potential impact domains in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that might

influence governance mode decisions in research alliances (by acting as indicators for the external uncertainty factor for the perceived strength of the IPRs regime), a qualitative exploratory approach based on primary respondent data was highly appropriate.

4.3.2. Research Methodology for Phase Two

Phase Two of the study intended to not only incorporate the three IPR related impact domains selected in Phase One as potential formative indicators for the external uncertainty factor Perceived IPRs Regime Strength, added to Pateli's VMG model (Pateli, 2009) for alliance governance mode decisions, but to also validate this modified model within the context of the CSIR's current and potential research alliance network. The VMG model (Pateli, 2009), as a tool for rational alliance governance mode decision making, was designed to utilise knowledge gained from past cases where governance mode decision making was influenced by internal and external uncertainty factors. It can be argued that Pateli (2009) had appropriately selected a research method that built the VMG model using many cases to describe the interrelationships between the Preferred Alliance Governance Mode construct and the uncertainty factors. This research method is commonly referred to as quantitative descriptive research (Zikmund, 2003) and was the research method of choice for Phase Two of the study.

4.4. Populations and Units of Analysis

Due to the nature of research questions and propositions defined for the study (see Chapter 3), the population and unit of analysis were identical for Phase One and Phase Two. The unit of analysis (Zikmund, 2003) was an existing or future research alliance that is impacted by the South African IPRs legislative framework for publicly financed R&D, while the population (Zikmund, 2003) consisted of all existing and future research alliances, with governance structures spanning all possibilities in a spectrum ranging from non-equity to equity, that comply with any one or more of the following requirements:

- For an existing research alliance:
    - One or more of the partners is a publicly financed South African government R&D research institute, such as the CSIR, which are impacted by both the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.
    - One or more of the partners is a publicly financed South African university actively performing R&D, such as the University of Pretoria, which are impacted by both the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.

  - One or more of the partners is a private sector firm that receives funding for R&D activities from the South African government.

- For a potential future research alliance, contemplating any alliance governance structure ranging from once-off contracts to RJVs:

  - One or more of the partners is publicly financed South African government R&D research institute, such as the CSIR, which are impacted by both the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.
  - One or more of the partners is a publicly financed South African university actively performing R&D, such as the University of Pretoria, which are impacted by both the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.

4.5. Sampling Frames, Plans and Size Requirements

4.5.1. Sampling Frames for Phases One and Two

As stated in Section 4.3, the objectives of the study was to firstly identify the three most significant impact factors from the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could potentially act as indicators for the perceived strength of the IPRs regime, which could in turn notably influence governance mode decisions for research alliances at South African publicly financed R&D institutions. Secondly, the study attempted to include these impact domains into a modified VMG model (Pateli, 2009) (see Section 2.2.3.1). As such, the most optimal set of respondents for Phase One of the research would have been a representative sample of managers involved in research alliance creation and management, selected from all South African publicly financed R&D institutes and universities. Similarly, the most optimal set of respondents for Phase Two would have been a representative sample of all existing and potential research alliance partners associated with South African publicly financed R&D institutes and universities. However, for the study sampling was limited to a sampling frame (Zikmund, 2003) consisting of managers from only the CSIR for Phase One, and to a sampling frame consisting of only the CSIR's current and potential research alliance partners for Phase Two. The reasons for selecting these sampling frames were as follows:

- The access and time constraints restricted the acquisition of contact information for managers and research alliance partners at all publicly financed R&D institutions in South Africa. Since the researcher is employed by the CSIR, contact information for potential

respondents within the selected sampling frames for Phase One and Phase Two could easily be obtained.

- The CSIR is an extremely diverse organisation that spans multiple industries, such as the defence, biotechnology, and minerals and manufacturing industries (CSIR, 2010a). The CSIR, thus, represents a microcosm that mimics the larger macro R&D business environment in South Africa. Using managers and research alliance partners from the CSIR made it possible to analyse data on a sectorised basis.
- As the CSIR supported the DST during the creation of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, it is most probably one of the best prepared publicly financed R&D organisations in South Africa in terms of the impact of the new legislative framework will have (Baloyi, *et al.*, 2009). For example, the CSIR had an operational TTO even before the enactment of the TIA (Republic of South Africa, 2008b) Act made this a legal requirement for all South African publicly financed R&D institutions (Baloyi, *et al.*, 2009).
- Staff at the CSIR has already received training on the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, while the same cannot be said of many other publicly financed R&D institutions (Baloyi, *et al.*, 2009). This greatly enhanced the usability of data captured during Phase One of the study.

4.5.2. Phase One Sampling

4.5.2.1. Sampling Plan for Phase One

A search to identify suitable management-level individuals within the CSIR-based sampling frame (see Section 4.5.1) for inclusion in the sample for this phase highlighted that most appropriate individuals within the CSIR are those performing the CAM function. These individuals act not only as the business unit (referred to as Competency Areas within the CSIR's vernacular) leaders within the CSIR's different operational units, but also act as the custodians for new and future research alliances within each competency area. CAMs at the CSIR are allocated proportionally to the 11 distinct operational units within the CSIR (CSIR, 2010a) by means of the number of competency areas covered by each operational unit (Table 28 in Appendix C lists the operational units present within the CSIR's organisational structure, as well as the number of CAMs allocated to each operational unit). Figure 1 in Chapter 1 indicates the relative position of these operational units within the larger CSIR organisational structure (shown in maroon).

A low response rate was expected for this qualitative research phase of the study. Hence, it was decided to distribute the online survey, represented by the questionnaire of Table 27 within Appendix B, to all 36 CAMs (CSIR, 2010a) allocated within the CSIR, as opposed to having

interviews with selected CAMS. Thus, this phase of the research did not employ sampling within the CSIR's CAM population, but rather constituted a census (Zikmund, 2003) amongst these managers.

4.5.2.2. Sample Size Requirement for Phase One

There seems to be consensus in the field of qualitative research that the sample size criterion for such studies is dictated by the principle of "data saturation" (Guest, Bunce & Johnson, 2006). Guest, *et al.* (2006) defined the concept of data saturation as a generally accepted numerical guideline for the number of themes extracted from a sample of interviews or qualitative surveys as a percentage of all themes present in the interviews or qualitative surveys for the entire population of analysis. To illustrate this concept, and define some rudimentary guidelines for qualitative research sample sizes, Guest, *et al.* (2006) performed a qualitative study amongst women from two West African countries. Guest, *et al.* (2006) performed 60 in-depth interviews using semi-structured and open-ended questions. They found that saturation occurred after only twelve interviews, as 92% of all themes present in the data collected for the 60 interviews had already been extracted at this stage (Guest, *et al.*, 2006). Thus, after an analysis of twelve interviews new themes emerged infrequently, a trend which progressively increased as the analysis continued (Guest, *et al.*, 2006).

Consensus Theory, developed by Romney, Batchelder and Weller (1986), relies on the principle that, within their domain of expertise, experts tend to agree more with each other than do novices. Therefore, the sample sizes for qualitative studies can be small and still deliver sufficient information accuracy if participants possess a certain degree of contextual expertise (Romney, *et al.*, 1986). According to calculations by Romney, *et al.* (1986) samples as small as four individuals can provide extremely accurate information with a confidence level as high as 0.999 if participants possess a high degree of competence for the domain of inquiry (Romney, *et al.*, 1986).

Merging the assertions of Ryan and Bernard (2004) with those of Guest, *et al.* (2006), it becomes apparent that the sample size required to achieve data saturation in qualitative studies is impacted by the following factors:

- *Theme Definitions:* The larger the number of themes defined for the data available from a population, the larger the sample will have to be to achieve a predefined level of data saturation.
- *Size and Complexity of the Data:* An increase in data size and complexity results in more diverse responses from participants, therefore requiring larger samples.

- *Experience and Level of Fatigue of the Researcher:* A tired or inexperienced researcher is more likely to simply scan data and miss important themes, therefore requiring larger samples of data in order to reach a satisfactory number of extracted themes.
- *Number of Researchers Processing the Data:* Interpretation of narratives in order to identify themes is a subjective process. Hence, the larger the number of researchers, the bigger the sample will have to be. This problem can be circumvented by having highly structured interview guides and questionnaires.

For Phase One of the study the qualitative survey presented in Table 27 was made available to all 36 CAMs at the CSIR. Hence, no sampling was employed. The required response rate in order to achieve an accurate level of data capture was governed by using the factors defined above as guidelines. Ostensibly a small sample size of only four respondents would suffice, since CSIR's CAMs can be viewed as experts on how IPRs legislation will impact their respective research partnerships. This small sample size requirement was further supported by the fact that only one researcher was involved in processing the data. Since the questions in the survey presented in Table 27 are related to the highly complex IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, it could argued that a larger sample size in the region of 12 respondents might be more appropriate. Finding a compromise between these two sample requirement extremes, the study defined the acceptable response rate range as ranging from four to 12 out of 36 participants (from 11.11% to 33.33%).

4.5.3. Phase Two Sampling

4.5.3.1. Sampling Plan for Phase Two

This phase of the study required a representative sample of current and potential research alliance partners from the CSIR-based sampling frame (Zikmund, 2003) defined in Section 4.5.1. A representative sample of the current and potential future research alliance partners within the CSIR's Strategic Research Alliances sub-portfolio was created using submissions from Phase One's CAMs in response to a request for the contact information of existing and potential research alliance partners associated with their respective competency areas. Since CAMs submitted contact information for their respective current and future research alliance partners (collected with the assistance of the employees assigned to each competency area) on a discretionary bases, the sampling plan for this phase can be described as stratified sampling, with the strata selected consisting of the 36 competency areas within the 11 operational units of the CSIR. Sampling within these strata consisted of convenience sampling (Zikmund, 2003) due to the access limitations imposed on the author by using the discretionary lists of contacts supplied by CAMs.

4.5.3.2. Sample Size Requirement for Phase Two

One of the main benefits of using PLS regression in SEM (see Section 4.7.2.3 for a description of SEM and Section 4.7.2.4 for a succinct discussion on the PLS regression technique) is that the partial nature of the PLS algorithm results in less stringent sample size requirements when compared to classic covariance-based SEM techniques, such as Linear Structural Relations (LISREL) (Chin & Newsted, 1999). Herman Wold, who is credited with the creation of the PLS regression technique, claimed that PLS regression is better suited for exploratory model searches, such as the study's exploratory investigation into the potential inclusion of IPRs legislation related factors in the VMG governance mode decision making model originally proposed by Pateli (2009), than hypothesis testing of accepted SEM models (Wold, 1980).

Many researchers believe that PLS regression in SEM only requires a sample size of 10 times the most complex relationship within the model (Chin & Newsted, 1999; Goodhue, Lewis & Thompson, 2006). Relationship complexity for this "10-times-rule" approach is defined (Goodhue, Lewis & Thompson, 2006) as the number of formative indicators contributing to the endogenous or exogenous latent construct (see Section 4.7.2.3 for a definition of these concepts) with the largest number of formative indicators (this concept is also defined in Section 4.7.2.3). In the case of the modified VMG model's SEM path diagram, as depicted in Figure 4 of Section 4.7.2.3, the most complex relationship present is that of the exogenous latent construct Alliance History, which has three formative indicators (Pateli, 2009). Hence, using this "10-times-rule" approach, the number of responses needed for the online survey of Phase Two of the study was at least 30, which agrees with Pateli's assertions (Pateli, 2009).

Goodhue, *et al.* (2006) cautions against using the "10-times-rule" as it does not take into account effect size, reliability, number of indicators or other factors that impact statistical power. Goodhue, *et al.* (2006) suggests that one should rather identify the dependent variable with the largest number of predictors, which includes formative indicators and other endogenous/exogenous constructs, and then use Cohen's power tables (Cohen, 1988) to select a sample size which will ensure that the effect size one wishes to detect is achieved. As this process can be highly subjective to researcher bias with regards to effect size selection, for an upper limited on the required number of respondents, the study opted to rather make use of a common rule-of-thumb for multiple regression, which states that 30 participants are required per predictor variable in the regression model (VanVoorhis & Morgan, 2007). As the Preferred Alliance Governance Mode construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) has the largest number of predictors (a total of eight predictors, consisting of seven relationships with exogenous latent constructs and one relationship with an endogenous latent construct), the upper limited on the required number of participants for Phase Two's online quantitative survey was 240.

4.6. Data Collection Processes and Research Instruments

4.6.1. Data Collection Process and Research Instrument for Phase One

Data collection for this phase of the research project utilised a Google Forms (Google, 2010) online self-administered survey (Zikmund, 2003), based on the questionnaire given in Table 27 of Appendix B. As this phase of the study was qualitative in nature, this questionnaire, which consisted of two distinct parts (Part A considering demographic questions, and Part B considering questions related to potential impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts), contained only open-ended questions. It was augmented with the support of a survey companion website that succinctly explained the contents of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts (see Appendix D). Google Forms was selected as preferred online survey tool over other solutions, such SurveyMonkey (SurveyMonkey, 2010), for the following reasons (Google, 2010):

- Any number of online surveys with any number of questions can be created free of charge.
- Surveys created in Google Forms are mobile friendly, allowing respondents to respond via their cellular phones.
- All responses to questions (open or structured) are immediately recorded in a Microsoft Excel spreadsheet that can easily be downloaded.
- Google Forms support a wider variety of open and structured survey questions than most of the other free online survey tools.
- The option to receive email notifications as respondents complete the survey is available.

The data collection process involved the following: The final questionnaire was first tested on two volunteers at the CSIR to ensure its usability. Next, a web link to the online survey containing the questions given in Table 27 was sent to each of the CSIR CAMs selected as respondents for this phase of the research, as discussed in Section 4.5.2. Due to the complexity of the survey, it was allowed to run for 27 days since its initial launch on 22 August 2010, with email reminders sent every three days to all respondents that had not yet completed the survey. The survey was closed on 17 September 2010 and the data analysed as described in Section 4.7.1.

4.6.2. Data Collection Process and Research Instrument for Phase Two

A Google Forms (Google, 2010) online self administered survey (Zikmund, 2003), based on the questionnaire presented in Table 29 of Appendix E, constituted the research instrument for Phase Two of the study. The survey, which consisted of 10 distinct parts, contained open-ended questions only in Part A to cover demographics. Although this demographic part of the survey was

not used to explicitly address any of the research propositions stated in Section 3.3.2, it was included in the survey in order to enhance the level of detail in the data captured, thereby potentially increasing its usability as secondary data during future studies. Sectorised analysis for different industries covered by the CSIR is thus possible with the collected data set. Parts B through I were taken from Pateli's questionnaire (Pateli, 2009), with slight modifications in wording for improved readability, and were designed to address the original set of research propositions defined for the VMG model in Pateli's study. Part J was added to Pateli's questionnaire (Pateli, 2009) in order to accommodate the Perceived IPRs Regime Strength external uncertainty factor, with statements for each of the three IPR impact domains identified during Phase One of the study acting as formative indicators.

Construct scaling for the survey items contained in the questionnaire of Table 27 for Phase Two mimicked the approach used by Pateli (2009) in the original VMG model. While there were selected instances of nominal scaling (Zikmund, 2003) present in the questionnaire, such as Question G.1 on operational location overlap of research alliance partners, as well as ratio scaling (Zikmund, 2003), such as Question H.3 on the duration of previous research alliances with the CSIR, the dominant scaling type was ordinal in nature and based on a 7-point Likert scale (Zikmund, 2003). The advantage of using Likert-type scaling is that it is one of the easiest scales to construct (Zikmund, 2003). On the flipside, this type of scaling (and nominal scaling even more so) is not that well suited for parametric statistics (Zikmund, 2003), such as the PLS regression SEM (see Section 4.7.2.3) used to verify the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) during Phase Two. Table 3 details the construct scaling approach employed for each of the survey items in the quantitative online survey for Phase Two of the study (as detailed in the questionnaire contained in Table 29).

Table 3: Construct scaling for the survey items of Phase Two

Modified VMG Model Constructs	Operationalised Survey Items (According to Assigned Variable Names)	Scaling Type (Refer to Table 29 for Defined Ranges)	Related References
Firm Size (Survey Part B)	SIZE1	Ordinal, 4-point	European Commission (2003); Pateli (2009)
Preferred Alliance Governance Mode (Survey Part C)	GOV1	Ordinal, 5-point (as opposed to nominal, since the level of alliance partner interdependence increases along this scale (see Section 2.2.2.1))	Gulati & Singh (1998); Pateli (2009)
Strategic	STRAT_OR1 to STRAT_OR4	Ordinal, 7-point Likert	Ansoff (1965); Kotler

Orientation (Survey Part D)			(2000); Pateli (2009)
Competitive Position (Survey Part E)	1. RES_POS1 to RES_POS9 2. MARK_POS1 to MARK_POS8 3. PERF_POS1 to PERF_POS4	Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert	Day & Wensley (1988); Das & Teng (2000); Pateli (2009)
Partner Compatibility (Survey Part F)	1. CULT_COMP1 to CULT_COMP3 2. OPER_COMP1 to OPER_COMP3 3. RES_COMP1 to RES_COMP3	Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert	Parkhe (1991); Anderson & Narus (1990); Sarkar, *et al.* (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995); Pateli (2009)
Competitive Relationship (Survey Part G)	1. LOC_OVER1 2. MARK_OVER1	Nominal, 3-point (encoded to only 0 or 1 as outcomes) Nominal, 8-point (encoded to only 0 or 1 as outcomes)	Oxley & Sampson (2004); Pateli (2009)
Alliance History (Survey Part H)	1. PREV_PAST1 2. PREV_NUM1 3. PREV_DUR1 4. PREV_GOV1	Nominal, 2-point Ratio Ratio Ordinal, 5-point	Parkhe (1993); Pateli (2009)
EAV (Survey Part I)	1. RISK_RED1 to RISK_RED3 2. VERT_INT1 to VERT_INT5 3. COMPLEM1 and COMPLEM2 4. LEARN1 to LEARN4 5. CO_OPTION1 and CO_OPTION2 6. ECONOM1 to ECONOM3 7. EXPANSION1	Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert Ordinal, 7-point Likert	Contractor & Lorange (2002); Pateli (2009)
Perceived IPRs regime strength (Survey Part J)	IPR_STREN1 to IPR_STREN3	Ordinal, 7-point Likert	Oxley (1999); Rapp & Rozek (1990); Seyoum (1996); Sherwood (1997)

The data collection process for this phase involved the following: Firstly, the final questionnaire, which included questions to measure constructs related to the IPR uncertainty factors identified in

Phase One, was tested on five volunteers at the CSIR to ensure its usability. Appendix D's online companion website, which explained the contents of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts in simple terms, was also made available to all respondents. Contact individuals at current and potential research alliances that were selected as respondents for this phase (see Section 4.5.3) were informed of the availability of the online survey via an email with a web link to the appropriate Google Forms web page. This survey was launched on 29 September 2010 and closed on 22 October 2010. During this time window reminder emails were sent every three days to respondents that not yet completed the survey.

4.7. Data Analysis Methods

4.7.1. Data Analysis Method for Phase One

4.7.1.1. Overview of the Analysis Approach

Data analysis for Phase One of the study combined Narrative Inquiry (Clandinin & Connelly, 2000), Constant Comparative Method (also known as Grounded Theory) (Glasser, 1965) and frequency analysis (Zikmund, 2003). The motivations for the use of these three methods are as follows:

- *Narrative Inquiry:* This method investigates narrative to develop a view of phenomena (Wiebe, 2009). There exists several approaches within the greater field of Narrative Inquiry, but the approach that was most applicable to the study is that of Thematic Analyses (Ellis, 2004). With this approach the researcher treats captured narrative as data and analyse it to identify themes that clarify the content, as well as hold within or across narratives from multiple respondents (Ellis, 2004). For the study narrative data was obtained from respondents' in response to Question B.1 in the Phase One questionnaire (see Table 27 in Appendix B). These narratives consisted of opinions relating to potential impact domains within the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could significantly influence governance mode decisions for research alliances linked to the respondents' respective competency areas. Capturing the richness of these opinions was accomplished by allowing unlimited length open-ended responses during the completion of Question B1.1 in the online survey. The narratives were scrutinised for common themes relating to potential domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that were perceived to impact governance mode decisions related to research alliances at the CSIR via their influence on the perceived strength of the IPRs regime.
- *Constant Comparative Method:* With this method the researcher takes one piece of data and compares it to all other pieces of data that are either similar or different in some way (Glasser, 1965). In the context of this study, this method was used in the analysis of the

narratives captured from Question B.1 of the Phase One survey (see Table 27 in Appendix B) by comparing the eight business impact areas previously identified within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts by Baloyi, *et al.* (2009) to the themes identified using Narrative Inquiry. From this analysis an updated list of impact domain areas was created.

- *Frequency Analysis:* This simple method (Zikmund, 2003) determined the weighted frequency of occurrence (with weighting based on severity level) with which the impact domains identified in the IPRs legislative framework were cited as having an impact on governance mode decisions for the research alliances of the respondents' competency areas. The encoding approach for these severity levels, which were identified during the analysis of responses to Question B.2, is detailed in Section 4.7.1.2. From this weighted frequency analysis the three highest impact domains related to the IPRs legislative framework were then identified and used in Phase Two as formative indicators for the Perceived IPRs Regime Strength (Oxley, 1999) external uncertainty factor in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1).

.

4.7.1.2. Encoding of Captured Data for Phase One

From an analysis of the responses to Question B.2 the impact domain themes identified from Question B.1's responses were tagged with severity levels of Low, Medium or High. These severity levels were then encoded as follows to numerical weights prior to calculating the weighted frequency analysis described above:

- Severity level = Low, encoded weight = 1.
- Severity level = Medium, encoded weight = 2.
- Severity level = High, encoded weight = 3.

4.7.1.3. Testing for Reliability and Validity for Phase One

Although reliability and validity are common concepts in quantitative research, the meaning of these concepts in qualitative research, such as Phase One of the study, is an ongoing debate (Golafshani, 2003). Golafshani (2003) conceptualised reliability and validity for such studies as trustworthiness, rigor and quality in the qualitative paradigm. According to Denzin (1978) the technique of triangulation can be used to attain reliability and validity by eliminating research bias and increasing the truthfulness of qualitative propositions. This notion is supported by Creswell and Miller (2000) who defines triangulation as a validity procedure which requires researchers to search for convergence among multiple and/or different sources of information when forming and identifying themes. Five types of triangulation can be distinguished (Guion, 2002):

- *Data Triangulation:* This method involves testing for reliability and validity of qualitative research by comparing data and information collected from different sources.
- *Investigator Triangulation:* Testing for reliability and validity through this triangulation method involves having multiple investigators extract data or information from the same source.
- *Theory Triangulation:* Multiple professional perspectives on a collected set of data or information forms the basis of this triangulation method.
- *Methodological Triangulation:* This triangulation method involves having data or information collected from the same source using various research instruments.
- *Environment Triangulation:* With this method the source of data and the research instruments are kept the same while the environment (such as location and time) of the collection of data is varied.

Due to its popularity this study employed the methodological triangulation approach (Guion, 2002) by attempting to interview CAMs that had already completed Phase One's online survey, posing the same questions as those listed in Table 27 to these CAMs in person. Unfortunately only the CAM from the Modelling and Digital Sciences operational unit within the CSIR was available for such an interview. Furthermore, due to time constraints a full transcription of this interview, which was held on 13 September 2010 (one week after this CAM had completed the online survey), was omitted and only selected interviewee comments were captured from this CAM. A comparison of the data and information collected via the online survey and the interview for this CAM were then used to confirm the reliability and validity of Phase One of the study.

4.7.2. Data Analysis Method for Phase Two

4.7.2.1. Overview of the Analysis Approach

Data analysis for the second phase of the study tested Section 3.3.2's research propositions related to the modified VMG model (Pateli, 2009) (see Section 2.2.3.1). PLS regression (Abdi, 2010; Vinzi, *et al.*, 2010) was employed In order to determine the strength of the relationships between the uncertainty factors driving governance mode decision making and the preferred alliance governance mode, as defined by the research propositions related to Figure 3's "Primary antecedents" (which included Research Proposition H2.1(a) through H2.6(a), as well as Research Proposition H2.7(a) that was defined to embody the Perceived IPRs Regime Strength external uncertainty factor, with formative indicators identified from the IPRs legislative framework during Phase One). In order to evaluate the direct mediating effects that EAV has on the relationships between these uncertainty factors and the Preferred Alliance Governance Mode construct, Research Propositions H2.1(b) through H2.7(b) were tested using PLS regression (Abdi, 2010;

Vinzi, *et al.*, 2010) as part of Baron and Kenny's method (see Section 4.7.2.5) (Baron & Kenny, 1986). The PLS regression process involved the determination and evaluation of the loadings and path coefficients in the SEM path diagram for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), shown in Figure 4. Table 4 describes the relationship between the different loadings and path coefficients in Figure 4, and Section 3.3.2's research propositions

Motivation for selecting the PLS regression technique (see Section 4.7.2.4) over covariance-based techniques to evaluate the SEM of the modified VMG model was fivefold (Pateli, 2009): Firstly, the end objective of the regression analysis was to create a prediction model. Secondly, the VMG model aimed at creating a sound theory based on several different theoretical perspectives (TCE, RBV and ROA). Thirdly, the relationships between latent constructs and their underlying indicators were in different modes (formative versus reflective (Haenlein & Kaplan, 2004)). The fourth reason was that the modified VMG model had a number of second-order factors caused by first-order factors with reflective indicators (see Section 2.2.3.2) that can only be modelled by means of PLS regression (Pateli, 2009). Lastly, the sample requirements for PLS regression is more relaxed than for classic covariance-based regression techniques (Pateli, 2009).

4.7.2.2. Encoding of Captured Data for Phase Two

Encoding of data captured using Phase Two's online survey (see Table 29 in Appendix E) was performed as follows:

- All data captured for items in Phase Two's online survey that employed ordinal or ratio scaling (Zikmund, 2003) were used verbatim, and therefore did not require any encoding.
- Data captured for items in Phase Two's online survey that employed nominal scaling were encode as follows:

    - *Question C.1:* The respondent's preferred alliance governance mode choice, captured by this item, was encoded according to the scaling definition indicated in Table 29 of Appendix E, which was based on the spectrum of Figure 2.
    - *Question G.1:* The location overlap, captured by this nominal scaled item, was encoded to a value of LOC_VER1 = 1 if Option 1 was selected, and to LOC_OVER1 = 0 for all other options (Pateli, 2009).
    - *Question G.2:* Similar to the encoding for Question G.1, the market overlap captured by this nominal scaled item was encoded to a value of MARK_OVER1 = 1 if Option 1 was selected, and to MARK1_OVER = 0 for all other options (Pateli, 2009).

- *Question H.4:* The dominant historic alliance governance mode choice, captured by this item was encoded according to the scaling definition in Table 29 of Appendix E, which was based on the spectrum of Figure 2.

4.7.2.3. Structural Equation Modelling of the Modified VMG Model

Regression analysis constitutes a family of statistical techniques geared at modelling and analysing the relationship between dependent and independent variables from empirical data (Haenlein & Kaplan, 2004). Moreover, regression analysis attempts to explain the variations in independent variables as functions (commonly referred to regression functions) of variations in dependent variables (Haenlein & Kaplan, 2004). With this knowledge it is then possible to perform prediction and forecasting of the values that dependent variable will assume for specific independent variable values (Haenlein & Kaplan, 2004). Although outside the scope of the study, for selected cases regression analysis can also be used to infer causal relationships between dependent and independent variables (Haenlein & Kaplan, 2004).

Classic regression techniques (such as multiple regression, discriminant analysis, logistic regression and analysis of variance) can be classified as first generation techniques, since these techniques explicitly assume independence between multiple dependent variables (Haenlein & Kaplan, 2004). This, unfortunately, limits the ability of such techniques to comprehensively model complex interrelationships, such as the interplay between the two output variables defined in the VMG model (Pateli, 2009) presented in Figure 3, namely the Preferred Alliance Governance Mode and the EAV constructs. More specifically, classic first generation regression techniques are not able to model the potential mediating or moderating effect that the EAV construct (Pateli, 2009) could have on the Preferred Alliance Governance Mode construct (see Research Proposition *H2.7* in Section 3.3.2). To overcome this limitation, Jöreskog (1973) proposed covariance-based SEM as a second generation technique, which allows for the simultaneous modelling of relationships among multiple dependent and independent constructs.

A further inherent limitation of first generation regression techniques is their explicit assumption that all dependent and independent variables are directly observable (Haenlein & Kaplan, 2004). This assumption implies that all variables' values can be directly obtained from real-world sampling experiments (Haenlein & Kaplan, 2004). As such, any variables that cannot be directly observed need to be considered unobservable and have to be excluded from first generation regression models (Haenlein & Kaplan, 2004). However, such unobservable variables, commonly referred to as latent constructs, are supported by SEM (Haenlein & Kaplan, 2004). Within SEM theory distinction is made between exogenous and endogenous latent constructs, with the former being variables that are not explained by the internal interrelationships embodied by the model, and

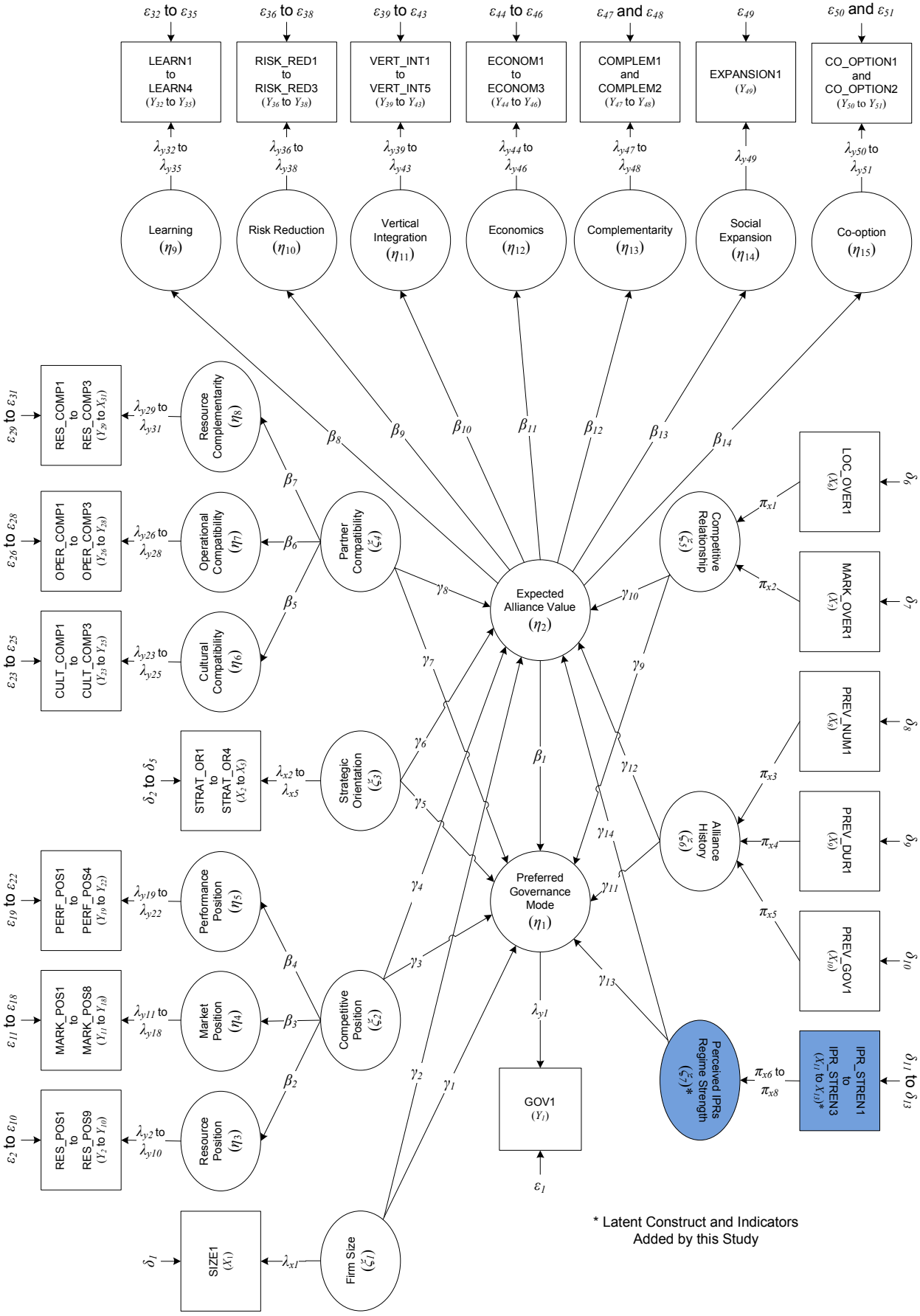
therefore always act as independent variables (Haenlein & Kaplan, 2004). Due to its generality, SEM terminology no longer refer to dependent and independent variables, but rather only to exogenous constructs, which are independent variables that are not functions of any relationship in the model, and endogenous constructs, which are either dependent or independent variables that are explained by the relationships with other dependent and/or independent variables present in the model (Haenlein & Kaplan, 2004).

With reference to the indicators measured as proxies to represent latent constructs, such latent constructs can be further classified as follows (Haenlein & Kaplan, 2004): A latent construct with reflective indicators is one in which all measured indicator proxies, also commonly referred to as factors, are expected to have high correlations to the latent construct, as well as other potential reflective indicators for the latent construct, and therefore have the ability to represent the variance in the unobserved variable sufficiently (Haenlein & Kaplan, 2004). In contrast, latent constructs with formative indicators are those that are represented by a weighted combination of indicators that are not highly correlated to either the latent construct itself, or the other formative indicators included in the weighted combination (Haenlein & Kaplan, 2004). The formative indicators of a latent construct can therefore be seen as representing different dimensions of this construct (Haenlein & Kaplan, 2004).

In SEM analysis path diagrams are frequently used to conceptualise system models. When creating such diagrams adherence to the following schematic conventions is required (Haenlein & Kaplan, 2004):

- Constructs/variables are represented by circles or ellipses.
- Observable measurement indicators are represented by squares or rectangles.
- Single-headed arrows are used to indicate directional relationships. In the case of relationships that exist between indicators and their associated constructs, arrows point towards reflective indicators, while arrows point toward constructs for formative indicators.
- Double-headed arrows are used to indicate non-directional relationships. This convention is sometimes used to represent the variance of a variable using a double-headed arrow that connects the variable to itself (this convention was not applied in this study).
- As each arrow represents either a free or fixed parameter, fixed parameters should be indicated by their value, while free parameters should be indicated using an appropriate mathematical symbol.

Figure 4: SEM path diagram for the modified VMG model



Using these schematic conventions the SEM path diagram shown in Figure 4 was created for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1). Within this diagram the variable names assigned to indicators and constructs, as defined in Table 29, were employed. Furthermore, the following popular symbol convention was applied (Pedhazer & Schmelkin, 1991):

- ξ_n = The n^{th} exogenous construct.
- η_m = The m^{th} endogenous construct.
- X_i = The i^{th} measurement indicator for the n^{th} exogenous latent construct ξ_n.
- δ_i = The measurement error term associated with X_i. This term comprises of a random error part, for example, caused by the order of items in the questionnaire presented by Table 29, as well as a systematic error part resulting from variance attributable to the measurement method itself, as opposed to the construct being measured (Bagozzi, Yi & Philipps, 1991).
- Y_j = The j^{th} measurement indicator for the m^{th} endogenous latent construct η_m.
- ε_j = The measurement error term associated with Y_j, also consisting of random and systematic error parts.
- λ_{xa} = The loading of a directional relation between the n^{th} exogenous latent construct ξ_n and its i^{th} reflective indicator X_i.
- λ_{yb} = The loading of a directional relation between the m^{th} endogenous latent construct η_m and its j^{th} reflective indicator Y_j.
- γ_c = The path coefficient of a directional relation between the m^{th} endogenous latent construct η_m and the n^{th} exogenous latent construct ξ_n.
- β_d = The path coefficient of a directional relation from the q^{th} to the p^{th} endogenous latent constructs, η_q and η_p.
- ζ_r = The r^{th} disturbance term (or error term) in the r^{th} endogenous construct η_r (not depicted in Figure 4 due to space constraints). Hence, this term models the fact that the endogenous latent constructs are not perfectly explained by the independent variables.
- π_{xa} = The loading of a directional relation between the n^{th} exogenous latent construct ξ_n and its i^{th} formative indicator X_i.
- π_{yb} = The loading of a directional relation between the m^{th} endogenous latent construct η_m and its j^{th} formative indicator Y_j.

Based on Figure 4's path diagram for the VMG model (Pateli, 2009), it is possible to create four sets of structural equations, which fully represent the interrelationships embodied by the SEM model (Haenlein & Kaplan, 2004). Using matrix notation, the first set of equations relates exogenous latent constructs to their indicators and associated measurement errors (Haenlein & Kaplan, 2004):

$$\mathbf{X} = \mathbf{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta} \quad (1)$$

where the elements of matrices $\mathbf{X}$, $\mathbf{\Lambda}_x$, $\boldsymbol{\xi}$ and $\boldsymbol{\delta}$ are X_i, λ_{xa}, ξ_n and δ_i, respectively, for all applicable values of i, a and n (Haenlein & Kaplan, 2004).The second set of equations express endogenous latent constructs as functions of their reflective indicators and associated measurement errors (Haenlein & Kaplan, 2004):

$$\mathbf{Y} = \mathbf{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\varepsilon} \quad (2)$$

where the elements of matrices $\mathbf{Y}$, $\mathbf{\Lambda}_y$, $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$ are Y_j, λ_{yb}, η_m and ε_j, respectively, for all applicable values of j, b and m (Haenlein & Kaplan, 2004). The third set of equations considers the relationships between exogenous latent constructs and formative indicators, as well as measurement errors (Haenlein & Kaplan, 2004):

$$\boldsymbol{\xi} = \mathbf{\Pi}_x \mathbf{X} + \boldsymbol{\delta} \quad (3)$$

where the elements of matrices $\boldsymbol{\xi}$, $\mathbf{\Pi}_x$, $\mathbf{X}$ and $\boldsymbol{\delta}$ are ξ_n, π_{xa}, X_i, and δ_i, respectively, for all applicable values of n, a, and i (Haenlein & Kaplan, 2004). The fourth set of equations considers the relationships between endogenous latent constructs and formative indicators, as well as measurement errors (Haenlein & Kaplan, 2004):

$$\boldsymbol{\eta} = \mathbf{\Pi}_y \mathbf{Y} + \boldsymbol{\varepsilon} \quad (4)$$

where the elements of matrices $\boldsymbol{\eta}$, $\mathbf{\Pi}_y$, $\mathbf{Y}$ and $\boldsymbol{\varepsilon}$ are η_m, π_{yb}, Y_j and ε_j, respectively, for all applicable values of m, b and j (Haenlein & Kaplan, 2004). The last set of equations deals with the relationships between endogenous latent constructs and exogenous latent constructs, as well as the associated measurement errors (Haenlein & Kaplan, 2004):

$$\boldsymbol{\eta} = \mathbf{B}\boldsymbol{\eta} + \mathbf{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta} \quad (5)$$

where the elements of matrices $\boldsymbol{\eta}$ ($\boldsymbol{\eta}$ is present on both sides of the equation since endogenous constructs can be dependent on one another), $\mathbf{B}$, $\mathbf{\Gamma}$, $\boldsymbol{\xi}$ and $\boldsymbol{\zeta}$ are η_m, β_d, γ_c, ξ_n and ζ_r respectively, for all applicable values of m, d, c, n and r (Haenlein & Kaplan, 2004).

Table 4 details the relationship between the path coefficients indicated in Figure 4 and Research Objective 2's research propositions, stated in Section 3.3.2. PLS regression, which is discussed in more detail in Section 4.7.2.4, attempts to estimate all loadings and path coefficients in the SEM path diagram.

Table 4: SEM path coefficients used in the evaluation of Research Objective 2

Relationship	Research Proposition	SEM Path Coefficients used in Proposition Evaluation (see Section 5.3.6)
Relationship between firm size and preferred alliance governance mode	H2.1(a)	γ_1
Relationship between firm size and the EAV	H2.1(b)	γ_1, γ_2 and β_1 (see Section 4.7.2.5)
Relationship between competitive position and preferred alliance governance mode	H2.2(a)	γ_3
Relationship between competitive position and the EAV	H2.2(b)	γ_3, γ_4 and β_1 (see Section 4.7.2.5)
Relationship between strategic orientation and preferred alliance governance mode	H2.3(a)	γ_5
Relationship between strategic orientation and the EAV	H2.3(b)	γ_5, γ_6 and β_1 (see Section 4.7.2.5)
Relationship between partner compatibility and preferred alliance governance mode	H2.4(a)	γ_7
Relationship between partner compatibility and the EAV	H2.4(b)	γ_7, γ_8 and β_1 (see Section 4.7.2.5)
Relationship between competitive relationship and preferred alliance governance mode	H2.5(a)	γ_9
Relationship between competitive relationship and the EAV	H2.5(b)	γ_9, γ_{10} and β_1 (see Section 4.7.2.5)
Relationship between alliance history and preferred alliance governance mode	H2.6(a)	γ_{11}
Relationship between alliance history and the EAV	H2.6(b)	γ_{11}, γ_{12} and β_1 (see Section 4.7.2.5)
Relationship between IPRs regime strength and preferred alliance governance mode	H2.7(a)	γ_{13}
Relationship between IPRs regime strength and the EAV	H2.7(b)	γ_{13}, γ_{14} and β_1 (see Section 4.7.2.5)
Relationship between preferred alliance governance mode and the EAV	H2.8	β_1

4.7.2.4. Partial Least Squares Regression Analysis for Structural Equation Modelling

Although Jöreskog (1973) originally proposed that the parameters of a SEM model be estimated using covariance-based techniques, of which the LISREL program that was developed by Jöreskog in 1975 is arguably the most popular, variance-based techniques, also commonly referred to as component-based techniques, have also gained traction (Haenlein & Kaplan, 2004). PLS, which was first introduced by Wold (1975) as Non-linear Iterative Partial Least Squares (NIPALS), is one such variance-based technique (Haenlein & Kaplan, 2004). While covariance-based techniques attempt to minimise the difference between the sample covariance values and

those predicted by the regression model, which is equivalent to estimating the model parameters such that the covariance matrix of the observed measurements is reproduced, PLS regression, which is also sometimes referred to Projections to Latent Structures, focuses on maximising the variance of the dependent variables explained by the independent variables (Haenlein & Kaplan, 2004).

PLS regression addresses several problems inherent in survey-based business research that limit the usability of classic covariance-based regression techniques (Vinzi, *et al.*, 2010). These problems include lower than expected response rates, respondents that do not answer all items contained in the survey, and highly correlated survey items (Vinzi, *et al.*, 2010). Typically, classic covariance-based regression techniques deliver unstable results under conditions of small sample sizes and missing values, while multi-colinearity increases the standard error of the estimated regression coefficients, which could result in valid predictors being rejected from the regression model (Haenlein & Kaplan, 2004). PLS regression is also capable of modelling multiple model output (dependent) variables, which are potentially correlated, as is the case with the EAV and the Preferred Alliance Governance Mode constructs in the modified VMG model (Pateli, 2009) (see Section 4.7.2.3).

In simplistic terms PLS regression for SEM involves the following process (Haenlein & Kaplan, 2004): Firstly the outer estimates are calculated for each latent construct in the model as a weighted linear combination of their respective measurable indicators. For exogenous latent construct ξ_n (for all applicable values of n) this calculation is given by (Vinzi, *et al.*, 2010):

$$\xi_n = \sum_i w_{\xi,i} X_i \tag{6}$$

where $w_{\xi,i}$ is the outer weight associated with measurement indicator X_i. For endogenous latent construct η_m (for all applicable values of m) this calculation is given by (Vinzi, *et al.*, 2010):

$$\eta_m = \sum_j w_{\eta,j} Y_j \tag{7}$$

where $w_{\eta,j}$ is the outer weight associated with measurement indicator Y_j. Next, weighted linear combinations of the outer estimates for the latent constructs are used to calculate an inner estimate for endogenous latent construct η_m (for all applicable values of m) (Vinzi, *et al.*, 2010):

$$\eta_m = \sum_n e_{\xi,n} \xi_n + \sum_{p \neq m} e_{\eta,p} \eta_p \tag{8}$$

where $e_{\xi,n}$ and $e_{\eta,p}$ are the inner weights associated with ξ_n and η_p, respectively (Vinzi, *et al.*, 2010). The process of calculating inner and outer estimates for the latent constructs is iterated until the

maximum variance in these latent constructs is captured (Haenlein & Kaplan, 2004). The final inner estimates are then treated as perfect substitutes for the latent constructs, which allow for the creation of a set of simple first generation regression equations that can be solved using ordinary least squares regression in order to obtain all loadings and path coefficients in the SEM (Vinzi, *et al.*, 2010).

The algorithm for the PLS regression process described above involves the following distinct stages and steps (Vinzi, *et al.*, 2010):

1. *Stage 1 – Iterative Calculation of Inner and Outer Weights:* This first stage of the PLS regression process iteratively determines the outer weights ($w_{\xi,i}$ and $w_{\eta,j}$ in Equation (6) and Equation (7), respectively) and inner weights ($e_{\xi,n}$ and $e_{\eta,p}$ in Equation (8)). The steps involved in this iterative process, consisting of alternating approximations of exogenous and endogenous latent constructs until convergence of the weight estimates are achieved, are as follows (Vinzi, *et al.*, 2010):

    a. *Step 1 – Outer Latent Variable Approximation*: Outer latent construct approximation involves determination of exogenous construct ξ_n (for all applicable values of n) using Equation (6), and endogenous construct η_m (for all applicable values of m) using Equation (7). During the first iteration arbitrary initial values for the outer weights are used, while subsequent iterations use outer weights calculated using one of the following modes (Vinzi, *et al.*, 2010):

        - *Mode A for Reflective Indicators:* If measurement indicator X_i is reflective in nature, simple linear regression is used to calculate weight $w_{\xi,i}$ (for all applicable values of i). In order to calculate $w_{\eta,j}$ when Y_j is reflective in nature a similar approach is used.
        - *Mode B for Formative Indicators:* If measurement indicator X_i is formative in nature, multiple linear regression is used to calculate weight $w_{\xi,i}$ (for all applicable values of i). In order to calculated $w_{\eta j}$ when Y_j is formative in nature a similar approach is used.

    b. *Step 2 – Inner Latent Variable Approximation*: This step considers the inner relationships amongst latent constructs by calculating endogenous latent construct η_m (for all applicable values of m) using the inner weights $e_{\xi,n}$ and $e_{\eta,p}$, as described in Equation (8). These inner weights can be calculated using the centroid, factor or path weighting schemes (Vinzi, *et al.*, 2010).

c. *Step 3 – Test for Weight Calculation Convergence*: Sequential execution of Steps 1 and 2 repeats until the absolute difference between successively calculated outer weights is less than an arbitrary convergence criterion. According to Wold (1975) this convergence criteria should be set to 10^{-5} to ensure both speedy convergence and small outer weight error.

2. *Stage 2 – Calculation of Loadings and Path Coefficients:* This stage, which commences after convergence of the outer weights have been achieved, determines the model parameters for the structural portion (interrelationships between latent constructs) and the measurement portion (interrelationships between latent constructs and measurement indicators) of the SEM model. For the structural portion of the SEM model this involves calculating the path coefficients γ_c and β_d (for all applicable values of c and d) using ordinary least squares regression between latent constructs. For the measurement portion of the SEM model this involves ordinary least squares regression to determine loadings λ_{xa} and λ_{yb} for reflective indicators, or π_{xa} and π_{yb} for formative indicators (Vinzi, *et al.*, 2010).

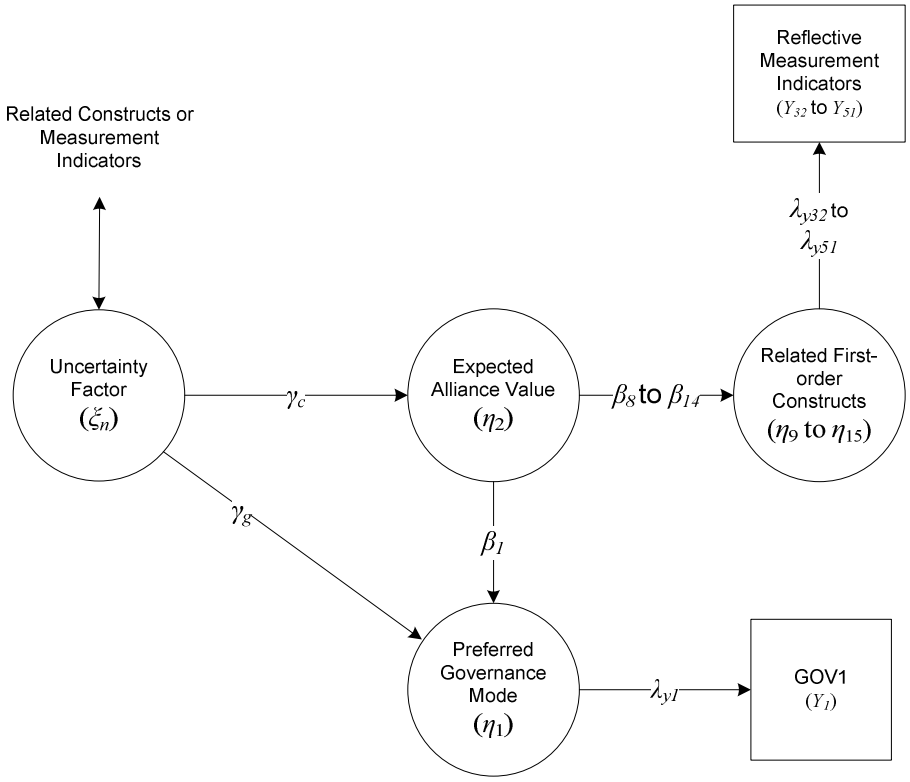
In this study the freeware software package SmartPLS (Ringle, Wende & Will, 2010) was employed to create the VMG model's (Pateli, 2009) SEM path diagram (see Figure 4), and calculate all loadings and path coefficients through PLS regression. SmartPLS was configured to normalise all measured survey items (Ringle, *et al.*, 2010), as a variety of scaling approaches and ranges was used in Phase Two's survey (see Table 3). SmartPLS was also used to evaluate the reliability and validity test criteria discussed in Section 4.7.2.6. The current version of SmartPLS does not allow for the creation of SEM path diagrams that contain second-order constructs that have no assigned measurement indicators, such as the Competitive Position construct in Figure 4 (Ringle, *et al.*, 2010). Fortunately, all second-order constructs in the SEM path diagram for the modified VMG model have reflective relationships with their associated first-order constructs (see Section 2.2.3.2). As such, these second-order constructs could still be modelled in SmartPLS by assigning the reflective indicators of their associated first-order constructs as their own reflective indicators (Ringle, *et al.*, 2010). For example, for the Competitive Position construct the reflective measurement indicators Y_2 to Y_{22} in Figure 4 were assigned as its associated set of reflective indicators.

4.7.2.5. Testing for Direct Mediating Effects in the SEM of the VMG Model

Mediation in SEM refers to the indirect influence that an exogenous/endogenous latent construct has on another endogenous latent construct via a mediating endogenous latent construct (Baron & Kenny, 1986). Within the context of this study's modified VMG model (Pateli, 2009) (see Section 2.2.3.1), the potential mediation effects of the EAV construct on the relationships between one of

the internal or external uncertainty factors, defined in Section 2.2.3.2, and the Preferred Alliance Governance Mode construct is depicted by Figure 5's path diagram. Mediator variables, such as the EAV construct, are also sometimes referred to as Intervening or Process variables (Baron & Kenny, 1986). In Figure 5 the path related to coefficients γ_c and β_1 is referred to as the Mediating Effect, while the path related to coefficient γ_g is referred to as the Direct Effect (Baron & Kenny, 1986). The uncertainty factor's effect on the Preferred Alliance Governance Mode construct is considered to be fully mediated if path coefficients γ_g and γ_c are zero and non-zero, respectively. Conversely, if none of the path coefficients are zero, the extent of the mediating effect is deemed to be partial.

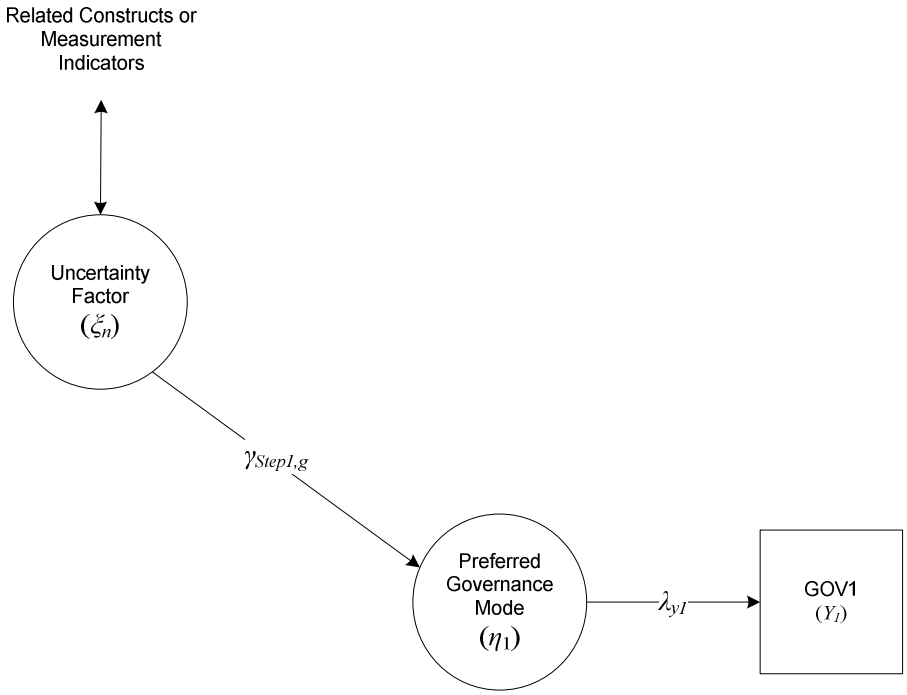
Figure 5: Direct mediating effects in the modified VMG model



In order to determine whether the relationship between a specific uncertainty factor and the Preferred Alliance Governance Mode construct is mediated by the EAV construct, as well as the extent of the potential mediating effects, the following four step process, adapted from Baron and Kenny (1986), was employed in this study:

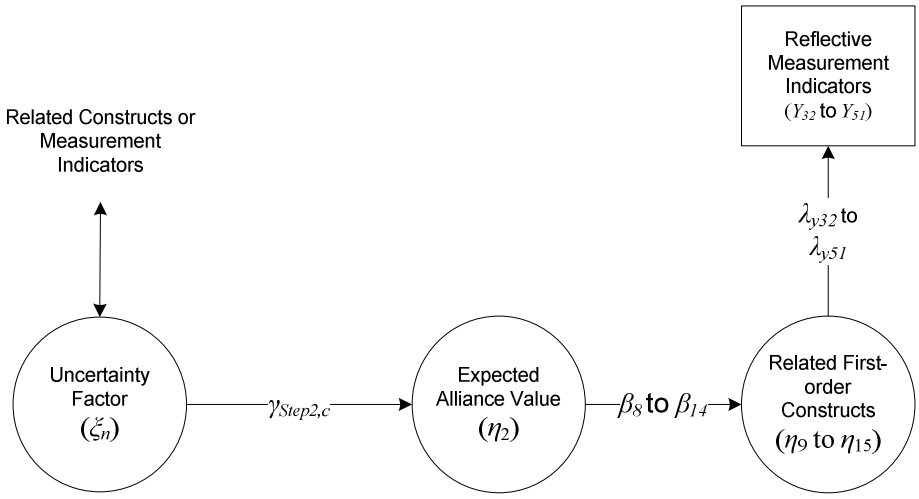
1. *Step 1 – Determine the Total Effect:* In order to determine the Total Effect (Baron & Kenny, 1986), the SEM path diagram shown in Figure 4 was simplified until only the diagram shown in Figure 6 remained (all indicators and path interconnections for all of the uncertain factors, except for the one currently under investigation, were removed from the SEM path diagram). The path coefficient $\gamma_{Step1,g}$, representing the Total Effect, was then determined using PLS regression.

Figure 6: The Baron and Kenny (1986) process – Step 1



2. *Step 2 – Determine the Relationship between the Input and Mediator Variables:* The original SEM path diagram was reduced until the diagram depicted in Figure 7 was obtained. Using this diagram the path coefficient $\gamma_{Step2,c}$ was then determined via PLS regression.

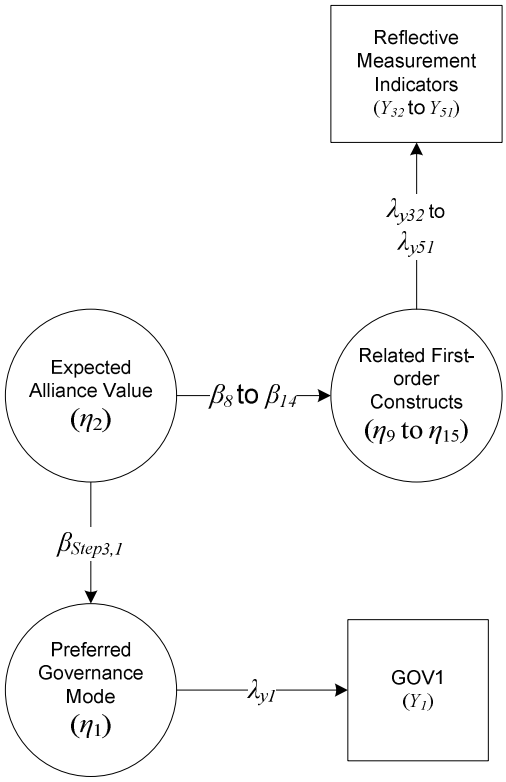
Figure 7: The Baron and Kenny (1986) process – Step 2



3. *Step 3 – Determine the Relationship between the Mediator and Output Variables:* For this step in the process the original SEM path diagram was reduced until the path diagram

represented by Figure 8 was obtained. Using PLS regression the path coefficient $\beta_{Step3,1}$ was determined.

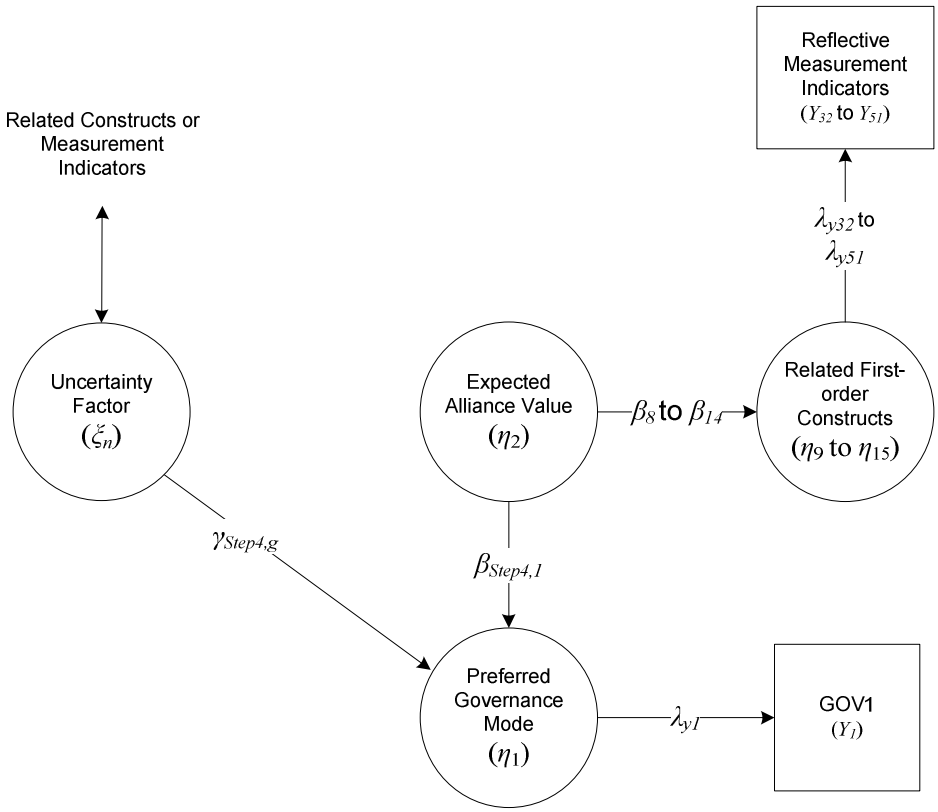
Figure 8: The Baron and Kenny (1986) process – Step 3



4. *Step 4 – Determine the Type of Mediation:* Finally, the reduced SEM path diagram depicted by Figure 9 was employed. After using PLS regression to calculate path coefficients $\gamma_{Step4,g}$ and $\beta_{Step4,1}$, the type of mediation present was determined as follows:

   a. If $\gamma_{Step1,g} = 0$, $\gamma_{Step2,c} = 0$ or $\beta_{Step3,1} = 0$, the EAV construct is not responsible for any mediating effects on the relationship that exists between the uncertainty factor under investigation and the Preferred Alliance Governance Mode construct.
   b. If $\gamma_{Step1,g} \neq 0$, $\gamma_{Step2,c} \neq 0$, $\beta_{Step3,1} \neq 0$, $\beta_{Step4,1} \neq 0$ and $\gamma_{Step4,g} \neq 0$, the EAV construct is responsible for Partial Mediation effects on the relationship that exists between the uncertainty factor under investigation and the Preferred Alliance Governance Mode construct.
   c. If $\gamma_{Step1,g} \neq 0$, $\gamma_{Step2,c} \neq 0$, $\beta_{Step3,1} \neq 0$, $\beta_{Step4,1} \neq 0$ and $\gamma_{Step4,g} = 0$, the EAV construct is responsible for Full Mediation effects on the relationship that exists between the uncertainty factor under investigation and the Preferred Alliance Governance Mode construct.

Figure 9: The Baron and Kenny (1986) process – Step 4



The process outlined above is based on the actual path coefficient values and not the significance of the path coefficients (see Section 4.7.2.6). Although the original process proposed by Baron and Kenny (1986) was based on Path Coefficient Significance, it has since been shown that testing for direct mediating effects can be accomplished by considering only the path coefficient values (Vinzi, *et al.*, 2010).

4.7.2.6. Testing for Reliability and Validity for Phase Two

The concept of reliability within the field of quantitative research (such as Phase Two of the study) consists of two dimensions, namely repeatability and internal consistency (Zimund, 2003). Hence, reliability considers the extent to which results are consistent over time and an accurate representation of the total population under investigation, as well as the research methodology's ability to reproduce the results obtained (Golafshani, 2003). Recalling that measurement errors consist of random and systematic parts, complete reliability of a measurement implies that the associated random error part is zero (Vinzi, *et al.*, 2010). As validity in quantitative studies is concerned with the quality of the research instrument, tests for validity determine whether the research instrument truly measures that which it was intended to measure (Golafshani, 2003; Zimund, 2003).

When evaluating the reliability and validity of PLS regression SEM models a common approach is to first consider the item measures present in the research survey, sometimes referred to as the measurement portion or outer model) and then the structural portion of the model, sometimes referred to as the inner model (Vinzi, *et al.*, 2010). The logic behind this approach is that a lack in confidence in the accuracy and representivity of the measurement indicators in a SEM model negates the need to continue testing the reliability and validity of the structural portion (Vinzi, *et al.*, 2010).

To evaluate the reliability and validity of the measurement portion (outer model) of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), this study employed the following tests (Vinzi, *et al.*, 2010):

- *Indicator Reliability:* For a reflective indicator (denoted as X_i and Y_j for the indicators of exogenous and endogenous latent constructs, respectively) this reliability measure gives an indication of the level of variance in the measurement indicator that can be explained by its associated latent construct (Vinzi, Chin, Henseler & Wang, 2010). Since a common threshold criterion is that 50% or more of a reflective indicator's variance should be explained by its associated latent construct, it follows that the loadings λ_{xa} and λ_{yb}, relating indicators X_i and Y_j with exogenous latent construct ξ_n and endogenous latent construct η_m, respectively, should be $\sqrt{0.5} = 0.707$ or higher (Vinzi, *et al.*, 2010). Although weak reflective indicators with loadings lower than this threshold can be tolerated (especially in exploratory studies evaluating new SEM models, such as the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) considered in this study), reflective indicators with loadings less than 0.4 (Vinzi, *et al.*, 2010) were removed from the SEM model of the study. The concept of Indicator Reliability is not applicable to formative indicators, as these indicators can exhibit low correlation with their associated latent constructs, but still contribute significantly to its overall variance (Vinzi, *et al.*, 2010). Hence, the study did not attempt to investigate Indicator Reliability for the formative indicators, which was present for selected latent constructs, such as Alliance History, Competitive Relationship and Perceived IPRs Regime Strength. Instead, it subjectively evaluated the relative contribution of each formative indicator in the set of indicators related to a specific latent construct (Vinzi, *et al.*, 2010). Furthermore, the study opted to retain all formative indicators, even if their relative contributions to a specific latent construct were low.
- *Construct Reliability:* The Indicator Reliability metric described above is designed to point to a given reflective indicator's inadequate measurement of a latent construct (Vinzi, *et al.*, 2010). However, it is important to consider whether the set of reflective indicators associated with a latent construct jointly measure it adequately (Vinzi, *et al.*, 2010). To that

end, Construct Reliability, also sometimes referred to as internal consistency, needs to be determined for each latent construct in a SEM model (Vinzi, *et al.*, 2010). In business research Construct Reliability, which requires reflective indicators assigned to the same latent construct to exhibit a strong mutual association, is frequently tested using Cronbach's Alpha (Vinzi, *et al.*, 2010). Although Cronbach's Alpha is also applicable to verification of internal consistency for the measurement portions of SEM models, use of the Composite Reliability measure have gained traction amongst academia, as it circumvents the inherent weakness of Cronbach's Alpha of not including the effects of the respective loadings of the reflective indicators (Vinzi, *et al.*, 2010). With reference to the SEM notation defined in Section 4.7.2.3, the Composite Reliability measure, which can take on values between 0 and 1, is calculated as follows for exogenous latent construct ξ_n (Fornell & Larcker, 1981):

$$\rho_{\xi,n} = \frac{\left(\sum_a \lambda_{xa}\right)^2}{\left(\sum_a \lambda_{xa}\right)^2 + \sum_i \mathrm{var}\left(\delta_i\right)} \tag{9}$$

For endogenous latent construct η_m it is defined as follows (Fornell & Larcker, 1981):

$$\rho_{\eta,m} = \frac{\left(\sum_b \lambda_{yb}\right)^2}{\left(\sum_b \lambda_{yb}\right)^2 + \sum_j \mathrm{var}\left(\varepsilon_j\right)} \tag{10}$$

Although the SmartPLS software package (Ringle, *et al.*, 2010) employed during the SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) produces both Cronbach's Alpha and Composite Reliability measures, the study elected to use only the latter. Furthermore, the popular threshold level of 0.6 for the Composite Reliability was deemed as acceptable for Construct Reliability (Vinzi, *et al.*, 2010). Internal consistency cannot be tested for latent constructs with formative indicators, as these indicators by definition exhibit low levels of mutual association (Hulland, 1999).

- *Convergent Validity:* The measurement of Convergent Validity considers the correlation between responses obtained by maximally different methods of measuring the same construct (Vinzi, *et al.*, 2010). To measure the Convergent Validity for the reflective indicators of latent constructs in a SEM model involves examining the Average Variance Extracted (AVE). For the reflective indicators of exogenous latent construct ξ_n the AVE is defined as follows (Fornell & Larcker, 1981):

$$AVE_{\xi,n} = \frac{\sum_a \lambda_{xa}^2}{\sum_a \lambda_{xa}^2 + \sum_i \mathrm{var}(\delta_i)} \quad (11)$$

For endogenous latent construct η_m it is defined as follows (Fornell & Larcker, 1981):

$$AVE_{\eta,m} = \frac{\sum_b \lambda_{yb}^2}{\sum_b \lambda_{yb}^2 + \sum_j \mathrm{var}(\varepsilon_j)} \quad (12)$$

From Equation (11) and Equation (12) it is clear that AVE measures the variance of a latent construct's indicators captured by the construct, relative to the total variance (including that of any measurement error). For this study the popular threshold value of 0.5 for AVE was used (Vinzi, *et al.*, 2010). An AVE below this threshold was considered insufficient and an indication that more of the total variance was due to measurement error than due to indicator variance. Convergent Validity is not applicable to formative indicators, as these indicators do not have to be strongly interrelated (Vinzi, *et al.*, 2010).

- *Discriminant Validity:* Discriminant Validity for the measurement portion considers the level of dissimilarity in the measurements obtained by the measurement tool for different constructs (Vinzi, *et al.*, 2010). A necessary condition to achieve Discriminant Validity requires that the shared variance between a latent construct and its indicators (determined by taking the square root of it AVE) exceeds the shared variance between this latent construct and any other latent constructs.

To evaluate the reliability and validity of the structural portion (the interrelationships between constructs in the SEM path diagram) of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), the study employed the following tests (Vinzi, *et al.*, 2010):

- *Coefficients of Determination (R^2) for Endogenous Variables*: This metric, which was used to judge the quality of the structural portion of the SEM of the modified VMG model (see Figure 3), reflects the share of an endogenous construct's variance explained by related endogenous or exogenous constructs (Vinzi, *et al.*, 2010). Although no generalisation can be made about acceptable threshold values for R^2 (Vinzi, *et al.*, 2010), Falk and Miller (1992) suggests that levels less than 0.1 indicate unacceptably low interrelationships between constructs. Moreover, the study applied the convention for classic multiple regression techniques that categorises an interrelationship between an endogenous construct and related constructs as weak, moderate or strong if the variance explained is

less than 30%, between 30% and 70% (inclusive), or more than 70%, respectively. (Zikmund, 2003)

- *Path Coefficient Significance:* Similar to covariance-based multiple regression techniques, the quality of the structural portion of a SEM model can be investigated by means of a bootstrapping procedure (Vinzi, *et al.*, 2010) in order to determine the significance levels of the path coefficients γ_c and β_d, for all applicable indexes c and d (Chin, 1998a). The significance of path coefficients (also sometimes referred to as Goodness-of-Fit) was tested via asymptotic t-statistics, with SmartPLS's bootstrapping function configured for a resampling size of 1000 (Vinzi, *et al.*, 2010). Various significance levels were considered, with p-values, calculated using the $t_{(999)}$ distribution, larger than α = 0.10 deemed insignificant (Vinzi, *et al.*, 2010). Insignificant paths, or paths that exhibited path coefficients with signs contrary to the postulated interrelations between constructs, as depicted in the SEM path diagram of Figure 4, were deemed not to support the research propositions stated in Section 3.3.2.
- *Predictive Validity:* In order to determine the Predictive Validity of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) the Stone-Geisser non-parametric test was used (Geisser, 1975; Stone, 1975; Chin, 1998b; Vinzi, *et al.*, 2010). Based on a blindfolding procedure (Vinzi, *et al.*, 2010), this test requires two data sets: One set for SEM and the other for determining the SEM model's Predictive Validity. Based on a specified Omission Distance D (Vinzi, *et al.*, 2010), the blindfolding procedure discards (omits) some of the data captured from the respondents, and estimates the SEM model parameters using this incomplete set of data. For this study the Omission Distance was set to seven, which is the default setting for SmartPLS (Ringle, *et al.*, 2010). During the next step the SEM model obtained with the incomplete data set is used to reconstruct the data removed during the blindfolding procedure. Using this information the Stone–Geisser test criterion is calculated (referred to as Q^2), which indicates how well the data collected empirically can be reconstructed through PLS regression using the SEM model (Vinzi, *et al.*, 2010). This criterion is defined as follows:

$$Q^2 = 1 - \frac{\sum_D E_D}{\sum_D O_D} \tag{13}$$

In this equation E_D represents the square of the prediction error, defined as the difference between the data deleted during the blindfolding procedure and the predicted values for this deleted data (Vinzi, *et al.*, 2010). Furthermore, O_D represents the square of the prediction error provided by the mean of remaining data not deleted during the blindfolding procedure (Vinzi, *et al.*, 2010). The SEM model is considered to have Predictive Validity if $Q^2 > 0$

(Chin, 1998a; Vinzi, *et al.*, 2010). The Stone–Geisser test criterion can take on two distinct forms, depending on the type of prediction that is investigated: The first form, which is geared at determining the Predictive Validity of the measurement portion (although usually calculated during the structural portion's validity evaluation), is referred to as the Cross-validated Communality (Vinzi, *et al.*, 2010), and is denoted by H^2. Cross-validated Communality measures the ability of the SEM model to predict the observable endogenous constructs from their own latent construct scores (Vinzi, *et al.*, 2010). The second form, which evaluates the Predictive Validity of the structural portion, is referred to as Cross-validated Redundancy (Vinzi, *et al.*, 2010). This metric, denoted by F^2, measures the SEM model's ability to predict the observable endogenous constructs using latent constructs that predict the block of data in question (Vinzi, *et al.*, 2010). This study considered both H^2 and F^2, which were calculated using SmartPLS (Ringle, *et al.*, 2010).

4.8. Research Limitations

The following potential limitations have been identified for the study:

- By performing Phase Two of the study using the CSIR's current and potential research alliance partners as respondent base, a one-sided view was obtained with regards to the impact of the modified VMG model's (Pateli, 2009) (see Section 2.2.3.1) uncertainty factors on alliance governance mode decisions. The CSIR's own view is not reflected in the collected data for Phase Two, thereby limiting the generated VMG model (Pateli, 2009) to only predict or explain the governance mode decision making of their current and potential research alliance partners, and not that of the CSIR itself.
- By limiting the sampling plans of the study to the CSIR, and its current and potential research alliance partners, the results that were obtained cannot be blindly generalised to a larger population consisting of all South African publicly financed R&D institutions and their current and potential research alliance partners.
- The original VMG model was designed by Pateli (2009) for R&D alliances in the Greek wireless services industry. Although the study attempted to modify Phase Two's survey to suite the publicly financed R&D industry in South Africa, it can be argued that some of the of the constructs that Pateli (2009) had defined, which were reused in this study, might be inappropriate.
- Since the author of the study is a CSIR employee, executing Phase Two amongst current and potential CSIR research alliance partners could have resulted in response bias in the form of auspices bias (Zikmund, 2003).
- The regulations governing the operationalisation of the IPRPFRD Act (Republic of South Africa, 2008a) has been promulgated on 2 August 2010 in South African Government

Gazette Vol. 542 No. 33433. However, at the time of the publication of the study, no case law related to this Act had yet been generated. Hence, the impact domains identified during Phase One of the study, with data collected via the online qualitative survey distributed amongst CSIR CAMs, can be viewed as highly speculative. Although the study's relevance to recent developments in the South African legislative framework related to IPRs for publicly financed R&D is unquestionable, but in terms of timing, can be seen as being somewhat premature.

- By making a survey companion website with overviews of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts available to respondents in both phases of the research project (see Appendix D), this might inadvertently have lead to the creation of response bias in the form of interviewer bias (Zikmund, 2003).
- The study's SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) was limited to investigating only the direct mediating effects of the EAV on the relationship between the uncertainty factors and the Preferred Alliance Governance Mode construct. Therefore, the modified model's incorporation of direct mediating effects is not as comprehensive as Pateli's original VMG model (Pateli, 2009), which considered the significance of the indirect mediating effects of the EAV using Sobel's (1982) ACIIESE.
- The methodologies applied for Phase One and Phase Two of the study did not consider differentiation at an industry sector level. Hence, the results obtained by the study could neither reflect industry sector nuances within the impact domains in the IPRs legislative framework that could influence research alliances, nor industry sector distinctiveness within the research alliance governance mode decision making.

Chapter 5 - Results

5.1. Introduction

This chapter presents the results obtained using the data analysis methodologies defined for Phase One (see Section 4.7.1) and Phase Two (see Section 4.7.2) of the study. For Phase One, this includes a discussion on the results obtained through Narrative Inquire and Constant Comparative Method in order to answer Research Question 1.1 (see Section 3.3.1), the results obtained through Frequency Analysis in order to answer Research Question 1.2 (see Section 3.3.1), and the results obtained through Methodological Triangulation in order to verify the validity and reliability of the research methodology followed (see Section 4.7.1.3). Results presented for Phase Two include descriptive statistics for the data captured through the online survey questions presented in Table 29 in Appendix E, PLS regression results for the SEM loadings and path coefficients of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) in order to prove/disprove all research propositions related to Research Objective 2 (see Section 3.3.2), as well as several measures to confirm the reliability and validity of the SEM of the modified VMG model. For both research phases the sample characteristics are also detailed.

5.2. Results for Phase One

5.2.1. Sample Characteristics for Phase One

A total of N = 10 CAMs responded to the Phase One online qualitative survey sent to the census of 36 CAMs within the CSIR operational units (see Table 28 within Appendix C). This response rate of 27.78% falls comfortably within the acceptable sample size range defined in Section 4.5.2.2. From Table 6 in Section 5.2.2.1 it is clear that all unique themes from the collected data had been already identified after the theme extraction process progressed up to the fifth responded. Hence, data saturation had already occurred when the fifth respondent had submitted his/her survey response, indicating that a sufficient sample size was achieved (Guest, *et al.*, 2006). Table 5 depicts a frequency analysis of the responses received from CAMs from the various operational units within the CSIR. This includes the total number of CAMs that responded per operational unit, as well as the relative frequency of response per operational unit, relative to the total number of CAMs assigned to each operational unit (see Table 28). Since the study's goal was to identify potential impact domains in the IPRPFRD and TIA Acts aggregated over all industries covered by the CSIR's operational units, the responses received from CSIR CAMs contained no representation by the following operational units in the CSIR (and, hence, the industry sectors covered by these units):

- Biosciences, which operates in the biotechnology and health sector.
- Consulting and Analytical Services, which operates the consulting and services sectors.
- National Laser Centre, which operates in the ICT and technology R&D sectors.

Table 5: Frequency analysis of responses to Phase One's survey

Operational Unit	Number of Responses	Response Frequency Relative to Assigned Number of CAMs
Biosciences	0	0.00%
Built Environment	1	16.67%
Consulting and Analytical Services	0	0.00%
Centre for Mining Innovation	1	100.00%
Defence, Peace, Safety and Security	1	16.67%
Meraka Institute	3	75.00%
Modelling and Digital Sciences	1	100.00%
Materials Science and Manufacturing	1	16.67%
National Laser Centre	0	0.00%
Natural Resources and the Environment	2	33.33%
Satellite Application Centre	0	Not Applicable

5.2.2. Results for the Questions of Research Objective 1

The following subsections present the results obtained for Research Question 1.1 and Research Question 1.2, as posed in Section 3.3.1.

5.2.2.1. Results for Research Question 1.1

Narrative Inquiry in the form of Theme Extraction, combined with Constant Comparative Method, using as baseline the eight business impact domains identified by Baloyi, *et al.* (2009) in the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts (see Section 2.3.4.2), extracted the impact domains listed in Table 6 for each of the 10 responses received for Question B.1 in Phase One's survey. The perceived severity of the impact domains listed by each respondent is also indicated in this table (see Section 5.2.2.2).

Merging all unique themes listed in Table 6 with the potential business impact domains identified by Baloyi, *et al.* (2009) (see Section 2.3.4.2) within the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, produced the updated list of potential business impact domains shown in Table 7. Example quotations, captured from respondents' responses related to each theme, are also supplied in this table.

Table 6: Themes extracted from responses to Question B.1 of Phase One's survey

Respondent Number	Impact Domains Identified (with Severity Levels extracted from responses to Question B.2)
1	1. Requirement for non-exclusivity in IP transactions (Severity = Low) 2. Choice of IPRs ownership (Severity = Low)
2	1. Requirement to register IP in the OpenSource software community (Severity = Medium) 2. Requirement for non-exclusivity in IP transactions (Severity = Medium)
3	1. IP declaration process (Severity = High) 2. Benefit sharing policies (Severity = High) 3. Offshore IP registration process (Severity = High) 4. State walk-in rights on IP not declared (Severity = High) 5. Preference in commercialisation rights to SMEs and BBBEE firms (Severity = High) 6. IP detection process (Severity = High)
4	1. Choice of IPRs ownership (Severity = High) 2. Unclear guidelines for the TIA funding of innovations (Severity = Medium)
5	1. Government reporting process (Severity = Medium) 2. Government reaction time (Severity = Medium) 3. Benefit sharing policies (Severity = Medium) 4. State walk-in rights on IP not declared (Severity = High) 5. Requirement to register IP in the OpenSource software community (Severity = Medium) 6. Offshore IP registration process (Severity = Medium) 7. Structural and resource requirements (Severity = Medium)
6	1. Choice of IPRs ownership (Severity = High) 2. Government reporting process (Severity = High) 3. Government reaction time (Severity = Medium) 4. Benefit sharing policies (Severity = High) 5. State walk-in rights on IP not declared (Severity = High)
7	1. Choice of IPRs ownership (Severity = High) 2. Benefit sharing policies (Severity = High) 3. Requirement for non-exclusivity in IP transactions (Severity = High) 4. State walk-in rights on IP not declared (Severity = High)
8	1. IP detection process (Severity = Medium) 2. Requirement to register IP in the OpenSource software community (Severity = Medium)
9	1. Choice of IPRs ownership (Severity = Medium) 2. Offshore IP registration process (Severity = Medium)
10	1. Requirement to register IP in the OpenSource software community (Severity = High) 2. Preference in commercialisation rights to SMEs and BBBEE firms (Severity = High)

Table 7: Updated list of potential business impact domains within the IPRPFRD and TIA Acts

Theme Identified	Theme Description	Selected Response Quotations
Choice of IPRs ownership	A public sector R&D organisation can choose the ownership of the IPRs obtained for Intellectual Property (IP) it had generated (with the potential assistance of funding, resources and services of other private sector R&D organisations) from partial or full government financing.	*"Under the IPRPFRD act, entities without an IP and commercialisation office will always struggle to arrive at an acceptable split."* *"We are already seeing some of this coming through with respect to IP ownership issues. We have been experiencing a lot of difficulties with the universities already, with respect to IP ownership in research partnerships/collaborations, especially where they perceive the CSIR to be a funding agency, as opposed to a research partner."*
State walk-in rights on IP not declared	The state is granted walk-in rights on the IPRs for IP that was generated through public financing, but was not properly declared to government.	*"The 'walk-in right' for government type clauses may also be hard to swallow in some industries."*
Benefit sharing policies	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Benefit sharing of IP creators - don't know how that will work in the private sector, particularly in the civil engineering industry."*
Requirement to register IP in the OpenSource software community	Publicly financed R&D projects that could generate IP during the development of software within the OpenSource community, will have to be approved by government.	*"However, the requirement by the new IPR act to declare all IP might seriously damage to OpenSource community. So, those of our private sector partners that are involved in developing OpenSource products might, due to this legislation, now be sceptical of doing business with the CSIR."*
Offshore IP registration process	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Need to understand what the influence will be on collaborative R&D (which includes technology transfer) with international R&D organisations such King Abdulaziz City for Science & Technology (KACST) (Saudi Arabia) and/or international industry such as Samsung Thales (South Korea)."*
Requirement for non-exclusivity in IP transactions	In transactions where IP is licensed to entities in order to pursue commercialisation, preference needs to be given to non-exclusive deals.	*"The preference for non-exclusive licensing is credit-worthy, but most partners we have spoken to are only willing to a take a commercial risk if they can have some exclusivity. This is a big issue for us."*

		"It will also make it a lot more difficult to negotiate licence agreements with private sector entities on an exclusive basis (which often makes more commercial sense than not), given the preference for non-exclusive licences in the IPR Act."
Preference in commercialisation rights to SMEs and BBBEE firms	Within the broad requirement for non-exclusive deals, preference needs to be given to South African SMEs and BBBEE accredited firms. If IP holders are not able to license the IP within this framework, evidence to this effect needs to be submitted to government for approval.	*"With regards to the IPR act's requirement for preference commercialisation though South African firms, more specifically BBBEE firms, we believe that this might spur on small ICT companies to seek partnerships with the CSIR, especially those created by black entrepreneurs. The TIA act will also enforce this via the drive to make VC funding available to such small firms."*
IP detection process	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Contracts will also need to specify the nature of IP (and everything associated with it), and the commercialisation thereof. The latter is new. Most agreements we've been involved in, end off with the product."*
Government reporting process	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Reporting to NIPMO may become an administrative burden on the CSIR and its partners."*
Government reaction time	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Inefficient and bureaucratic operations and functioning of NIPMO could adversely affect the ability and attractiveness of the private sector to partner with a public institution like the CSIR."*
IP declaration process	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"Disclosure of IP to NIPMO is of great concern. If I was in the private sector, I would rather engage with another private company, local or overseas, to develop and commercialise a product."*
Structural and resource requirements	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	*"CSIR needs to ensure that our systems serve us adequately and assist with retrieving relevant information, costing, etc. Currently we are slaves to our systems, which hinder our agility and flexibility to partner."*
Unclear guidelines for the TIA funding of innovations	The TIA Act does not given concrete guidelines on the requirements or process to follow in order to obtain	*"With TIA, the Chief Executive Officer (CEO) was appointed recently and the broader NSI community is uncertain as to what will be funded or not."*

	funding from the agency (via the Intellectual Property Fund).	
Government publication approval process	See Section 2.3.4.2 for the description given by Baloyi, *et al.* (2009).	Not included in any of the responses captured from the CSIR CAMs.

5.2.2.2. Results for Research Question 1.2

An analysis of the responses to Question B.2 of Phase Two's survey was used to determine the perceived severity of the impact domains identified by each respondent. Instances where responses to this survey question did not explicitly indicate the perceived level of severity, a severity level of Medium was selected. The extracted severity levels (indicated in Table 6) were then encoded using the weighting scheme described in Section 4.7.1.2). Weightings for each identified impact domain were then summed to obtain a cumulative weighting. Based on this cumulative weighting the impact domains given in Table 7 were then ranked in a descending order. The result of this weighted frequency analysis and ranking process is shown in Table 8. Several identified impact domains received similar rankings, due to identical cumulative weighting factors. Furthermore, the 10th ranked impact domain was not present in the survey responses of any of the respondents.

Table 8: Ranking of extracted impact domains according to perceived severity

Theme Identified	Cumulative Weighting	Severity Ranking
Choice of IPRs ownership	12	1
State walk-in rights on IP not declared	12	1
Benefit sharing policies	11	2
Requirement to register IP in the OpenSource software community	9	3
Offshore IP registration process	7	4
Requirement for non-exclusivity in IP transactions	6	5
Preference in commercialisation rights to SMEs and BBBEE firms	6	5
IP detection process	5	6
Government reporting process	5	6
Government reaction time	4	7
IP declaration process	3	8
Structural and resource requirements	2	9
Unclear guidelines for the TIA funding of innovations	2	9
Government publication approval process	0	10

From this ranked list of impact domains the following three highest ranked impact domains were selected as formative indicators for the Perceived IPRs Regime Strength (Oxley, 1999) construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.3):

- Choice of IPRs ownership.
- State walk-in rights on IP not declared.
- Benefit sharing policies.

5.2.3. Reliability and Validity for Phase One

Reliability and validity for Phase One of the study was tested using the methodological triangulation approach (see Section 4.7.1.3). This involved comparing the online survey responses of the CAM from the Modelling and Digital Sciences operational unit (see Table 28) within the CSIR to the questions listed in Table 27, with the responses captured via an in-depth interview during which the same questions were posed. Table 9 presents this response comparison, from which it is clear that the responses captured via the in-depth interview and the online survey are highly correlated. As such, it is safe to assume an acceptable level of reliability and validity was achieved during Phase One.

Table 9: Phase One methodological triangulation through response comparison

Question from Phase One Survey	Responses Captured via the Online Survey	Responses Captured via the In-depth Interview
Question B.1	*"External clients are state departments that are interested OpenSource."*	*"Our competency area's main deliverable is modelling software. As South Africa does not allow for the patenting of software, it is not foreseen that the new IPR act will have a huge impact on our business. However, for instances where they have developed new algorithms, the act might play a big role."*
Question B.2	*"We do software development. Don't think it will impact us too much."*	*"Requirement to declare all publicly financed IP generated will have an overall low impact, as the majority of the time we only produce new software, which is not patentable. Even for the case where we might lose partners that only want to create OpenSource products, it is expected to have a low impact."*
	"Internal CSIR collaboration is	*"One possible type of partnership that this*

	hindered because some CSIR departments close their research for us - they consider software IP and we operate in the OpenSource domain."	*legislation might seriously impact is those partnerships created between the operational units within the CSIR. The reason for this can be described through an example. Let's say Meraka developed software for a defence sector project, lead by the DPSS operational unit. In this instance, DPSS would be obliged to declare all IP emanating from the project, while Meraka would like to make the software available as OpenSource. Hence, this legislation is going to create problems for internal partnerships to the extent that CSIR operational units might become hesitant to pursue multi-disciplinary multi-unit projects. Impact on internal partnerships between operational units within the CSIR might be severe, especially between operational units with different business models."*

5.3. Results for Phase Two

5.3.1. Sample Characteristics for Phase Two

A total of N = 62 responses were received for the Phase Two online quantitative survey (see Appendix E) sent to a sample consisting of 171 current and potential research alliance partners of the CSIR (which complied with the population criteria defined in Section 4.4). This is a better response level than Pateli's 57 responses, received during the initial evaluation of the original VMG model (Pateli, 2009). This response level, which falls comfortably within the sample size requirement for Phase Two (as defined in Section 4.5.3.2), relates to a theoretical response rate of 36.26%. However, it was discovered that some of the survey requests sent to potential respondents within this sample were forwarded to other firms and organisations that also fell in Section 4.4's defined population, but were not listed as part of the original sample of 171 potential respondents. Hence, the actual response rate will undoubtedly be lower. This snowballing effect was not tracked during the study, making it impossible to accurately determine the actual response rate.

The population definition for Phase Two, stated in Section 4.4, encompassed both current research alliances, as well as potential research alliances with the CSIR. Responses to Question H.1 (with

assigned variable PREV_PAST1) in the online survey for Phase Two (see Table 29), which tested for the presence of past research alliances with the CSIR, were used to categorise respondents as part of subpopulations consisting of either current research alliance partners, or potential research alliance partners, assuming that at least one of the past research alliances between the CSIR and a firm that responded positively to Question H.1 were still in existence. From the results of this categorisation process, which is depicted in Table 10, it is clear that both these subpopulations were optimally represented by the survey responses received, with relative response rates of 50% each.

Table 10: Distribution of Phase Two responses according to subpopulation type

Subpopulation	Number of Reponses	Relative Response Frequency
Current research alliance partners	31	50%
Potential research alliance partners	31	50%

It is also important to consider the distribution of Phase Two responses for the different industry sectors represented by respondents, as the impact domains identified during Phase One's investigation of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts (see Section 5.2.2.1) exhibited a high level of dependence on industry sectors. Table 11 contains the response distribution results for Phase Two's online survey (see Table 29), based on the major industry sectors represented by respondents. As is clear from this table the ICT and Education industry sectors dominated the responses received for Phase Two's survey.

Table 11: Distribution of Phase Two responses according to industry sectors

Industry Sector	Number of Responses	Relative Response Frequency
Agriculture	1	1.61%
Health	1	1.61%
Mining	1	1.61%
Public Services	1	1.61%
Engineering	2	3.23%
High-tech Entrepreneur	2	3.23%
Infrastructure	2	3.23%
Retail	2	3.23%
Consulting	5	8.06%
Defence	6	9.68%
Financial Services	6	9.68%
Education	13	20.97%
ICT	20	32.26%

5.3.2. Descriptive Statistics for Phase Two

Table 12 presents frequency analysis results for all nominal-scaled items (see Table 3) in Phase Two's quantitative survey (see Table 29). The formative indicators for the Competitive Relationship latent construct have also been included in this table, since these indicators are reduced to nominal-scaled items after performing the encoding process detailed in Section 4.7.2.2. From these descriptive statistics it can observed that 90.32% of respondents represented organisations that were located in South Africa, while only 6.45% represented a South African government financed R&D organisation similar to the CSIR. It is also apparent that there is a perfect balance in the level of responses received from organisations that are currently are involved in research alliances with the CSIR, and responses received from those that are not (see Section 5.3.1).

Table 12: Descriptive statistics for the nominal-scaled items in Phase Two's survey

Construct	Measurement Indicators	Encoding	Relative Occurrence of 0	Relative Occurrence of 1
Competitive Relationship (ξ_5)	LOC_OVER1 (X_6) (post encoding)	See Section 4.7.2.2	90.32%	9.68%
	MARK_OVER1 (X_7) (post encoding)	See Section 4.7.2.2	6.45%	93.55%
Alliance History (ξ_6)	PREV_PAST1	Yes = 1, No = 0	50.00%	50.00%

The descriptive statistics for all of ordinal-scaled items (see Table 3) in Phase Two's quantitative survey (see Table 29) are given in Table 13. These descriptive statistics encompassed an investigation of the minimum, maximum, median, first quartile, second quartile and mode characteristics of the 62 responses received for each item (Albright, Winston & Zappe, 2009). The unencoded versions of the formative indicators for the Competitive Relationship latent construct have also been included in Table 13. From these results the following two salient observations are evident:

- 40% of respondents rated relational contracts as their most preferred governance mode for research alliances with publicly financed R&D organisation, making this the dominant governance mode choice.
- With reference to the three impact domains identified during Phase One as potential formative indicators for the Perceived IPRs Regime Strength construct (see Section 6.2.1), both the choice of the ownership of IPRs and the requirement for benefit-sharing policies received dominant ratings of 5 (selected by 26% and 29% of the respondents for the former and the latter impact domains, respectively). Using relative response frequency as basis, these two impact domains were deemed to contribute significantly to an increase in the perceived IPRs regime strength. Conversely, state walk-in rights on undeclared IP received

a neutral dominant rating (selected by 22% of the respondents), indicating that, using relative response frequency as basis, this impact domain exhibited a low material contribution to the perceived IPRs regime strength.

Table 13: Descriptive statistics for the ordinal-scaled items in Phase Two's survey

Construct	Measurement Indicator	Min	Max	Median	First Quartile	Third Quartile	Mode
Firm Size (ξ_1)	SIZE1 (X_1)	1	4	3.5	2	4	4
Strategic Orientation (ξ_3)	STRAT_OR1 (X_2)	1	7	5	4	6	6
	STRAT_OR2 (X_3)	1	7	5	3.25	6	6
	STRAT_OR3 (X_4)	1	7	5.5	4	6	6
	STRAT_OR4 (X_5)	1	7	4	3	5.75	4
Competitive Relationship (ξ_5)	LOC_OVER1 (X_6) (prior to encoding)	1	3	1	1	1	1
	MARK_OVER1 (X_7) (prior to encoding)	1	8	4	3.25	5	4
Alliance History (ξ_6)	PREV_GOV1 (X_{10})	1	5	2	1	3	1
Perceived IPRs Regime Strength (ξ_7)	IPR_STREN1 (X_{11})	1	7	4.5	3.25	5	5
	IPR_STREN1 (X_{12})	1	7	4	3	5	4
	IPR_STREN3 (X_{13})	1	7	5	4	6	5
Preferred Alliance Governance Mode (η_1)	GOV1 (Y_1)	1	5	3	1.25	3	3
Resource Position (η_3)	RES_POS1 (Y_2)	1	7	5	3	6	5
	RES_POS2 (Y_3)	1	7	5.5	5	6	6
	RES_POS3 (Y_4)	1	7	5	3.25	6	4
	RES_POS4 (Y_5)	1	7	6	4	6	6
	RES_POS5 (Y_6)	1	7	4	3	6	6
	RES_POS6 (Y_7)	1	7	6	4.25	6	6
	RES_POS7 (Y_8)	1	7	6	4	6	6
	RES_POS8 (Y_9)	1	7	6	5	7	6
	RES_POS9 (Y_{10})	1	7	5	4.25	6	5
Market Position (η_4)	MARK_POS1 (Y_{11})	1	7	4	4	5	4
	MARK_POS2 (Y_{12})	1	7	4	4	5	4
	MARK_POS3 (Y_{13})	2	7	6	5	6	6
	MARK_POS4 (Y_{14})	2	7	4	3	5	4
	MARK_POS5 (Y_{15})	2	7	5	4	6	4
	MARK_POS6 (Y_{16})	1	7	5	5	6	5
	MARK_POS7 (Y_{17})	1	6	4	4	4	4
	MARK_POS8 (Y_{18})	1	7	6	5	6	6

Performance Position (η_5)	PERF_POS1 (Y_{19})	1	7	5	4	6	5
	PERF_POS1 (Y_{20})	1	7	5	5	6	5
	PERF_POS3 (Y_{21})	1	7	5	3	6	5
	PERF_POS4 (Y_{22})	1	7	5	4	5	5
Cultural Compatibility (η_6)	CULT_COMP1 (Y_{23})	2	7	5	4	5	5
	CULT_COMP2 (Y_{24})	1	6	4	4	5	5
	CULT_COMP3 (Y_{25})	3	7	5	4	6	4
Operational Compatibility (η_7)	OPER_COMP1 (Y_{26})	2	7	5	4	6	5
	OPER_COMP2 (Y_{27})	2	6	4	4	5	4
	OPER_COMP3 (Y_{28})	1	7	5	4	6	6
Resource Complementarity (η_8)	RES_COMP1 (Y_{29})	1	7	4.5	3.25	6	4
	RES_COMP2 (Y_{30})	1	7	5	4	6	6
	RES_COMP3 (Y_{31})	1	7	5	4	6	5
Learning (η_9)	LEARN1 (Y_{32})	1	7	5	4	6	6
	LEARN2 (Y_{33})	1	7	5	3	5	5
	LEARN3 (Y_{34})	2	7	5	5	6	5
	LEARN4 (Y_{35})	2	7	5	4	6	6
Risk Reduction (η_{10})	RISK_RED1 (Y_{36})	1	7	4	3.25	5	5
	RISK_RED2 (Y_{37})	1	6	5	4	5.75	4
	RISK_RED3 (Y_{38})	1	7	5	4	6	5
Vertical Integration (η_{11})	VERT_INT1 (Y_{39})	1	7	4	3	5	4
	VERT_INT2 (Y_{40})	1	7	4	3.25	5	4
	VERT_INT3 (Y_{41})	2	7	5	4	5	5
	VERT_INT4 (Y_{42})	1	7	5	3	5	5
	VERT_INT5 (Y_{43})	1	7	4	4	6	4
Economics (η_{12})	ECONOM1 (Y_{44})	1	7	5	3.25	5	5
	ECONOM2 (Y_{45})	1	7	5	4	5	4
	ECONOM3 (Y_{46})	1	7	5	4	5.75	5
Complementarity (η_{13})	COMPLEM1 (Y_{47})	1	7	5	4	6	5
	COMPLEM2 (Y_{48})	1	7	5	4	6	5
Social Expansion (η_{14})	EXPANSION1 (Y_{49})	1	7	5	4	6	5
Co-option (η_{15})	CO_OPTION1 (Y_{50})	1	7	5	4	6	4
	CO_OPTION2 (Y_{51})	1	7	4	3	5	4

The descriptive statistics for the only two ratio-scaled items in Phase Two's quantitative survey (see Table 29) is shown in Table 14. These statistics were calculated based on only those responses captured from respondents that had indicated the existence of past research alliances with the CSIR in response to Question H.1 of Phase Two's survey.

Table 14: Descriptive statistics for the ratio-scaled items in Phase Two's survey

Construct	Measurement Indicators	Min (years)	Max (years)	Mean (years)	Standard Deviation (years)
Alliance History (ξ_6)	PREV_NUM1 (X_8)	1	50	9.39	15.38
	PREV_DUR1 (X_9)	1	60	13.79	13.44

5.3.3. PLS Regression SEM Results for Phase Two

Reporting of the PLS regression results of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) is based on the proposed reporting standard defined by Vinzi, *et al.* (2010). According to their SEM reporting standard, the PLS regression results for the measurement portion of the SEM path diagram, consisting of the loadings for all of the measurement indicators in the model, are reported first, followed by the PLS regression results for the structural portion of the SEM path diagram, consisting of the path coefficients for all interrelationships between constructs, as depicted in Figure 4. To that end, Section 5.3.3.1 details the measurement portion SEM results, followed by Section 5.3.3.2's treatment of the structural portion SEM results.

5.3.3.1. Measurement Portion SEM Results

The measurement indicator loadings for the measurement portion of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), determined using SmartPLS (Ringle, *et al.*, 2010), are listed in Table 15. Although these loadings were not used directly in order to evaluate the research propositions stated in Section 3.3.2 for Research Objective 2 (as discussed in Table 4), a detailed investigation thereof was crucial in order to determine those reflective indicators that did not comply with the minimum Indicator Reliability level of 0.4 (see Section 4.7.2.6). The results given in Table 15 constitute the final indicator loadings, determined following the removal of seven unreliable reflective indicators, which were revealed during a first-run PLS regression SEM analysis. Removal of the unreliable reflective indicators resulted in improved Construct Reliability for their associated latent constructs (see Section 5.3.5.1).

Table 15: Measurement portion SEM loading results

Endogenous and Exogenous Constructs	Indicator Type	Measurement Indicators	Loadings
Firm Size (ξ_1)	Reflective	SIZE1 (X_1)	λ_{x1} = 1.000
Strategic Orientation (ξ_3)	Reflective	STRAT_OR1 (X_2)	λ_{x2} = 0.892
		STRAT_OR2 (X_3)	λ_{x3} = 0.708
		STRAT_OR3 (X_4)	λ_{x4} = 0.644
		STRAT_OR4 (X_5)	Excluded – loading less than 0.4
Competitive Relationship (ξ_5)	Formative	LOC_OVER1 (X_6)	π_{x1} = 0.029

		MARK_OVER1 (X_7)	π_{x2} = 0.923
Alliance History (ξ_6)	Formative	PREV_NUM1 (X_8)	π_{x3} = 0.601
		PREV_DUR1 (X_9)	π_{x4} = 0.318
		PREV_GOV1 (X_{10})	π_{x5} = 0.954
Perceived IPRs Regime Strength (ξ_7)	Formative	IPR_STREN1 (X_{11})	π_{x6} = 0.779
		IPR_STREN1 (X_{12})	π_{x7} = 0.591
		IPR_STREN3 (X_{13})	π_{x8} = 0.906
Preferred Alliance Governance Mode (η_1)	Reflective	GOV1 (Y_1)	λ_{y1} = 1.000
Resource Position (η_3)	Reflective	RES_POS1 (Y_2)	λ_{y2} = 0.635
		RES_POS2 (Y_3)	λ_{y3} = 0.692
		RES_POS3 (Y_4)	λ_{y4} = 0.657
		RES_POS4 (Y_5)	λ_{y5} = 0.776
		RES_POS5 (Y_6)	λ_{y6} = 0.646
		RES_POS6 (Y_7)	λ_{y7} = 0.737
		RES_POS7 (Y_8)	λ_{y8} = 0.705
		RES_POS8 (Y_9)	λ_{y9} = 0.686
		RES_POS9 (Y_{10})	λ_{y10} = 0.782
Market Position (η_4)	Reflective	MARK_POS1 (Y_{11})	Excluded – loading less than 0.4
		MARK_POS2 (Y_{12})	Excluded – loading less than 0.4
		MARK_POS3 (Y_{13})	λ_{y13} = 0.794
		MARK_POS4 (Y_{14})	Excluded – loading less than 0.4
		MARK_POS5 (Y_{15})	λ_{y15} = 0.845
		MARK_POS6 (Y_{16})	λ_{y16} = 0.766
		MARK_POS7 (Y_{17})	Excluded – loading less than 0.4
		MARK_POS8 (Y_{18})	λ_{y18} = 0.633
Performance Position (η_5)	Reflective	PERF_POS1 (Y_{19})	λ_{y19} = 0.758
		PERF_POS1 (Y_{20})	λ_{y20} = 0.779
		PERF_POS3 (Y_{21})	λ_{y21} = 0.772
		PERF_POS4 (Y_{22})	λ_{y22} = 0.783
Cultural Compatibility (η_6)	Reflective	CULT_COMP1 (Y_{23})	λ_{y23} = 0.839
		CULT_COMP2 (Y_{24})	λ_{y24} = 0.826
		CULT_COMP3 (Y_{25})	λ_{y25} = 0.462
Operational Compatibility (η_7)	Reflective	OPER_COMP1 (Y_{26})	λ_{y26} = 0.851
		OPER_COMP2 (Y_{27})	λ_{y27} = 0.805
		OPER_COMP3 (Y_{28})	Excluded – loading less than 0.4
Resource Complementarity (η_8)	Reflective	RES_COMP1 (Y_{29})	λ_{y29} = 0.803
		RES_COMP2 (Y_{30})	λ_{y30} = 0.903
		RES_COMP3 (Y_{31})	λ_{y31} = 0.834

Learning (η_9)	Reflective	LEARN1 (Y_{32})	λ_{y32} = 0.856
		LEARN2 (Y_{33})	λ_{y33} = 0.866
		LEARN3 (Y_{34})	λ_{y34} = 0.841
		LEARN4 (Y_{35})	λ_{y35} = 0.976
Risk Reduction (η_{10})	Reflective	RISK_RED1 (Y_{36})	λ_{y36} = 0.871
		RISK_RED2 (Y_{37})	λ_{y37} = 0.893
		RISK_RED3 (Y_{38})	λ_{y38} = 0.890
Vertical Integration (η_{11})	Reflective	VERT_INT1 (Y_{39})	λ_{y39} = 0.847
		VERT_INT2 (Y_{40})	λ_{y40} = 0.764
		VERT_INT3 (Y_{41})	λ_{y41} = 0.662
		VERT_INT4 (Y_{42})	Excluded – loading less than 0.4
		VERT_INT5 (Y_{43})	λ_{y43} = 0.743
Economics (η_{12})	Reflective	ECONOM1 (Y_{44})	λ_{y44} = 0.834
		ECONOM2 (Y_{45})	λ_{y45} = 0.859
		ECONOM3 (Y_{46})	λ_{y46} = 0.735
Complementarity (η_{13})	Reflective	COMPLEM1 (Y_{47})	λ_{y47} = 0.906
		COMPLEM2 (Y_{48})	λ_{y48} = 0.931
Social Expansion (η_{14})	Reflective	EXPANSION1 (Y_{49})	λ_{y49} = 1.000
Co-option (η_{15})	Reflective	CO_OPTION1 (Y_{50})	λ_{y50} = 0.904
		CO_OPTION2 (Y_{51})	λ_{y51} = 0.863

5.3.3.2. Structural Portion SEM Results

The path coefficients for the structural portion of the SEM for the modified VMG model (see Figure 4), which were determined using SmartPLS, are listed in Table 16. Significance testing for these path coefficients, based on asymptotic t-statistics, is presented in Section 5.3.5.2. As described in Table 4, selected path coefficients and their associated significance test results were used in Section 5.3.6 in order to evaluate the research propositions listed for Research Objective 2 (see Section 3.3.2).

Table 16: Structural portion SEM path coefficient results

SEM Path for the Modified VMG Model	Path Coefficient
Firm Size (ξ_1) → Preferred Alliance Governance Mode (η_1)	γ_1 = -0.078
Firm Size (ξ_1) → EAV (η_2)	γ_2 = -0.019
Competitive Position (ξ_2) → Resource Position (η_3)	β_2 = 0.963
Competitive Position (ξ_2) → Market Position (η_4)	β_3 = 0.751
Competitive Position (ξ_2) → Performance Position (η_5)	β_4 = 0.817
Competitive Position (ξ_2) → Preferred Alliance Governance Mode (η_1)	γ_3 = 0.072
Competitive Position (ξ_2) → EAV (η_2)	γ_4 = 0.112

Strategic Orientation (ξ_3) → Preferred Alliance Governance Mode (η_1)	γ_5 = -0.130
Strategic Orientation (ξ_3) → EAV (η_2)	γ_6 = 0.246
Partner Compatibility (ξ_4) → Cultural Compatibility (η_6)	β_5 = 0.691
Partner Compatibility (ξ_4) → Operational Compatibility (η_7)	β_6 = 0.799
Partner Compatibility (ξ_4) → Resource Complementarity (η_8)	β_7 = 0.8946
Partner Compatibility (ξ_4) → Preferred Alliance Governance Mode (η_1)	γ_7 = -0.1848
Partner Compatibility (ξ_4) → EAV (η_2)	γ_8 = 0.410
Competitive Relationship (ξ_5) → Preferred Alliance Governance Mode (η_1)	γ_9 = 0.192
Competitive Relationship (ξ_5) → EAV (η_2)	γ_{10} = -0.059
Alliance History (ξ_6) → Preferred Alliance Governance Mode (η_1)	γ_{11} = 0.270
Alliance History (ξ_6) → EAV (η_2)	γ_{12} = -0.043
Perceived IPRs Regime Strength (ξ_7) → Preferred Alliance Governance Mode (η_1)	γ_{13} = 0.1687
Perceived IPRs Regime Strength (ξ_7) → EAV (η_2)	γ_{14} = 0.1785
EAV (η_2) → Learning (η_9)	B_8 = 0.649
EAV (η_2) → Risk Reduction (η_{10})	β_9 = 0.888
EAV (η_2) → Vertical Integration (η_{11})	β_{10} = 0.750
EAV (η_2) → Economics (η_{12})	β_{11} = 0.830
EAV (η_2) → Complementarity (η_{13})	β_{12} = 0.867
EAV (η_2) → Social Expansion (η_{14})	β_{13} = 0.490
EAV (η_2) → Co-option (η_{15})	β_{14} = 0.733
EAV (η_2) → Preferred Alliance Governance Mode (η_1)	β_1 = 0.1978

5.3.4. Direct Mediating Effect Results for Phase Two

Table 17 details the results obtained by applying the Baron and Kenny (1986) process (detailed in Section 4.7.2.5) to test for the direct mediating effects of the EAV construct on the relationships between the uncertainty factors and the Preferred Alliance Governance Mode construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1). These results indicate that the EAV construct was responsible for mediating the relationships between the Preferred Alliance Governance Mode construct and each of the uncertainty factors incorporated into the modified VMG model (see Figure 3). Furthermore, in all instances the EAV construct produced Partial Mediation effects (see Section 4.7.2.5), except for the relationship with Competitive Position construct, which exhibited Full Mediation effects. Section 5.3.6's evaluation of Research Proposition H2.1(b) through H2.7(b), which hypothesised the mediating effects created by the EAV construct, was based on the results presented in Table 17.

Table 17: SEM direct mediating effect test results

Relationship Potentially Mediated by EAV	Step 1 Results	Step 2 Results	Step 3 Results	Step 4 Results	Judge-ment
Between Firm Size (ξ_1) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,1}$ = 0.061	$\gamma_{Step2,2}$ = 0.016	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,1}$ = 0.058 $\beta_{Step4,1}$ = 0.203	Partial Mediation
Between Competitive Position (ξ_2) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,3}$ = 0.064	$\gamma_{Step2,4}$ = 0.317	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,3}$ = 0 $\beta_{Step4,1}$ = 0.203	Full Mediation
Between Strategic Orientation (ξ_3) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,5}$ = 0.086	$\gamma_{Step2,6}$ = 0.376	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,5}$ = 0.060 $\beta_{Step4,1}$ = 0.196	Partial Mediation
Between Partner Compatibility (ξ_4) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,7}$ = 0.163	$\gamma_{Step2,8}$ = 0.491	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,7}$ = 0.085 $\beta_{Step4,1}$ = 0.163	Partial Mediation
Between Competitive Relationship (ξ_5) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,9}$ = 0.258	$\gamma_{Step2,10}$ = 0.143	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,9}$ = 0.242 $\beta_{Step4,1}$ = 0.182	Partial Mediation
Between Alliance History (ξ_6) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,11}$ = 0.319	$\gamma_{Step2,12}$ = 0.164	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,11}$ = 0.304 $\beta_{Step4,1}$ = 0.179	Partial Mediation
Between Perceived IPRs Regime Strength (ξ_7) and Preferred Alliance Governance Mode (η_1)	$\gamma_{Step1,13}$ = 0.271	$\gamma_{Step2,14}$ = 0.460	$\beta_{Step3,1}$ = 0.204	$\gamma_{Step4,13}$ = 0.232 $\beta_{Step4,1}$ = 0.137	Partial Mediation

5.3.5. Reliability and Validity Test Results for Phase Two

Similar to the reporting standard for SEM loading and path coefficient results, Vinzi, *et al.* (2010) suggests that the reporting of reliability and validity test results first considers the measurement portion, which include Indicator Reliability, Construct Reliability and Convergent Validity, followed by the structural portion, which include Coefficients of Determination, Path Coefficient Significance and Predictive Validity. Section 5.3.5.1 details the measurement portion reliability and validity test

results, followed by Section 5.3.5.2's treatment of the structural portion reliability and validity test results.

5.3.5.1. Measurement Portion Reliability and Validity Test Results

This subsection details the reliability and validity test results for the measurement portion of the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), based on the metrics defined in Section 4.7.2.6 and determined using SmartPLS (Ringle, *et al.*, 2010). Table 18 presents the Indicator Reliability judgement, Construct Reliability and Convergent Validity test results, while Table 19 to Table 21 present the Discriminant Validity test results.

Table 18: Indicator Reliability, Construct Reliability and Convergent Validity test results

Endogenous and Exogenous Constructs	Measurement Indicators	Indicator Reliability Judgement	Construct Reliability		Convergent Validity
			Cronbach's Alpha	Composite Reliability	
Firm Size (ξ_1)	SIZE1 (X_1)	Included	1.000	$\rho_{\xi,1}$ = 1.000	$AVE_{\xi,1}$ = 1.000
Strategic Orientation (ξ_3)	STRAT_OR1 (X_2)	Included	0.616	$\rho_{\xi,3}$ = 0.796	$AVE_{\xi,3}$ = 0.571
	STRAT_OR2 (X_3)	Included			
	STRAT_OR3 (X_4)	Included			
	STRAT_OR4 (X_5)	Excluded – loading less than 0.4			
Competitive Relationship (ξ_5)	LOC_OVER1 (X_6)	Included	Tests not applicable to formative indicators (see Section 4.7.2.6)		
	MARK_OVER1 (X_7)	Included			
Alliance History (ξ_6)	PREV_NUM1 (X_8)	Included	Tests not applicable to formative indicators (see Section 4.7.2.6)		
	PREV_DUR1 (X_9)	Included			
	PREV_GOV1 (X_{10})	Included			
Perceived IPRs Regime Strength (ξ_7)	IPR_STREN1 (X_{11})	Included	Tests not applicable to formative indicators (see Section 4.7.2.6)		
	IPR_STREN1 (X_{12})	Included			
	IPR_STREN3 (X_{13})	Included			
Preferred Alliance Governance Mode (η_1)	GOV1 (Y_1)	Included	1.000	$\rho_{\eta,1}$ = 1.000	$AVE_{\eta,1}$ = 1.000
Resource Position (η_3)	RES_POS1 (Y_2)	Included	0.871	$\rho_{\eta,3}$ = 0.898	$AVE_{\eta,3}$ = 0.495
	RES_POS2 (Y_3)	Included			
	RES_POS3 (Y_4)	Included			
	RES_POS4 (Y_5)	Included			
	RES_POS5 (Y_6)	Included			
	RES_POS6 (Y_7)	Included			

	RES_POS7 (Y_8)	Included			
	RES_POS8 (Y_9)	Included			
	RES_POS9 (Y_{10})	Included			
Market Position (η_4)	MARK_POS1 (Y_{11})	Excluded – loading less than 0.4	0.758	$\rho_{\eta,4}$ = 0.847	$AVE_{\eta,4}$ = 0.583
	MARK_POS2 (Y_{12})	Excluded – loading less than 0.4			
	MARK_POS3 (Y_{13})	Included			
	MARK_POS4 (Y_{14})	Excluded – loading less than 0.4			
	MARK_POS5 (Y_{15})	Included			
	MARK_POS6 (Y_{16})	Included			
	MARK_POS7 (Y_{17})	Excluded – loading less than 0.4			
	MARK_POS8 (Y_{18})	Included			
Performance Position (η_5)	PERF_POS1 (Y_{19})	Included	0.778	$\rho_{\eta,5}$ = 0.856	$AVE_{\eta,5}$ = 0.598
	PERF_POS1 (Y_{20})	Included			
	PERF_POS3 (Y_{21})	Included			
	PERF_POS4 (Y_{22})	Included			
Cultural Compatibility (η_6)	CULT_COMP1 (Y_{23})	Included	0.527	$\rho_{\eta,6}$ = 0.764	$AVE_{\eta,6}$ = 0.533
	CULT_COMP2 (Y_{24})	Included			
	CULT_COMP3 (Y_{25})	Included			
Operational Compatibility (η_7)	OPER_COMP1 (Y_{26})	Included	0.544	$\rho_{\eta,7}$ = 0.814	$AVE_{\eta,7}$ = 0.686
	OPER_COMP2 (Y_{27})	Included			
	OPER_COMP3 (Y_{28})	Excluded – loading less than 0.4			
Resource Complementarity (η_8)	RES_COMP1 (Y_{29})	Included	0.804	$\rho_{\eta,8}$ = 0.885	$AVE_{\eta,8}$ = 0.720
	RES_COMP2 (Y_{30})	Included			
	RES_COMP3 (Y_{31})	Included			
Learning (η_9)	LEARN1 (Y_{32})	Included	0.908	$\rho_{\eta,9}$ = 0.936	$AVE_{\eta,9}$ = 0.786
	LEARN2 (Y_{33})	Included			
	LEARN3 (Y_{34})	Included			
	LEARN4 (Y_{35})	Included			
Risk Reduction (η_{10})	RISK_RED1 (Y_{36})	Included	0.861	$\rho_{\eta,10}$ = 0.915	$AVE_{\eta,10}$ = 0.783
	RISK_RED2 (Y_{37})	Included			

	RISK_RED3 (Y_{38})	Included			
Vertical Integration (η_{11})	VERT_INT1 (Y_{39})	Included	0.752	$\rho_{\eta,11}$ = 0.842	$AVE_{\eta,11}$ = 0.573
	VERT_INT2 (Y_{40})	Included			
	VERT_INT3 (Y_{41})	Included			
	VERT_INT4 (Y_{42})	Excluded – loading less than 0.4			
	VERT_INT5 (Y_{43})	Included			
Economics (η_{12})	ECONOM1 (Y_{44})	Included	0.742	$\rho_{\eta,12}$ = 0.852	$AVE_{\eta,12}$ = 0.658
	ECONOM2 (Y_{45})	Included			
	ECONOM3 (Y_{46})	Included			
Complementarity (η_{13})	COMPLEM1 (Y_{47})	Included	0.815	$\rho_{\eta,13}$ = 0.915	$AVE_{\eta,13}$ = 0.843
	COMPLEM2 (Y_{48})	Included			
Social Expansion (η_{14})	EXPANSION1 (Y_{49})	Included	1.000	$\rho_{\eta,14}$ = 1.000	$AVE_{\eta,14}$ = 1.000
Co-option (η_{15})	CO_OPTION1 (Y_{50})	Included	0.722	$\rho_{\eta,15}$ = 0.877	$AVE_{\eta,1}$ = 0.781
	CO_OPTION2 (Y_{51})	Included			

The Indicator Reliability test results revealed that the following list of reflective indicators exhibited loadings less than 0.4 during a first-run PLS regression SEM analysis:

- STRAT_OR4 (X_5)
- MARK_POS1 (Y_{11})
- MARK_POS4 (Y_{14})
- MARK_POS4 (Y_{14})
- MARK_POS7 (Y_{17})
- OPER_COMP3 (Y_{28})
- VERT_INT4 (Y_{42})

As a result, these unreliable reflective indicators were removed from all subsequent SEM analyses (see Section 4.7.2.6). However, all formative indicators were retained (see Section 4.7.2.6), even if their respective loadings were less than 0.4, as was the case for PREV_DUR1 (X_9) and LOC_OVER1 (X_6). LOC_OVER1 showed a particularly poor performance as a formative indicator of the latent construct Competitive Relationship, which can potentially be attributed to fact that the majority of respondents exhibited perfect location overlap with the CSIR, as their firms are also based in South Africa, resulting in low level in the encoded data (see Table 12).

Construct Reliability tests considered both the classic Cronbach's Alpha metric and the more contemporary Composite Reliability measure (see Section 4.7.2.6). This study's final judgment on the adequacy of a set of reflective indicators to jointly measure their related latent construct, was based on the requirement that the Composite Reliability measure needs to exceed a minimum level of 0.6 (Vinzi, *et al.*, 2010). As is clear from Table 18, all sets of reflective indicators associated with latent constructs complied with this requirement.

Convergent Reliability, which was determined through the AVE metric, measured the variance of each latent constructs reflective indicators, as captured by the construct itself, relative to the total measured variance (see Section 4.7.2.6). Measured against the study's elected threshold value of 0.5 for this metric, it can be concluded from Table 18's results that only the Resource Position latent construct's set of reflective indicators exhibited an insufficient AVE level, indicating that, for this construct, more of the total variance measured was due to measurement error than due to indicator variance. As such, the results obtained relating to this construct cannot be viewed as valid.

Table 19: Discriminant Validity test results (Part A)

Endogenous and Exogenous Constructs	**Square Root of AVE**	**Latent Variable Correlations**						
		Alliance History (ξ_6)	Co-option (η_{15})	Competitive Relationship (ξ_5)	Complementarity (η_{13})	Cultural Compatibility (η_6)	Economics (η_{12})	Firm Size (ξ_1)
Alliance History (ξ_6)	Not applicable	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Co-option (η_{15})	$\sqrt{AVE}_{\eta,15}$ = 0.884	0.090	1.000	0.000	0.000	0.000	0.000	0.000
Competitive Relationship (ξ_5)	Not applicable	0.382	-0.013	1.000	0.000	0.000	0.000	0.000
Complementarity (η_{13})	$\sqrt{AVE}_{\eta,13}$ = 0.919	0.149	0.651	0.133	1.000	0.000	0.000	0.000
Cultural Compatibility (η_6)	$\sqrt{AVE}_{\eta,6}$ = 0.730	0.106	0.228	0.198	0.240	1.000	0.000	0.000
Economics (η_{12})	$\sqrt{AVE}_{\eta,12}$ = 0.811	-0.117	0.495	0.025	0.652	0.214	1.000	0.000
Firm Size (ξ_1)	$\sqrt{AVE}_{\xi,1}$ = 1.000	0.211	-0.077	0.129	-0.004	0.008	-0.135	1.000
Learning (η_9)	$\sqrt{AVE}_{\eta,9}$ = 0.886	0.295	0.193	0.162	0.519	0.385	0.454	0.245
Market Position (η_4)	$\sqrt{AVE}_{\eta,14}$ = 0.763	-0.034	0.142	-0.140	0.004	0.283	-0.014	0.050
Operational Compatibility (η_7)	$\sqrt{AVE}_{\eta,7}$ = 0.828	0.388	0.241	0.320	0.313	0.395	0.074	0.040

Perceived IPRs Regime Strength (ξ_7)	Not applicable	0.154	0.503	0.149	0.348	0.408	0.284	0.152
Preferred Alliance Governance Mode (η_1)	$\sqrt{AVE}_{\eta,1}$ = 1.000	0.317	0.127	0.256	0.175	0.093	0.213	0.061
Performance Position (η_5)	$\sqrt{AVE}_{\eta,5}$ = 0.773	0.075	0.308	-0.028	0.151	0.220	0.267	0.359
Resource Complementarity (η_8)	$\sqrt{AVE}_{\eta,8}$ = 0.848	0.422	0.432	0.262	0.547	0.397	0.226	0.017
Resource Position (η_3)	$\sqrt{AVE}_{\eta,3}$ = 0.704	0.062	0.227	0.029	0.107	0.303	0.218	0.328
Risk Reduction (η_{10})	$\sqrt{AVE}_{\eta,10}$ = 0.885	0.049	0.677	0.101	0.785	0.326	0.669	0.093
Social Expansion (η_{14})	$\sqrt{AVE}_{\eta,14}$ = 1.000	0.154	0.316	0.094	0.347	0.342	0.301	-0.137
Strategic Orientation (ξ_3)	$\sqrt{AVE}_{\xi,3}$ = 0.755	-0.107	0.353	0.112	0.101	0.269	0.388	-0.088
Vertical Integration (η_{11})	$\sqrt{AVE}_{\eta,11}$ = 0.757	-0.044	0.604	0.034	0.544	0.126	0.646	-0.083

Table 20: Discriminant Validity test results (Part B)

Endogenous and Exogenous Constructs	**Square Root of AVE**	**Latent Variable Correlations**						
		Learning (η_9)	Market Position (η_4)	Operational Compatibility (η_7)	Perceived IPRs Regime Strength (ξ_7)	Preferred Alliance Governance Mode (η_1)	Performance Position (η_5)	Resource Complementarity (η_8)
Learning (η_9)	$\sqrt{AVE}_{\eta,9}$ = 0.886	1.000	0.000	0.000	0.000	0.000	0.000	0.000
Market Position (η_4)	$\sqrt{AVE}_{\eta,14}$ = 0.763	-0.057	1.000	0.000	0.000	0.000	0.000	0.000
Operational Compatibility (η_7)	$\sqrt{AVE}_{\eta,7}$ = 0.828	0.278	0.089	1.000	0.000	0.000	0.000	0.000
Perceived IPRs Regime Strength (ξ_7)	Not applicable	0.253	0.125	0.361	1.000	0.000	0.000	0.000
Preferred Alliance Governance Mode (η_1)	$\sqrt{AVE}_{\eta,1}$ = 1.000	0.125	-0.098	0.104	0.206	1.000	0.000	0.000

Performance Position (η_5)	$\sqrt{AVE}_{\eta,5}$ = 0.773	0.092	0.414	0.111	0.233	0.138	1.000	0.000
Resource Complementarity (η_8)	$\sqrt{AVE}_{\eta,8}$ = 0.848	0.442	0.034	0.599	0.400	0.171	-0.081	1.000
Resource Position (η_3)	$\sqrt{AVE}_{\eta,3}$ = 0.704	0.187	0.640	0.104	0.186	0.085	0.708	-0.016
Risk Reduction (η_{10})	$\sqrt{AVE}_{\eta,10}$ = 0.885	0.503	0.086	0.191	0.461	0.112	0.298	0.387
Social Expansion (η_{14})	$\sqrt{AVE}_{\eta,14}$ = 1.000	0.397	0.358	0.194	0.211	0.108	0.101	0.366
Strategic Orientation (ξ_3)	$\sqrt{AVE}_{\xi,3}$ = 0.755	0.134	0.280	-0.023	0.281	0.016	0.495	-0.054
Vertical Integration (η_{11})	$\sqrt{AVE}_{\eta,11}$ = 0.757	0.214	0.224	0.128	0.299	0.215	0.441	0.299

Table 21: Discriminant Validity test results (Part C)

Endogenous and Exogenous Constructs	**Square Root of AVE**	**Latent Variable Correlations**				
		Resource Position (η_3)	Risk Reduction (η_{10})	Social Expansion (η_{14})	Strategic Orientation (ξ_3)	Vertical Integration (η_{11})
Resource Position (η_3)	$\sqrt{AVE}_{\eta,3}$ = 0.704	1.000	0.000	0.000	0.000	0.000
Risk Reduction (η_{10})	$\sqrt{AVE}_{\eta,10}$ = 0.885	0.329	1.000	0.000	0.000	0.000
Social Expansion (η_{14})	$\sqrt{AVE}_{\eta,14}$ = 1.000	0.272	0.297	1.000	0.000	0.000
Strategic Orientation (ξ_3)	$\sqrt{AVE}_{\xi,3}$ = 0.755	0.465	0.217	0.346	1.000	0.000
Vertical Integration (η_{11})	$\sqrt{AVE}_{\eta,11}$ = 0.757	0.393	0.566	0.386	0.531	1.000

An investigation of the Discriminant Validity results for the SEM of the modified VMG model (presented in Table 19 to Table 21) highlighted that all latent constructs complied with the necessary requirement that the square root of each latent construct's AVE exceeds its correlation with all other latent constructs (see Section 4.7.2.6).

5.3.5.2. Structural Portion Reliability and Validity Test Results

The results for the reliability and validity tests for the structural portion of the SEM of the modified VMG model (see Section 4.7.2.3), based on the metrics defined in Section 4.7.2.6, are presented

in this subsection. Table 22 details the Path Coefficient test results, while Table 23 considers the Coefficients of Determination and Predictive Validity test results, all obtained using SmartPLS (Ringle, *et al.*, 2010).

From Table 22's Path Coefficient Significance test results, obtained using SmartPLS's bootstrapping function, configured for a resampling size of 1000, it is clear that the following paths exhibited p-values, calculated using the asymptotic t-statistic distribution $t_{(999)}$, larger the maximum acceptable significance level of $\alpha = 0.10$, and were therefore deemed insignificant:

- Firm Size (ξ_1) → Preferred Alliance Governance Mode (η_1)
- Firm Size (ξ_1) → EAV (η_2)
- Competitive Position (ξ_2) → Performance Position (η_5)
- Competitive Position (ξ_2) → EAV (η_2)
- Strategic Orientation (ξ_3) → Preferred Alliance Governance Mode (η_1)
- Competitive Relationship (ξ_5) → EAV (η_2)
- Alliance History (ξ_6) → EAV (η_2)
- Perceived IPRs Regime Strength (ξ_7) → EAV (η_2)

Table 22: Path Coefficient Significance test results

SEM Path for the Modified VMG Model	Asymptotic t-Statistic	Calculated p-Value	Significance Judgement		
			$\alpha = 0.01$	$\alpha = 0.05$	$\alpha = 0.10$
Firm Size (ξ_1) → Preferred Alliance Governance Mode (η_1)	0.998	0.318	No	No	No
Firm Size (ξ_1) → EAV (η_2)	0.301	0.764	No	No	No
Competitive Position (ξ_2) → Resource Position (η_3)	138.353	< 0.001	Yes	Yes	Yes
Competitive Position (ξ_2) → Market Position (η_4)	22.042	< 0.001	Yes	Yes	Yes
Competitive Position (ξ_2) → Performance Position (η_5)	0.800	0.424	No	No	No
Competitive Position (ξ_2) → Preferred Alliance Governance Mode (η_1)	30.606	< 0.001	Yes	Yes	Yes
Competitive Position (ξ_2) → EAV (η_2)	1.400	0.162	No	No	No
Strategic Orientation (ξ_3) → Preferred Alliance Governance Mode (η_1)	1.376	0.169	No	No	No
Strategic Orientation (ξ_3) → EAV (η_2)	2.967	0.003	Yes	Yes	Yes
Partner Compatibility (ξ_4) → Cultural Compatibility (η_6)	12.315	< 0.001	Yes	Yes	Yes

Partner Compatibility (ξ_4) → Operational Compatibility (η_7)	26.845	< 0.001	Yes	Yes	Yes
Partner Compatibility (ξ_4) → Resource Complementarity (η_8)	54.436	< 0.001	Yes	Yes	Yes
Partner Compatibility (ξ_4) → Preferred Alliance Governance Mode (η_1)	1.981	0.048	No	Yes	Yes
Partner Compatibility (ξ_4) → EAV (η_2)	3.528	< 0.001	Yes	Yes	Yes
Competitive Relationship (ξ_5) → Preferred Alliance Governance Mode (η_1)	3.343	0.001	Yes	Yes	Yes
Competitive Relationship (ξ_5) → EAV (η_2)	0.965	0.335	No	No	No
Alliance History (ξ_6) → Preferred Alliance Governance Mode (η_1)	3.184	0.001	Yes	Yes	Yes
Alliance History (ξ_6) → EAV (η_2)	0.471	0.638	No	No	No
Perceived IPRs Regime Strength (ξ_7) → Preferred Alliance Governance Mode (η_1)	1.979	0.048	No	Yes	Yes
Perceived IPRs Regime Strength (ξ_7) → EAV (η_2)	1.291	0.197	No	No	No
EAV (η_2) → Learning (η_9)	9.888	< 0.001	Yes	Yes	Yes
EAV (η_2) → Risk Reduction (η_{10})	50.633	< 0.001	Yes	Yes	Yes
EAV (η_2) → Vertical Integration (η_{11})	21.957	< 0.001	Yes	Yes	Yes
EAV (η_2) → Economics (η_{12})	35.726	< 0.001	Yes	Yes	Yes
EAV (η_2) → Complementarity (η_{13})	42.618	< 0.001	Yes	Yes	Yes
EAV (η_2) → Social Expansion (η_{14})	6.213	< 0.001	Yes	Yes	Yes
EAV (η_2) → Co-option (η_{15})	18.841	< 0.001	Yes	Yes	Yes
EAV (η_2) → Preferred Alliance Governance Mode (η_1)	2.594	0.010	Yes	Yes	Yes

The Coefficients of Determination test results given in Table 23 revealed that all of the interrelationships between the endogenous latent constructs and their related latent constructs (see Figure 4) produced explained variances exceeding the minimum level of 10% (see Section 4.7.2.6). Moreover, the interrelationships with the following endogenous latent constructs were deemed to be strong, since the R^2 for these constructs exceeded 0.7:

- Resource Position (η_3)
- Resource Complementarity (η_8)
- Risk Reduction (η_{10})
- Complementarity (η_{13})

Interrelationships with the following endogenous latent constructs were viewed as weak, since the R^2 for these constructs were lower than 0.3:

- Preferred Alliance Governance Mode (η_1)
- Social Expansion (η_{14})

Table 23: Coefficients of Determination and Predictive Validity test results

Endogenous and Exogenous Constructs	Coefficients of Determination (R^2)	Predictive Validity (Q^2)	
		Cross-validated Communality (H^2)	Cross-validated Redundancy (F^2)
Firm Size (ξ_1)	Not applicable (exogenous)	0.992	0.992
Competitive Position (ξ_2)	Not applicable (exogenous)	0.413	0.413
Strategic Orientation (ξ_3)	Not applicable (exogenous)	0.565	0.565
Partner Compatibility (ξ_4)	Not applicable (exogenous)	0.376	0.376
Competitive Relationship (ξ_5)	Not applicable (exogenous)	0.442	0.442
Alliance History (ξ_6)	Not applicable (exogenous)	0.491	0.491
Perceived IPRs Regime Strength (ξ_7)	Not applicable (exogenous)	0.595	0.595
Preferred Alliance Governance Mode (η_1)	0.178	1.000	0.215
EAV (η_2)	0.397	0.395	0.160
Resource Position (η_3)	0.927	0.515	0.463
Market Position (η_4)	0.565	0.606	0.324
Performance Position (η_5)	0.668	0.587	0.386
Cultural Compatibility (η_6)	0.477	0.143	0.217
Operational Compatibility (η_7)	0.639	0.672	0.424
Resource Complementarity (η_8)	0.800	0.742	0.592
Learning (η_9)	0.421	0.781	0.340
Risk Reduction (η_{10})	0.789	0.782	0.617
Vertical Integration (η_{11})	0.563	0.583	0.332
Economics (η_{12})	0.677	0.314	0.399
Complementarity (η_{13})	0.751	0.455	0.613
Social Expansion (η_{14})	0.240	0.000	0.153
Co-option (η_{15})	0.538	0.317	0.404

A review of the Predicative Validity test results in Table 23 revealed that both Cross-validated Communality (H^2) and Cross-validated Redundancy (F^2) tested positively (see Section 4.7.2.6), indicating that the SEM for the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) is capable of, from both measurement and structural perspectives, successfully predicating governance mode decisions for research alliances with South African publicly financed R&D organisations.

5.3.6. Evaluating the Propositions of Research Objective 2 using the SEM Results

The following subsections present the statistical evaluation of the research propositions stated in Section 3.3.2 for Research Objective 2. For Research Proposition H2.1(a) to H2.7(a), as well as Research Proposition H2.8, this evaluation was based on the SEM path coefficients and their respective significance test result, presented in Section 5.3.3.2 and Section 5.3.5.2, respectively (see Table 4). Research Proposition H2.1(b) to H2.7(b) were evaluated using the SEM direct mediation test results presented in Section 5.3.4 (see Table 4).

5.3.6.1. Evaluation of Research Proposition 2.1

Research proposition H2.1(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and partner firm size (see Section 3.3.2). This hypothesised relationship was rejected, since not only did the path coefficient of γ_1 = -0.078 not support the direction of the proposed relationship, but it was also judged as not significant at the maximum allowed significance level of α = 0.10 (see Table 22).

Research Proposition H2.1(b) hypothesised that the relationship between partner firm size and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). Although the results in Section 5.3.4 supported the existence of Partial Mediation effects (see Section 4.7.2.5), the hypothesised mediating effect of the EAV construct on this relationship was rejected, due to the rejection of Research Proposition H2.1(a) (Pateli, 2009).

5.3.6.2. Evaluation of Research Proposition 2.2

Research proposition H2.2(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and the strength of the alliance partner firm's competitive position (see Section 3.3.2). Since the path coefficient of γ_3 = 0.072 support the direction of the proposed relationship, and was also judged to be significant at the maximum allowed significance level of α = 0.10 (see Table 22), this hypothesised relationship could not be rejected.

Research Proposition H2.2(b) hypothesised that the relationship between the strength of the alliance partner firm's competitive position and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). The hypothesised mediating effect of the EAV construct on this relationship could not be rejected, since the results in Section 5.3.4 supported the existence of Full Mediation effects (see Section 4.7.2.5).

5.3.6.3. Evaluation of Research Proposition 2.3

Research Proposition H2.3(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and the increased importance of growth strategies (diversification and integration) (see Section 3.3.2). This hypothesised relationship was rejected, since not only did the path coefficient γ_5 = -0.130 not support the direction of the proposed relationship, but it was also judged as not significant at the maximum allowed significance level of α = 0.10 (see Table 22).

Research Proposition H2.3(b) hypothesised that the relationship between the increased importance of growth strategies (diversification and integration) and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). Section 5.3.4's results supported the existence of Partial Mediation effects (see Section 4.7.2.5). However, the hypothesised mediating effect of the EAV construct on this relationship could was rejected, due to the rejection of Research Proposition H2.3(a) (Pateli, 2009).

5.3.6.4. Evaluation of Research Proposition 2.4

Research Proposition H2.4(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and increased partner compatibility (see Section 3.3.2). The path coefficient of γ_7 = -0.1848 did not support the direction of the proposed relationship. Hence, this hypothesised relationship was rejected, even though the path coefficient was judged as significant at the maximum allowed significance level of α = 0.10 (see Table 22).

Research Proposition H2.4(b) hypothesised that the relationship between increased partner compatibility and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). The hypothesised mediating effect of the EAV construct on this relationship was rejected due to the rejection of Research Proposition H2.4(a) (Pateli, 2009), even though the existence of partial Mediation effects (see Section 4.7.2.5) was supported by the results of Section 5.3.4.

5.3.6.5. Evaluation of Research Proposition 2.5

Research Proposition H2.5(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and intensity in the partner competitive relationship (see Section 3.3.2). This hypothesised relationship could not be rejected, since not only did the path coefficient of γ_9 = 0.192 support the direction of the proposed relationship, but it was also judged to be significant at the maximum allowed significance level of α = 0.10 (see Table 22).

Research Proposition H2.5(b) hypothesised that the relationship between the intensity in the partner competitive relationship and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). Since the results in Section 5.3.4 supported the existence of Partial Mediation effects (see Section 4.7.2.5), the hypothesised mediating effect of the EAV construct on this relationship could not be rejected.

5.3.6.6. Evaluation of Research Proposition 2.6

Research Proposition H2.6(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and the alliance history between partners (see Section 3.3.2). Not only was the path coefficient of γ_{11} = 0.270 judged to be significant at the maximum allowed significance level of α = 0.10 (see Table 22), but it also supported the direction of the proposed relationship. Hence, this hypothesised relationship could not be rejected.

Research Proposition H2.6(b) hypothesised that the relationship between the alliance history between partners and the preference for quasi-hierarchy governance modes is mediated via the EAV construct (see Section 3.3.2). The hypothesised mediating effect of the EAV construct on this relationship could not be rejected, since the results in Section 5.3.4 supported the existence of Partial Mediation effects (see Section 4.7.2.5).

5.3.6.7. Evaluation of Research Proposition 2.7

Research Proposition 2.7(a) hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and the perceived strength of the IPRs regime within which the research alliance operates (see Section 3.3.2). This hypothesised relationship could not be rejected, since not only did the path coefficient of γ_{13} = 0.1687 support the direction of the proposed relationship, but it was also judged to be significant at the maximum allowed significance level of α = 0.10 (see Table 22).

Research Proposition 2.7(b) hypothesised that the relationship between the perceived strength of the IPRs regime within which the research alliance operates and the preference for quasi-hierarchy

governance modes is mediated via the EAV construct (see Section 3.3.2). Since the results in Section 5.3.4 supported the existence of Partial Mediation effects (see Section 4.7.2.5), the hypothesised mediating effect of the EAV construct on this relationship could not be rejected.

5.3.6.8. Evaluation of Research Proposition 2.8

Research Proposition H2.8 hypothesised that there exists a positive relationship between the preference for quasi-hierarchy governance modes and high expectations for EAV (see Section 3.3.2). Since the path coefficient of β_1 = 0.1978 support the direction of the proposed relationship, and it was also judged to be significant at the maximum allowed significance level of α = 0.10 (see Table 22), this hypothesised relationship could not be rejected.

Chapter 6 - Discussion

6.1. Introduction

In this chapter the qualitative results for Phase One (see Section 5.2) and quantitative results for Phase Two (see Section 5.3) are discussed in more detail. Firstly, Phase One's answers to the research questions posed under Research Objective 1 (see Section 3.3.1) are discussed. Thereafter, the outcomes of Phase Two's evaluation of the research propositions listed under Research Objective 2 (see Section 3.3.2) are examined.

6.2. Discussion on the Results for Research Objective 1

As indicated in Section 5.2.1 a total of N = 10 CAMs, spread across the various operational units of the CSIR, responded to Phase One's online qualitative survey (detailed in Appendix B). Application of Theme Extraction and Constant Comparative Method analysis to these responses (see Section 4.7.1.1) confirmed the sufficiency of this sample size, since data saturation (Guest, *et al.*, 2006) for the extracted themes, representing potential impact domains within the new South Africa IPRs legislation for publicly financed R&D that could influence research alliances, had already occurred when the fifth response was captured. The following subsection discusses the potential impact domains, identified using Theme Extraction and Constant Comparative Method analysis in order to answer Research Question 1.1. This is followed by a discussion on the ranking results for these impact domains, obtained using weighted frequency analysis in order to answer Research Question 1.2. Section 5.2.3's methodological triangulation results confirmed both the reliability and viability of the data collected for Research Objective 1.

6.2.1. Discussion on the Results for Research Question 1.1

Research Question 1.1 attempted to qualitatively identify potential impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could influence research alliances with publicly financed R&D organisations. Responses from CSIR CAMs in response to this question was analysed using Theme Extraction during Narrative Inquiry. The list of business impact domains identified by Baloyi, *et al.* (2009) (see Section 2.3.4.2) was used as a baseline set of themes, which was then augmented with the newly identified themes using the Constant Comparative Method. During the theme extraction process newly identified and unique themes were aligned with the distinct sections within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, which are detailed in Section D.3 and Section D.4, respectively.

Theme Extraction and Constant Comparative Method revealed that seven business impact domains originally listed by Baloyi, *et al.* (2009) (see Section 2.3.4.2) were regarded by CSIR CAMs as impact domains that could potentially influence current and future research alliances with the CSIR. The discussion below details the potential influences that these seven impact domains could exert on the EAV and governance mode decisions for such research alliances. This discussion includes speculative judgements on the drivers behind these influences (TCE, RBV or ROA):

- *IP Detection Process:* Two CAMs indicated that the requirement for researchers and engineers to identify, with the assistances of the CSIR's TTO (DST, 2006), potential IP that qualify for registration, will require the creation of more complex contractual agreements within research alliances to clearly define what constitutes the characteristics of such IP. For example, one CAM commented as follows: *"Contracts will also need to specify the nature of IP (and everything associated with it), and the commercialisation thereof."* Although, from a TCE perspective (see Section 2.2.2.2), the additional costs in policing of such complex contractual agreements could be interpreted as deterrent to establish research alliances with quasi-hierarchy governance modes (Williamson, 1979, 1981), the fact that these agreements will mitigate concerns that stem from the perception of a weak IPRs regime could encourage such governance modes (Oxley, 1999).
- *IP Declaration Process:* One CAM viewed the requirement to declare newly generated IP as a disincentive to establish quasi-hierarchy research alliances with the CSIR. As case in point, this CAM commented as follows: *"Disclosure of IP to NIPMO is of great concern. If I was in the private sector, I would rather engage with another private company, local or overseas, to develop and commercialise a product."* If viewed from a TCE perspective (see Section 2.2.2.2), the rational behind this sentiment could be attributed to the additional costs associated in establishing and managing such a declaration process (Williamson, 1979, 1981). Moreover, from an ROA perspective (see Section 2.2.2.4) the stifling effects that this requirement will place on the managerial flexibility (Leiblein, 2003) allowed by the state during transactions related to the declared IP, such as the requirement for exclusive licensing, could diminish the EAV (see Section 2.2.3.1).
- *Benefit Sharing Policies:* Four CAMs responded positively to this domain within the IPRPFRD Act (Republic of South Africa, 2008a), indicating that this could potentially incentivise the creation of research alliances with publicly financed R&D organisations. One CAM did raise concerns with regards to the practical implementation of this aspect of the legislation within certain industry sectors, as is apparent from this response: *"Benefit sharing of IP creators - don't know how that will work in the private sector, particularly in the civil engineering industry."* The positive sentiments towards this impact domain, and its

potential encouragement of the creation of quasi-hierarchy research alliances, could be explained using the RBV perspective (see Section 2.2.2.3): Research and engineering staff, which are the core assets of R&D organisations (Prahalad & Hamel, 1994), will be financially incentivised to continue developing and protecting IP. This, in turn, will grow the knowledge and skills of research alliance partners, which can be viewed as their core competencies (Prahalad & Hamel, 1994), thereby creating a sustainable competitive advantage (Wernerfelt, 1984; Rumelt, 1984; Prahalad & Hamel, 1994).

- *Offshore IP Registration Process:* Two CAMs raised concerns with regards to the potential negative impacts that this aspect of the IPRPFRD Act (Republic of South Africa, 2008a) could have on research alliances with publicly financed R&D organisations. Unfortunately, none of these CAMs hinted at the nature of their perceived negative impacts. However, one could argue that, from a TCE perspective (see Section 2.2.2.2), the additional costs associated in establishing and managing such a process could create negative sentiments towards quasi-hierarchy research alliance governance modes (Williamson, 1979, 1981). IPRs regime mismatches between international alliance partners, as a result of the implementation of Bayh-Dole-like legislation, could also adversely affect appetite for the creation of quasi-hierarchy research alliances (Oxley, 1999).
- *Government Reporting Process:* The requirement to report IPR related issues to NIPMO twice yearly, was raised by two CAMs as a potential impact domain that could influence research alliances with publicly financed R&D organisations. For example, one of the CAMs commented as follows: *"Reporting to NIPMO may become an administrative burden on the CSIR and its partners."* This potential negative perception towards this impact domain could be as a result of the additional costs incurred by the administrative burden placed on research alliance partners, based on the TCE perspective (see Section 2.2.2.2) (Williamson, 1979, 1981).
- *Government Reaction Time:* Going hand-in-hand with the negative sentiments towards the requirement of the IPRPFRD Act (Republic of South Africa, 2008a) to report IP related issues to NIPMO twice yearly, the same two CAMs indicate that the reaction time from government to IP related requests could hamper operations at research alliances. As such, from a TCE perspective (see Section 2.2.2.2), the additional "lead time" that will be incurred in commercialising IP, as a results of this slow reaction time, could negatively impact the desire to create quasi-hierarchy research alliances with publicly financed R&D organisations (Williamson, 1979, 1981).
- *Structural and Resource Requirements:* Only one CAM indicated the potential structural and resource requirements to support the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts as a danger to research alliances with publicly financed R&D organisations. More specifically, this CAM highlighted that flexibility in

creating research alliances are hampered by current inefficient systems and process: *"CSIR needs to ensure that our systems serve us adequately and assist with retrieving relevant information, costing, etc. Currently we are slaves to our systems, which hinder our agility and flexibility to partner."* Arguably, this inefficiency could be aggravated by the new legislative framework's additional reporting requirements, thereby increasing administrative costs and decreasing managerial flexibility, based on the TCE (Williamson, 1979, 1981) (see Section 2.2.2.2) and ROA (Leiblein, 2003) (see Section 2.2.2.4) perspectives, respectively.

The eighth business impact domain identified by Baloyi, *et al.* (2009) (see Section 2.3.4.2), which involves the process to obtain government approval to publish research papers on IP generated from publicly financed R&D, was not identified by any of the CAMs as a potential impact domain for research alliances. This is could be attributed to the fact that research alliances are created primarily in order to save costs (see Section 2.2.2.2), leverage resources (see Section 2.2.2.3) and establishing real options (see Section 2.2.2.4) whereby new IP can be created and commercialised, whereas generating publications from R&D performed by such alliances is viewed as a non-core added benefit (Hertzfeld, *et al.*, 2006).

Apart from identifying seven of the eight business impact domains listed by Baloyi, *et al.* (2009) as potential areas within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts that could influence research alliances with publicly financed R&D organisations, an six additional domains were also identified through the application of Theme Extraction to the data captured for Research Question 1.1. The discussion below details the potential influences that these additional six impact domains could exert on the EAV and governance mode decisions for such research alliances, as well as speculative judgements on the drivers behind these influences (TCE, RBV or ROA):

- *Choice of IPRs Ownership:* A total of five CAMs identified the section in the IPRPFRD Act (Republic of South Africa, 2008a) related to choosing the split in IPR ownership between research alliance partners as a significant area of potential impact domain for research alliances. For example, one of the CAMs stated: "*Under the IPRPFRD act, entities without an IP and commercialisation office will always struggle to arrive at an acceptable split."* This impact domain could adversely influence decisions favouring quasi-hierarchy alliance governance modes for the following reason: From an ROA perspective (see Section 2.2.2.4), the options for growth and flexibility, and therefore the EAV (see Section 2.2.3.1) generated by the creation of research alliances, are diminished by allowing the publicly financed R&D partners to control the choice of IPRs ownership (Leiblein, 2003).

Furthermore, in research alliances with multiple publicly financed partners, control of the choice of IPRs ownership could become a heavily contested contractual issue, as is evident from the following CAM response: "*We have been experiencing a lot of difficulties with the universities already, with respect to IP ownership in research partnerships and collaborations, especially where they perceive the CSIR to be a funding agency, as opposed to a research partner."* This impact domain could, however, also positively influence the preference for quasi-hierarchy governance modes, based on a TCE perspective (see Section 2.2.2.2): Costs that are usually incurred in creating, negotiating and policing contractual agreements that capture the complexities related to the split of IPRs will be avoided for research alliances with publicly financed R&D partners that are governed by the IPRPFRD Act (Republic of South Africa, 2008a).

- *State Walk-in Rights on IP not Declared:* Four CAMs identified this area within the IPRPFRD Act (Republic of South Africa, 2008a) as a potential impact domain that could influence research alliances with publicly financed R&D organisations, and hence, governance mode decisions favouring quasi-hierarchy structures. Adverse effects on the preference for quasi-hierarchies could be explained by an ROA perspective (see Section 2.2.2.4), since such state walk-in rights effectively limit managerial flexibility (Leiblein, 2003) that are obtained by creating research alliances with publicly financed R&D organisations, thereby decreasing the EAV (see Section 2.2.3.1). A counter argument that explains the potential positive influence that this impact domain could have on selecting quasi-hierarchy alliance structures, also rooted in the ROA perspective, is as follows: The IPRPFRD Act (Republic of South Africa, 2008a) enforces the commercialisation of all IP generated through publicly financed research activities (see Section 2.3.4.1). Hence, research partners of publicly financed R&D organisations could see this as a vehicle to ensure that none of the foreground IP generated within the alliance remains dormant. Therefore, it could be viewed as a driver of potential economic growth, albeit somewhat forced.
- *Requirement to Register IP in the OpenSource Software Community:* This seemed to be a concern amongst four CAMs, of which two are operating in the ICT industry. For example, one of these CAMs stated the following: "*So, those of our private sector partners that are involved in developing OpenSource products might, due to this legislation, now be sceptical of doing business with the CSIR."* Based on the TCE perspective (Williamson, 1979, 1981) (see Section 2.2.2.2), quasi-hierarchy governance modes for research alliances with publicly financed R&D organisations could be discouraged by this impact domain, since additional administrative costs will be incurred by having to declare OpenSource projects to NIPMO (Baloyi, *et al.*, 2009). Furthermore, it could have limiting effects on the managerial flexibility within such research alliances, thereby decreasing the EAV, based on the ROA perspective (Leiblein, 2003) (see Section 2.2.2.4).

- *Requirement for Non-exclusivity in IP Transactions:* Three CAMs indicated that the IPRPFRD Act's (Republic of South Africa, 2008a) requirement to give preference to non-exclusive licensing of IP generated from publicly financed R&D is a potential impact domain that could affect research alliances. These CAMs believe that the additional costs involved in negotiating exclusive license agreements could bias preference towards quasi-market governance modes for research alliances. This belief is apparent from the following statement from one of these CAMs: *"It will also make it a lot more difficult to negotiate licence agreements with private sector entities on an exclusive basis (which often makes more commercial sense than not), given the preference for non-exclusive licences in the IPR Act."* This TCE-driven (see Section 2.2.2.2) negative perception (Williamson, 1979, 1981) is supported by the ROA perspective (Leiblein, 2003) (see Section 2.2.2.4), which suggests that the EAV (see Section 2.2.3.1) could be decreased due to the limitations placed on growth and flexibility options.
- *Preference in Commercialisation Rights to SMEs and BBBEE Firms:* Only two CAMs flagged this requirement of the IPRPFRD Act (Republic of South Africa, 2008a) as a potential impact domain that could influence research alliances with publicly financed R&D organisations. These two CAMs, however, exhibited divergent views on the nature of the impact emanating from this legislative requirement: One CAM believed that it would hamper the creation of quasi-hierarchy research alliances with publicly financed R&D organisations, as it will limit managerial flexibility, based on the ROA perspective (Leiblein, 2003) (see Section 2.2.2.4). The other CAM was of the opinion that based on the RBV perspective (Wernerfelt, 1984; Rumelt, 1984; Prahalad & Hamel, 1994) (see Section 2.2.2.3), it could allow for the development of a largely untapped pool of black technology entrepreneurs who would seek to create quasi-hierarchy research alliances. This latter view is apparent from the following statement: *"With regards to the IPR act's requirement for preference commercialisation though South African firms, more specifically BBBEE firms, we believe that this might spur on small ICT companies to seek partnerships with the CSIR, especially those created by black entrepreneurs."*
- *Unclear Guidelines for the TIA Funding of Innovations:* One CAM indicated that, although positive in its intentions to spur R&D in South Africa, and therefore the creation of quasi-hierarchy research alliances, the processes, procedures and qualification involved in obtaining VC funding from the TIA, via the Innovation Fund, remains unclear. This CAM commented as follows: "...*the broader NSI community is uncertain as to what will be funded or not."* As such, potential research alliance partners could view such difficulties in accessing public sector funding resources from the TIA as a disincentive to collaborate with publicly financed R&D organisations, based on the RBV perspective (Wernerfelt, 1984; Rumelt, 1984; Prahalad & Hamel, 1994) (see Section 2.2.2.3).

An important observation from the results obtained for Research Question 1.1 was the high level of commonality in the responses received from CAMs operating within a specific industry sector. For example, all CAMs that operate within the ICT sector raised concerns with regards to the negative impact of the IPRPFRD Act's (Republic of South Africa, 2008a) requirement to register IP generated by research alliances within OpenSource community initiatives. Likewise, CAMs that operate within the natural resources and environment sector exhibited unease concerning the IPRPFRD Act's (Republic of South Africa, 2008a) requirements concerning the choice of IPRs ownership. Thus, future studies need to consider industry sector related responses to the new IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.

6.2.2. Discussion on the Results for Research Question 1.2

Research Question 1.2 quantitatively investigated the severity levels of the impact domains identified within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts in response to Research Question 1.1. Using these severity levels a weighted frequency analysis was performed (see Section 4.7.1 and Section 5.2.2.2) in order to determine an appropriate severity ranking for each impact domain. Lastly, the three highest ranked impact domains were then selected as formative indicators for the Perceived IPRs Regime Strength construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1), which was evaluated during Phase Two of the study. With reference to Question B.2 in the quantitative survey for this phase (see Appendix B), the CAMs were not requested to indicate whether the influence of the impact domains they had identified were positive or negative in nature, as is was expected that the nature of the influence would become visible during the SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1).

Following the simple encoding scheme detailed in Section 4.7.1.2, the severity levels specified by the CAMs for the impact domains that they had identified within IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts were set to three, two and one for High, Medium and Low severities, respectively. In instances where CAMs failed to specific the severity levels of the impact domains that they had listed in response to Research Question 1.1 the severity was set to a default level of Medium. Relative ranking of the identified impact domains were then determined through a weighted frequency analysis based on the cumulative weights for each of the 14 impact domains, consisting of the eight domains identified by Baloyi, *et al.* (2009) (of which seven were present in CAM responses to Research Question 1.1) and the additional six identified by this study (see Section 6.2.1). The results of this frequency analysis, which is presented in Table 8, revealed that the following three impact domains ranked the highest:

- *Choice of IPRs Ownership:* This potential impact domain within the IPRPFRD Act (Republic of South Africa, 2008a) was listed by a total of five CAMs, resulting in a cumulative weighting of 12.
- *State Walk-in Rights on IP not Declared:* Four CAMs listed this as a potential impact domain within the IPRPFRD Act (Republic of South Africa, 2008a), with a cumulative weighting of 12.
- *Benefit Sharing Policies:* Scoring a cumulative weighting of 11, four CAMs listed this as a potential impact domain within the IPRPFRD Act (Republic of South Africa, 2008a).

These three impact domains, achieving the top three spots in terms of cumulative weight ranking, were then used in Phase Two as formative indicators for the Perceived IPRs Regime Strength construct in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1). Note, however, if the average impact severity levels were used as ranking criteria instead of cumulative weighting, the three highest ranked impact domains would have consisted of the following:

- *State Walk-in Rights on IP not Declared:* An average impact severity level of 3.0 was achieved by this impact domain.
- *IP Declaration Process:* This impact domain scored an average impact severity level of 3.0.
- *Preference in Commercialisation Rights to SMEs and BBBEE Firms:* The average impact severity level of this impact domain was also 3.0.

6.3. Discussion on the Results for Research Objective 2

Section 5.3.1 indicated that a total of N = 62 responses were received for Phase Two's online quantitative survey (detailed in Appendix E), divided equally between current and potential research alliance partners of the CSIR. These survey responses were then processed using PLS regression SEM (see Section 4.7.2) in order to address Research Objective 2, as defined in Section 3.2.

In order to ensure the reliability and validity of the SEM results obtained, both the measurement and the structural portions of the SEM path diagram depicted in Figure 4 were considered. From a measurement portion perspective, the results given in Section 5.3.5.1 indicated that acceptable levels of reliability and validity were achieved during data capturing, since only seven of the 64 measurement indicators did not complying with the Indicator Reliability minimum requirement. Furthermore, only one of the 19 constructs that had assigned measurement indicators did not complying with the Convergent Reliability minimum requirement. Lastly, all constructs complied with the minimum requirement for Construct Reliability.

From a structural portion perspective, Section 5.3.5.2's reliability and validity results indicated that all latent constructs complied with both the Predicative Validity and Coefficients of Determination minimum requirements. Results obtained for the Path Coefficient Significance indicated that only eight of the 28 hypothesised interrelationships in the SEM path diagram depicted in Figure 4 were not significant at the maximum acceptable significance level of α = 0.10.

The path coefficient results obtained through PLS regression SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) were used in Section 5.3.6 in order to evaluate the research propositions stated under Research Objective 2. These research propositions considered not only the direct relationships between the various uncertainty factors included in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) and the Preferred Alliance Governance Mode construct, but also the potential mediating effects experienced by these relationships via the EAV construct. The following subsections discuss the results of Section 5.3.6's evaluation of the research propositions in more detail. This discussion includes speculative judgements on the drivers behind these results (TCE, RBV or ROA):

6.3.1. Discussion on the Results for Research Proposition 2.1

The proposition that the preference for quasi-hierarchy governance modes for research alliances with publicly financed R&D organisation is positively related to the size of the alliance partner firm was rejected (see Section 5.3.6.1). Consequently, the hypothesised mediation of such a relationship via the EAV construct was also rejected (see Section 5.3.6.1). This study's results challenge the findings of Pateli (2009) and oppose the reasoning of several researchers, including Leiblein and Miller (2003), Osborn and Baughn (1990), as well as Tether (2002). These researchers postulated that larger firms prefer quasi-hierarchy alliances, based on RBV logic (see Section 2.2.2.3) that more hierarchal alliances allow for the exploitation of power over resources (Leiblein & Miller, 2003; Osborn & Baughn, 1990; Tether, 2002). From the findings of this study one could postulate that smaller R&D firms prefer quasi-hierarchy governance modes for research alliances (this hypothesis, however, is not explicitly proven by the study's results). Argumentation for such a hypothesis could potentially be found in RBV (see Section 2.2.2.3) and ROA (see Section 2.2.2.4) perspectives: According to the ROA perspective (see Section 2.2.2.4), which is supported by EAV producing Partial Mediation effects (see Section 5.3.4) in the relationship between the Firm Size and the Preferred Alliance Governance Mode constructs, smaller R&D firms could indicate preference for quasi-hierarchy alliance governance modes, as this could produce options for faster growth (for example, by leveraging the publicly financed R&D partner's brand)(Leiblein, 2003). From an RBV perspective, the capital intensive nature of R&D could entice small firms to seek quasi-hierarchy partnerships with larger publicly financed R&D firms that have already invested in costly resources.

6.3.2. Discussion on the Results for Research Proposition 2.2

The hypothesised positive relationship between the preference for quasi-hierarchy governance modes and the strength of the alliance partner firm's competitive position could not be rejected by the results of Phase Two (see Section 5.3.6.2). It was also shown in Section 5.3.4 that the EAV produced Full Mediation effects (see Section 4.7.2.5) in the relationship between the strength of the alliance partner firm's competitive position and the preference for quasi-hierarchy governance modes (see Section 5.3.6.2). Although these findings contradict those of Pateli (2009), they are supported by certain researchers. For example, Day and Wensley (1988) stated that the competitive position of a firm is partially determined by its resource position. Based on an RBV perspective (see Section 2.2.2.3) firms wishing to maintain or achieve a competitive advantage in an environment where the rate of technological change is rapid, time-to-market and timing is critical, and the nature of future competition is difficult to determine, will prefer quasi-hierarchy alliances (Hemphill & Vonortas, 2003). The need to not only acquire new competitive competencies through learning, but also protect current competitive skills and resources, drives this preference (Hemphill & Vonortas, 2003; Hamel & Prahalad, 1994). It is also motivated by an ROA perspective (see Section 2.2.2.4) that obtaining such competitive competencies will create options for future growth.

6.3.3. Discussion on the Results for Research Proposition 2.3

Based on Pateli's (2009) findings the hypothesised positive relationship between the preference for quasi-hierarchy governance modes and the increased importance of growth strategies (diversification and integration) could not be rejected. This study, however, revealed that the hypothesised relationship (and any mediation effects due to the EAV) has to be rejected within the context of research alliances with South African publicly financed R&D organisations (see Section 5.3.6.3). This seems to contradict the ROA perspective (see Section 2.2.2.4) promoted by Ansoff (1965) and Kotler (2000) that alliance creation is sometimes viewed as option for growth, which allows for rapid service/product diversification and integration. It also challenges TCE and RBV perspectives that promote growth strategies, obtained through more hierarchical governance modes, as a vehicle to ensure cost effective safeguarding of the resources shared by the alliance (Pateli, 2009). A plausible explanation for these controversial findings could be based on the temporal context of this study: The current global financial crisis, which started in 2007 due to a liquidity shortfall in the US banking system, forced many firms in countries that experienced mild recessions, such as South Africa, to downsize aggressive diversification and expansion strategies (Orr, 2010). With the median of the responses captured for measurement indicators STRAT_OR1 to STRAT_OR4 (see Table 13) ranging from 4.0 to 5.5, this seems to also be the case for the Phase Two respondents. Furthermore, these respondents' preference for quasi-hierarchy governance modes for research alliances with South African publicly financed R&D organisations

could be indicative of expectations for improved economic conditions, driven by the ROA perspective's option for future growth through partnering (Leiblein, 2003).

6.3.4. Discussion on the Results for Research Proposition 2.4

Contrary to Pateli's (2009) findings, Section 5.3.6.4 rejected the hypothesised positive relationship (and potential mediating effect via the EAV construct) between the preference for quasi-hierarchy governance modes and increased partner compatibility, which Parkhe (1991) conceptualised as the complementarity of resources, together with cultural and operational compatibility. These findings oppose the TCE perspective that the coordination costs inherent in alliance management decreases if the compatibility in partners' cultures and operational strategies increase, resulting in a preference for quasi-hierarchies (Gulati & Singh, 1998). It also contests the RBV perspective that a preference for quasi-hierarchies results from the increased availability of complementary resources (Pateli, 2009). However, from an ROA perspective (see Section 2.2.2.4) dissimilarity between alliance partners can be viewed as a source of diversity Parkhe (1991), which can be a powerful driver of innovation (Hamel & Prahalad, 1994). Since innovation is at the core of R&D, this ROA perspective could explain the rejection of the hypothesised relationship between the preference for quasi-hierarchy governance modes and increased partner compatibility.

6.3.5. Discussion on the Results for Research Proposition 2.5

Similar to the findings of Pateli (2009), Section 5.3.6.5 could not reject the hypothesised positive relationship between the preference for quasi-hierarchy governance modes and intensity in the partner competitive relationship. Section 5.3.6.5 also ascertained that this relationship exhibited Partial Mediation effects (see Section 4.7.2.5) via the EAV construct. These findings support Kogut's (1988) notion that quasi-hierarchies are preferred in highly competitive alliances, since the RBV perspective (see Section 2.2.2.3) suggests that these structures provide protection to induce knowledge sharing, while the TCE perspective (see Section 2.2.2.2) advocates that it allows partners to sustain their own core competencies. The observed mediation effects can be explained from an ROA perspective (see Section 2.2.2.4): Competitive relationships in emerging industries are characterised by the phenomenon of information asymmetry (Pateli, 2009). Players in such markets aspire to increase their knowledge of the competition, the technologies allowing them to compete in the market, the risks inherent in the market, and customer demand (Pateli, 2009). This knowledge allows firms to differentiate themselves in such emerging markets (Pateli, 2009). Thus, even though R&D firms view certain research alliance partners as competition, the option for growth resulting from the potential detection of complementary resources and skills at these partners could increase the EAV, followed by an increase in the attractiveness of quasi-hierarchy governance modes (Pateli, 2009).

6.3.6. Discussion on the Results for Research Proposition 2.6

The findings presented in Section 5.3.6.6 supported Pateli's (2009) findings that the hypothesised positive relationship between the preference for quasi-hierarchy governance modes and the alliance history between partners could not be rejected. It also supported the existence of Partial Mediation effects (see Section 4.7.2.5) in this relationship, due to the EAV construct (see Section 5.3.6.6). These findings can be explained from an ROA perspective (see Section 2.2.2.4): Increased levels of trust are created through mutual experiences in research alliances, leading to decreased uncertainty and positive expectations of partner behaviour (Gulati, 1995). This increased level of trust will enhance the preference for quasi-hierarchies, as the decrease in partner uncertainty encourages partners to commit more resources to create options for future growth (Pateli, 2009).

6.3.7. Discussion on the Results for Research Proposition 2.7

Based on the findings presented in Section 5.3.6.7, it was determined that the hypothesised positive relationship between the preference for quasi-hierarchy governance modes and the perceived strength of the IPRs regime within which a research alliance operates, could not be rejected. This relationship was found to also exhibit Partial Mediation effects (see Section 4.7.2.5) via the EAV construct (see Section 5.3.6.7). Furthermore, the three impact domains related to the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, identified during Phase One, proved to be useful as formative indicators in the SEM of the modified VMG model (Pateli, 2009)(see Section 2.2.3.1) for the Perceived IPRs Regime Strength (Oxley, 1999) external uncertainty factor, since these indicators' loadings, $\pi_{x6} = 0.779$, $\pi_{x7} = 0.591$ and $\pi_{x8} = 0.906$, were substantial. The preference for quasi-hierarchy governance modes for research alliances with South African publicly financed R&D organisations could be attributed to an RBV perspective (see Section 2.2.2.3) that a strong IPRs regime will ensure the protection of the IPRs assets created and owned by the alliance. Furthermore, from an ROA perspective (see Section 2.2.2.4), the IPRPFRD Act's (Republic of South Africa, 2008a) resolute requirement that all IP generated from publicly financed R&D needs to be commercialised, can be viewed as an option for growth, although somewhat forced.

Oxley (1999), who evaluated the relationship between the IPRs regime strength and the preferred governance mode for international research alliances, found that this hypothesised relationship could only be rejected for alliances with one party located in a high strength IPRs regime (such as the US) and the other in a low strength IPRs regime (such as India). When both partners were located in a country with high IPRs regime strength, Oxley (1999) found that the hypothesised relationship could not be rejected. With reference to Table 12, a total of 90.32% of the Phase Two respondents were co-located with the CSIR in South Africa, a country which has an IPRs regime

that is regarded as strong by the WIPO (Maredia, 2001). Hence, the findings obtained during Phase Two seem to corroborate those of Oxley (1999).

6.3.8. Discussion on the Results for Research Proposition 2.8

The hypothesised positive relationship between the preference for quasi-hierarchy governance modes and high expectations for EAV could not be rejected, as is clear from the findings presented in Section 5.3.6.8. Although this conforms to Pateli's (2009) assertion that EAV is a significant determinant of the governance mode choice, it did not support Patel's findings that quasi-market alliances will be preferred in cases of high expectations for the alliance value. As such, one could argue that the ROA perspective (see Section 2.2.2.4) that the options for growth resulting from the creation of equity alliances (Ansoff, 1965; Kotler, 2000), outweighed the counter perspective that the ability to delay or defer irreversible investment in such equity alliances under high exogenous uncertainty can produce managerial flexibility (Leiblein, 2003; McDonald & Siegel, 1986).

Chapter 7 – Conclusions and Future Work

7.1. Introduction

This chapter commences by presenting conclusions related to Phase One's investigation of the impact of IPRs legislation for publicly financed R&D, within the context of the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, on research alliances. This is followed by conclusions related to Phase Two's examination of the impact of several internal and external uncertainty factors on the governance mode decision making for publicly financed research alliances, based on the modified VMG model presented in Section 2.2.3.1 (Pateli, 2009). Next, future research areas related to the impact of IPRs legislation for publicly financed R&D on research alliances are detailed. Lastly, future research areas within the domain of governance mode decision making for publicly financed research alliances are presented.

7.2. Conclusions

This study consisted of two distinct research phases, with the overall goal of developing a decision making model that would enable strategists at publicly financed R&D organisations to analyse and predict governance mode decisions, as well as select optimal governance mode structures for research alliances (ranging from quasi-market structures, such as once-off contracts, to quasi-hierarchy structures, such as research joint ventures) in order to maximise their perceived value. The first phase of the study aimed to qualitatively identify impact domains within South Africa's new Bayh-Dole-like IPRs legislative framework, consisting of the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, which could potentially influence research alliances with publicly financed R&D organisations. This was then followed by a quantitative second phase that attempted to verify the validity of a modified VMG model, adapted from Pateli's original VMG model (Pateli, 2009) by including the three highest ranked impact domains identified during Phase One as formative indicators for the additional perceived IPRs regime strength external uncertainty factor. The following subsections present several important conclusions drawn from Phase One's investigation into the impact of IPRs legislation for publicly financed R&D on research alliances, as well as Phase Two's exploration of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) as governance mode decision making tool for such alliances.

7.2.1. Impact of IPRs Legislation for Publicly Financed R&D on Research Alliances

During Phase One of the study, which attempted to identify and rank impact domains within the South African legislative framework for IPRs from publicly financed R&D, data was collected via a qualitative online survey amongst CAMs at the South African CSIR. This was followed by a data processing methodology consisting of Theme Extraction, Constant Comparative Method analysis using the eight business impact domains identified by Baloyi, *et al.* (2009) in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts as baseline, and a weighted frequency analysis.

Phase One demonstrated (see Section 6.2.1) that seven of the eight original business impact domains identified by Baloyi, *et al.* (2009) as areas in the new legislative framework that could influence operations, infrastructure and resources at the CSIR in general (see Section 2.3.4.2), were regard as potential impact domains that could either positively or negatively impact research alliances with publicly financed R&D organisations. A further six additional impact domains that were not previously identified by Baloyi, *et al.* (2009), were also discovered. The 13 potential impact domains identified during Phase One were then ranked in terms of their relative severity levels using a weighted frequency analysis. Based on the comprehensive discussion presented in Section 6.2, Table 24 summarises the ranked list of impact domains identified in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts. Also shown in this table is the speculated nature of the influences, and their respective drivers, that each of these impact domains could have on research alliances' preference to choose quasi-hierarchy governance modes.

Table 24: Summary of the main findings of Phase One

Impact Domain (with Ranking)	Nature of the Potential Influence on the Preference for Quasi-Hierarchies	Driver(s) of the Expected Influence
Choice of IPRs Ownership (Ranked 1st)	Positive	TCE
	Negative	ROA
State Walk-in Rights on IP not Declared (Ranked 1st):	Positive	ROA
	Negative	ROA
Benefit Sharing Policies (Ranked 2nd)	Positive	RBV
Requirement to Register IP in the OpenSource Software Community (Ranked 3rd)	Negative	TCE and ROA
Offshore IP Registration Process (Ranked 4th)	Negative	TCE
Requirement for Non-exclusivity in IP Transactions (Ranked 5th)	Negative	TCE and ROA
Preference in Commercialisation Rights to SMEs and	Negative	ROA

BBBEE Firms (Ranked 5th)	Positive	RBV
IP Detection Process (Ranked 6th)	Positive	TCE
	Negative	TCE
Government Reporting Process (Ranked 6th)	Negative	TCE
Government Reaction Time (Ranked 7th)	Negative	TCE
IP Declaration Process (Ranked 8th)	Negative	TCE and ROA
Structural and Resource Requirements (Ranked 9th)	Negative	TCE and ROA
Unclear Guidelines for the TIA Funding of Innovations (Ranked 9th)	Negative	RBV

From Table 24 it is clear that two impact domains were identified that are seemingly unique to the South African context, namely the 5th ranked impact domain related to the requirement to give preference in commercialisation rights to SMEs and BBBEE firms, as well the 9th ranked impact domain addressing issues related to the guidelines to obtain TIA funding for innovations. Hence, one can conclude that the remaining impact domains could also influence the governance decision making for research alliances with publicly financed R&D organisations in other emerging countries that have implemented Bayh-Dole-like legislation, such as India, Brazil and China (see Section 2.3.3.2).

Table 24 demonstrates that the expected impact that the identified domains will have on research alliances' preference for quasi-hierarchies is primarily rooted in TCE's cost savings perspective (see Section 2.2.2.2). This TCE driver is followed by ROA's managerial flexibility perspective (see Section 2.2.2.4), with RBV's shared resource leveraging perspective (see Section 2.2.2.3) acting is the least significant driver. Hence, it can be concluded that the additional administrative and operational costs resulting from, for example, the creation and policing of complex contractual agreements for research alliances with publicly financed R&D organisations are the primary disincentives for the selection of quasi-hierarchy governance modes for such alliances that operate within Bayh-Dole-like IPRs legislative regimes.

7.2.2. Governance Mode Decision Making for Publicly Financed Research Alliances

Phase Two of the study was quantitative in nature, as it attempted to verify the validly of the modified VMG model (Pateli, 2009)(see Section 2.2.3.1) depicted in Figure 3 as a governance mode decision making analysis and prediction tool for research alliances with South African publicly financed R&D organisations. This modified VMG model, which embody cost savings (via the TCE perspective), resource sharing (via the RBV perspective) and managerial flexibility (via the ROA perspective) drivers, was created by adapting Pateli's (2009) original VMG model to include

the Perceived IPRs Regime Strength as an external uncertainty factor, with formative indicators consisting of the three highest ranked impact domains identified in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts during Phase One. A quantitative online survey (see Appendix E), distributed amongst current and potential research alliance partners of the CSIR, was used as data collection tool. The captured data was then analysed by applying PLS regression SEM to the path diagram depicted in Figure 4. The path coefficients determined through the PLS regression SEM of the modified VMG model were the used in order to evaluate the research propositions listed under Research Objective 2 (see Section 5.3.6).

Phase Two revealed that three of the uncertainty factors included in the original VMG model proposed by Pateli (2009) did not significantly influence the governance mode preference for research alliances with South African publicly financed R&D organisations. Table 25 indicates that the Phase Two results rejected the relationships between the preferred governance mode and the Firm Size, Strategic Orientation and Partner Compatibility constructs. Furthermore, the relationships with the remaining uncertainty factors, which were not rejected, all exhibited mediation effects (see Section 4.7.2.5) via the EAV construct.

Table 25: Summary of the main findings of Phase Two

Uncertainty Factor (Type of Factor)	Judgement on the Relationship with the Preferred Alliance Governance Mode	Driver(s) for the Judgement
Firm Size (Internal)	Rejected	ROA and RBV
Competitive Position (Internal)	Not Rejected, Fully Mediated by EAV	ROA and RBV
Strategic Orientation (Internal)	Rejected	ROA
Partner Compatibility (Internal)	Rejected	ROA
Competitive Relationship (External)	Not Rejected, Partial Mediation by EAV	ROA, RBV, TCE
Alliance History (Internal)	Not Rejected, Partial Mediation by EAV	ROA
Perceived IPRs Regime Strength (External)	Not Rejected, Partial Mediation by EAV	ROA and RBV

Also included in Table 25 are the suggested drivers (TCE, RBV or ROA) behind the findings related to the relationships between the uncertainty factors and the preferred alliance governance mode (extracted from the detailed discussion in Section 6.3). Corroborating the findings of Pateli (2009) for the Greek wireless service provider industry, Phase Two of this study revealed that the popular TCE perspective was not capable explaining many of the findings related to the hypothesised relationships between uncertainty factors and the governance mode preference for research alliances that operate within Bayh-Dole-like legislation. The findings of five of the seven proposed relationships could, in part, be explained using argumentation based on ROA

perspectives. It can therefore be concluded that there is validity in Pateli's (2009) claim that many theoretical models for the governance mode decision making of alliances, such as the models by Parkhe (1993) and Leiblein (2003), not only have an over reliance on opportunism-based TCE perspectives, but completely neglect the value-related aspects of the alliance, embodied by ROA perspectives. In general, the following interplay between the TCE, RBV and ROA drivers were observed from the Phase Two findings for the relationships between uncertainty factors and the preferred alliance governance mode:

- Whenever the TCE perspective (see Section 2.2.2.2) promoted a decision to create a quasi-hierarchy research alliance in order to save costs, this decision was countered by the ROA perspective (see Section 2.2.2.4) that costs could be saved in the long run through the option to defer investment in such an alliance.
- Whenever the RBV perspective (see Section 2.2.2.3) promoted a decision to create a quasi-hierarchy research alliance in order to leverage shared resources, this decision was supported by the ROA perspective (see Section 2.2.2.4) that such an alliance could create an option for growth.

The Perceived IPRs Regime Strength external uncertainty factor that was added to Pateli's (2009) original VMG model during Phase Two (see Section 2.2.3.3), proved to be a significant predictor for the preferred alliance governance mode of research alliances that operate within Bayh-Dole-like IPRs regimes (see Section 5.3.6.7). Furthermore, it was conclusively shown in Section 5.3.6.7 that the relationship that this external uncertainty factor has with the preference for quasi-hierarchies is partially mediated by the EAV. The three highest ranked impact domains indentified in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts during Phase One (consisting of the choice of IPRs ownership, state walk-in rights on undeclared IP and benefit-sharing policies), proved to be adequate formative indicators for the Perceived IPRs Regime Strength construct. A detailed investigation of the data capture during Phase Two revealed that each of these three formative indicators contributed positively to the perceived IPRs regime strength. Thus, based on the expected influence that each of these impact domains could exert on the preference for quasi-hierarchy research alliances (as is detailed in Table 24), one can conclude that the respondents of Phase Two perceived these impact domains as positive influences.

7.3. Future Work

The following subsections present potential research topics related to the impact of IPRs legislation for publicly financed R&D on research alliances, as well as governance mode decision making for research alliances.

7.3.1. Impact of IPRs Legislation for Publicly Financed R&D on Research Alliances

During Phase One's qualitative investigation into domains within the South African legislative framework for IPRs from publicly financed R&D that could potentially impact research alliances, the following areas for future research were identified:

- The study considered only inter-firm research alliances' impacted by the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, which includes both private-public and public-public R&D alliances. However, responses to Phase One's online survey indicated that an additional concern exists amongst CSIR CAMs related to the impact that this legislation could have on intra-firm research alliances amongst different operational units. Hence, the need exists to investigate the potential impact of the legislative framework on alliances between diverse operational units. For example, within the context of the CSIR one could consider the impact on alliances that exist between the Meraka Institute, which focuses on developing OpenSource software, and Biosciences, which operates by generating and licensing IP within the field of biotechnology.
- The weighted frequency analysis of the data collected from CSIR CAMs during Phase One of the study produced a severity ranking (see Table 8) for the impact domains identified in the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts which is aggregated across the industries covered by the various competency areas and operational units of the CSIR. Comparing the responses from CAMs operating in these various industry sectors showed that the severities of impact domains are dependent on the respondent's industry. As such, future research could consider ranking the severity levels of impact domains on a per industry sector basis, prior to including the highest ranked impact domains as formative indicators for the perceived IPRs regime strength (Oxley, 1999) in the modified VMG model (Pateli, 2009) (see Section 2.2.3.1).
- The belief that Bay-Dole-like legislation will grow national wealth in emerging countries through increased IPR registration and subsequent commercialisation of publicly financed R&D remains untested (So, *et al.*, 2008). As such, a future quantitative study that empirically measures the increase in national wealth due to such legislation is required within the context of the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts.
- As high technology entrepreneurial ventures frequently employ the R&D services of publicly financed R&D organisations, such as research institutes and universities, a study on the impact of Bayh-Dole-like legislation on the entrepreneurial activity of such ventures is required. For example, one such study could investigate the South African IPRPFRD

(Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts' impact on the entrepreneurial activity present at the South African Innovation Hub.

- From Table 5 it is clear that Phase One of the study failed to explicitly identify those impact domains within the South African IPRPFRD and TIA Acts which could influence research alliances with publicly financed R&D organisations that focus on the biotechnology and consulting services industry sectors. Since research alliances within these industry sectors will undoubtedly be severely impacted by the new legislative framework, future studies that replicate the methodology of Phase One of this study needs to be focussed at these industry sectors.

7.3.2. Governance Mode Decision Making for Publicly Financed Research Alliances

During Phase Two's quantitative examination of the impact of several internal and external uncertainty factors on the governance mode decision making for publicly financed research alliances, the following areas for future research were identified:

- The modified VMG model (Pateli, 2009) (see Section 2.2.3.1) presented in the study (see Section 2.2.3) considered only the direct mediating effects of the EAV construct on the relationships between the uncertainty factors and the Preferred Alliance Governance Mode construct. Hence, future studies could also investigate the indirect mediating effects using, for example, Sobel's (1982) ACIIESE to test for the significance of such effects.
- Future research related to the SEM of the impact of external and internal uncertainty factors on governance mode decision making for research alliances, using models such as the modified VMG model (Pateli, 2009) (see Section 2.2.3.1) described in Section 2.2.2.4, could also investigate the impact of other pertinent external uncertainty factors, such as the rate of technology change and the level of procedural difficulty in creating and registering quasi-hierarchy legal entities. Internal factors that could be considered in future studies include the rate of technology transfer between alliance partners, as well as the reputation (or standing) of the alliance partners within the larger research community. Pursuit of this suggested research area is further justified by the weak R^2 obtained for the Preferred Alliance Governance Mode construct in the study's modified VMG model (Pateli, 2009) (see Section 2.2.3.1), which is proof that additional uncertainty factors specifically tailored to research alliances need to be considered.
- Oxley (199) showed that IPRs regime mismatches between international research alliance partners have a measureable impact on alliance governance mode decision making. As such, future research studies considering the VMG modelling (Pateli, 2009) of governance

mode decision making for publicly financed R&D alliances could consider the level of IPRs regime mismatch as an external uncertainty when international partners are involved.

- Phase Two of the study evaluated the modified VMG model (Pateli, 2009) shown in Figure 3 using a sample consisting of current and potential research alliance partners of the CSIR. It did, however, not consider the specific roles of the individuals who represented these current and potential research alliance partners by completing Phase Two's online survey (see Appendix E). Since these roles ranged from strategists to researchers, responses to items in Phase Two's online survey will undoubted have varied as a function of their respective focus areas. Hence, future studies could consider role related nuances during the SEM of the modified VMG model (Pateli, 2009) (see Section 2.2.3.1).
- Phase One's three highest ranked impact domains within the IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008b) Acts, were used as formative indicators for the Perceived IPRs Regime Strength construct included in the modified VMG model (Pateli, 2009) of Figure 3. Using these impact domains in a formative mode was based on the assumption that each reflects only a portion of the overall perceived strength of the IPRs regime (see Section 2.2.3.3). However, future studies could challenge this assumption by employing these impact domains as reflective indicators.

"We cannot enter into informed alliances until we are acquainted with the designs of our neighbours and the plans of our adversaries. When entering enemy territory, in order to lead your army, you must know the face of the country - its mountains and forests, its pitfalls and precipices, its marshes and swamps. Without local guides, you are unable to turn to your account the natural advantages to be obtained from the land. Without local guides, your enemy employs the land as a weapon against you."
(Source: "The Art of War" by San Tzu, 6th century before Christ)

Appendix A - Consistency Matrix

The following table presents the study's consistency matrix. The research questions and propositions listed here are described in detail in Section 3.3. Furthermore, the data collection tools referred to in this table are presented in Appendix B (containing the questionnaire for Phase One) and Appendix E (containing the questionnaire for Phase Two).

Table 26: Consistency matrix

Research Questions and Propositions	Literature Reviewed	Data Collection Tools	Analysis Methods
Research Question 1.1	Baloyi, *et al.* (2009); Republic of South Africa (2008a); Republic of South Africa (2008b); DST (2006)	Phase One Questionnaire: Question B.1	Narrative Inquiry; Constant Comparative Method; Triangulation
Research Question 1.2	Baloyi, *et al.* (2009); Republic of South Africa (2008a); Republic of South Africa (2008b); DST (2006)	Phase One Questionnaire: Question B.2	Frequency analysis; Triangulation
Research Proposition H2.1(a)	Pateli (2009); Vinzi, *et al.* (2010); European Commission (2003); Leiblein & Miller (2003); Osborn & Baughn (1990); Tether (2002)	Phase Two Questionnaire: Parts B and C	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.1(b)	Pateli (2009); Vinzi, *et al.* (2010); European Commission (2003); Leiblein & Miller (2003); Osborn & Baughn (1990); Tether (2002); Baron & Kenny (1986)	Phase Two Questionnaire: Parts B, C and I	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.2(a)	Pateli (2009); Vinzi, *et al.* (2010); Day & Wensley (1988); Das & Teng (2000)	Phase Two Questionnaire: Parts C and E	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.2(b)	Pateli (2009); Vinzi, *et al.* (2010); Day & Wensley (1988); Das & Teng (2000); Baron & Kenny (1986)	Phase Two Questionnaire: Parts C, E and I	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.3(a)	Pateli (2009); Vinzi, *et al.* (2010); Ansoff (1965); Kotler (2000);	Phase Two Questionnaire:	SEM; PLS regression; Measurement portion

	Hemphill & Vonortas (2003); Hamel & Prahalad (1994)	Parts C and D	reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.3(b)	Pateli (2009); Vinzi, *et al.* (2010); Ansoff (1965); Kotler (2000); Hemphill & Vonortas (2003); Hamel & Prahalad (1994); Baron & Kenny (1986)	Phase Two Questionnaire: Parts C, D and I	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.4(a)	Pateli (2009); Vinzi, *et al.* (2010); Parkhe (1991); Anderson & Narus (1990); Sarkar, *et al.* (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995)	Phase Two Questionnaire: Parts C and F	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.4(b)	Pateli (2009); Vinzi, *et al.* (2010); Parkhe (1991); Anderson & Narus (1990); Sarkar, *et al.* (2001); Heide & John (1992); Morgan & Hunt (1994); Wilson (1995); Baron & Kenny (1986)	Phase Two Questionnaire: Parts C, F and I	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.5(a)	Pateli (2009); Vinzi, *et al.* (2010); Oxley & Sampson (2004); Hamel, *et al.* (1989); Kogut (1988)	Phase Two Questionnaire: Parts C and G	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.5(b)	Pateli (2009); Vinzi, *et al.* (2010); Oxley & Sampson (2004); Hamel, *et al.* (1989); Kogut (1988); Baron & Kenny (1986)	Phase Two Questionnaire: Parts C, G and I	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.6(a)	Pateli (2009); Vinzi, *et al.* (2010); Parkhe (1993); Gulati (1995); Santoro & McGill (2005)	Phase Two Questionnaire: Parts C and H	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.6(b)	Pateli (2009); Vinzi, *et al.* (2010); Parkhe (1993); Gulati (1995); Santoro & McGill (2005); Baron &	Phase Two Questionnaire: Parts C, H and I	SEM; PLS regression; Test for Direct Mediating Effects

	Kenny (1986)		
Research Proposition H2.7(a)	Pateli (2009); Vinzi, *et al.* (2010); Baloyi, *et al.* (2009); Republic of South Africa (2008a); Republic of South Africa (2008b); Oxley (1999); Hertzfeld, *et al.* (2006); Hertzfeld, *et al.* (2001); So, *et al.* (2008); Kim (2009); Rapp & Rozek (1990); Seyoum (1996); Sherwood (1997)	Phase Two Questionnaire: Part J	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests
Research Proposition H2.7(b)	Pateli (2009); Vinzi, *et al.* (2010); Baloyi, *et al.* (2009); Republic of South Africa (2008a); Republic of South Africa (2008b); Oxley (1999); Hertzfeld, *et al.* (2006); Hertzfeld, *et al.* (2001); So, *et al.* (2008) ; Kim (2009); Rapp & Rozek (1990); Seyoum (1996); Sherwood (1997); Baron & Kenny (1986)	Phase Two Questionnaire: Part J	SEM; PLS regression; Test for Direct Mediating Effects
Research Proposition H2.8	Pateli (2009); Vinzi, *et al.* (2010); Leiblein (2003); McDonald & Siegel (1986)	Phase Two Questionnaire: Parts C and I	SEM; PLS regression; Measurement portion reliability and validity tests; Structural portion reliability and validity tests

Appendix B - Questionnaire for Phase One

B.1. Overview

The questionnaire presented in this appendix was used as base for the online survey sent to the census of CSIR CAMs during Phase One of this research project in order to address Research Objective 1. As this phase of the research was qualitative and exploratory in nature, all questions in this questionnaire were open ended (Zikmund, 2003).

B.2. Survey Invitation Email

The following text represents the invitation email that was sent to CSIR CAMs, requesting their participation in this phase of the study. Note that this email statement makes reference to the survey companion website (discussed in Appendix D), which presented short overviews of the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008a) Acts:

Dear CAM,

As part of my Master of Business Administration (MBA) studies with the Gordon Institute of Business Science (GIBS), I am doing research on the new South African legislative framework for IPRs from publicly financed research and development, which impacts institutions such as the CSIR. More specifically, I am investigating the impact of this new legislation on governance mode decision making for research alliances and partnerships (in other words, deciding between various alliance/partnership structures, such as once-off contracts, recurring contracts, relational contracts or equity partnerships).

This email is an invitation to participate in a survey that has as goal to identify which impact domains within the new legislative framework (consisting of the IPRPFRD and TIA Acts) could potential influence governance mode decision making for each competency area's clients/partners.

If you are willing to assist me with this study, please proceed as follows:

1. *Visit the survey's companion website for information on the IPRPFRD and TIA Acts. This site is available at: https://sites.google.com/site/mbasurveycompanionsite/.*
2. *Complete the online survey available at:*

https://spreadsheets.google.com/viewform?formkey=dGxCODZPNmVqQUtaTG5CaDNPc3QxMUE6MQ.

Please note the following:

- *Participation in this survey is completely voluntary.*
- *Reviewing the information on the companion website and completing the survey should not take you more than 30 minutes.*
- *Your contact details have been obtained via the assistance of the CSIR's Human Resources division and will not be distributed.*
- *All information captured via this survey will be kept confidential and the reporting of results will not reveal any personal details of respondents.*

Thank you for investing time in reading this email. Should you have any questions, please contact me using the details given below.

Kind regards,

--

Leon Staphorst
Pr.Eng, B.Eng, M.Eng, SMIEEE, SMSAIEE

Principle Researcher
Radar Applications and Research
CSIR DPSS

Tel: +27 12 841 3236
Fax: +27 12 841 2455
Cell: +27 82 857 1135
Email: lstaphorst@csir.co.za

B.3. Informed Consent Statement

The following text represents the consent statement that was included with Phase One's Google Forms online survey containing the questions of Table 27. This consent statement also makes reference to the survey companion website (discussed in Appendix D), which presented short overviews of the South African IPRPFRD (Republic of South Africa, 2008a) and TIA (Republic of South Africa, 2008a) Acts:

Dear CAM,

As part of my MBA studies with GIBS, I am doing research on the new South African legislative framework for Intellectual Property Rights from publicly financed research and development, which impacts institutions such as the CSIR. More specifically, I am investigating the impact of this new legislation on governance mode decision making for research alliances and partnerships (in other words, deciding between various alliance/partnership structures, such as once-off contracts, recurring contracts, relational contracts or equity partnerships). To that end, you have been asked in the survey invitation email to first review a succinct overview of the recently enacted South African IPRPFRD and TIA Acts, which is available from the survey companion website located at:

https://sites.google.com/site/mbasurveycompanionsite/

Your responses with regards to the potential impact that these Acts will have on your research alliance(s) with partners/clients outside the CSIR will greatly assist me in understanding the overall impact of these Acts on research alliance governance mode decisions in general. This survey should not take more than 30 minutes of your time to complete. Your participation is voluntary and you can withdraw at any time without penalty. Please note that all data will be kept confidential and results will be reported in aggregated form without any detailed reference to the respondents of this survey. By completing this survey, you indicate that you voluntarily participate in this research. If you have any concerns, please contact me or my research supervisor using the details provided below.

Researcher Name: Leon Staphorst
Email: lstaphorst@csir.co.za
Phone: +27 82 857 1135

Research Supervisor Name: Mike Holland
Email: mholland@pricemetrics.co.za
Phone: +27 82 495 1283

Please note that this survey closes on 17 September 2010.

B.4. Questionnaire Questions for Phase One

Table 27 presents the structure, open-ended questions and measurement variable names for the online Google Forms survey distributed as part of Phase One of the study. This survey consisted of two distinct parts.

Table 27: Questionnaire for Phase One of the study

Survey Section	Survey Questions and Statements	Variable Name
Part A: Demographics ***Help text supplied for this part:*** Please note that this information is captured in order to perform industry sectorised analyses and will not be reported in the final results	A.1 Please supply the name of the Competency Area that you manage *(Open-ended question)* A.2 Within which CSIR operational unit does your competency area reside? *(Open-ended question)*	DEMOG1 DEMOG2
Part B: Impact of the IPRPFRD and TIA Acts on governance mode decision making for research alliances at the CSIR ***Help text supplied for this part:*** Responses in this part of the survey are not limited in length	B.1 Please describe which domains within the new IPRPFRD and TIA Acts do you foresee will impact governance mode decision making for your existing and future research alliances and partnerships (with reference to the sections in the IPRPFRD and TIA Acts, as discussed in the information overview brochures available from the companion website) *(Open-ended question)* ***Help text supplied for this question:*** Governance mode decision making refers to decisions related to the optimal structure of the alliances/partnerships (such as once-off contracts, recurring contracts, relational contracts and equity partnerships) B.2 For the impact domains you have indicated in Question B.1, please detail the extent and severity of the impact you foresee on governance mode decision making for your existing and future research alliances and partnerships *(Open-ended question)*	IMPACT1 IMPACT2

Appendix C - CSIR Operational Units

Table 28 presents the 11 operational units present within the CSIR's organisational structure, with the number of CAMs allocated to competency areas within each operational unit (CSIR, 2010a).

Table 28: CSIR operational units with the numbers of CAMs allocated (CSIR, 2010a)

Operational Unit	Number of CAMs Allocated
Biosciences	3
Built Environment	6
Consulting and Analytical Services	1
Centre for Mining Innovation	1
Defence, Peace, Safety and Security	6
Meraka Institute	4
Modelling and Digital Sciences	1
Material Science and Manufacturing	6
National Laser Centre	2
Natural Resources and the Environment	6
Satellite Application Centre	0

Appendix D - Survey Companion Website

D.1. Overview

In this appendix the contents of the survey companion website, which was made available during Phase One and Phase Two of the study, is presented. This includes the Home Page statement, as well as the information overview brochures created for both the IPRPFRD and TIA Acts. The companion website was made available at: *https://sites.google.com/site/mbasurveycompanionsite/*

D.2. Home Page Statement

The following statement constituted the content of the opening Home Page of the survey companion website, which was made available during Phase One and Phase Two of the study:

This website is a survey companion site to support the research being performed by Leon Staphorst on the impact of the new South African legislative framework for IPRs from publicly financed research and development (consisting of the recently enacted IPRPFRD and TIA Acts). This research focuses on the impact of these Acts on governance mode decision making for research alliances and partnerships (in other words, deciding between various alliance/partnership structures, such as once-off contracts, recurring contracts, relational contracts or equity partnerships). By navigating the sidebar on the left, survey respondents will be able to access the following:

- *Information brochures giving succinct overviews of the domains covered within each of these Acts.*
- *Copies of the published Acts.*

For any questions or suggestions, please contact Leon Staphorst at mailto:leon.staphorst@gmail.com.

D.3. IPRPFRD Act Overview Information Brochure

Below the survey companion website's IPRPFRD Act information overview brochure, created in order to summarise the domains covered within this Act, is given. Note that great care was taken during the creation of this brochure to objectively reproduce the essence of the different domains within the Act, without including any subjective statements that could lead to interviewer bias during the surveys of both phases of the research.

Information Overview Brochure:

IPRPFRD Act (Act No. 51 of 2008)

Source:

Republic of South Africa (2008). Intellectual Property Rights from Publicly Financed Research and Development Act. Available online from http://www.info.gov.za/view/DownloadFileAction?id=94343.

Goals of the IPRPFRD Act:

- *To provide for more effective utilisation of IP emanating from publicly financed R&D.*
- *To establish NIPMO and the Intellectual Property Fund.*
- *To provide for the establishment of TTOs at institutions.*

Domains covered by the Act (excluding purely administrative sections related to, for example, the definition of terms, creation of regulations and Act title):

Section 4: Choice of IPRs ownership

Here the IPRPFRD Act reiterates that IP generated by publicly financed R&D institutions are owned by these institutions. However, if institutions plan not to obtain statutory protection for their generated IP, this choice needs to be declared to NIPMO and ownership thereof will then pass to NIPMO. If private sector entities funded the research in part, these entities should be given the option to take ownership of the IP within the stipulations of Section 10 of the IPRPFRD Act.

Section 5: Management obligations and disclosure duties

This section details the requirements for publicly financed institutions to put in place systems/processes to detect new IP, declare IP to NIPMO and report to NIPMO on all matters pertaining to the IPRPFRD Act (such as reasons why certain IP was not commercially pursued).

Section 6: Establishment of TTOs at institutions

Here the requirement to establish TTOs at publicly financed R&D institutions is detailed. It elaborates on the goal of these offices in detecting IP and reporting to NIPMO.

Section 7: Functions of TTOs

The functions of TTOs are described here, including the creation of processes and establishing of resources to detect and declare IP. It also elaborates on its functions to manage IP related transactions, the obligation to pursue statutory protection of IP in order to realise its commercial potential, and its responsibility to liaise with NIPMO.

Section 8: Establishment of NIPMO

This section states that, as part of the IPRPFRD Act, NIPMO is henceforth established and that the functions thereof be defined by the South African Minister of Science and Technology.

Section 9: Functions of NIPMO

Here the IPRPFRD Act describes the primary function of NIPMO, which entails the promotion of the goals of the IPRPFRD Act. Furthermore, it describes NIPMO's obligation to ensure that it has the capacity to deal with all IP referred to it according to Section 4 of the IPRPFRD Act.

Section 10: Rights of IP creators in institutions to benefit-sharing

The obligatory granting of a portion of the revenue that accrues from IP to the creators of the IP is covered by this section of the IPRPFRD Act. It also defines specific benefit-sharing proportioning formulae that need to be adhered to.

Section 11: Conditions for IP transactions

This section of the IPRPFRD Act defines certain guidelines that need to be adhered to by institutions holding IP when executing commercial transactions related to this IP. For example, in transactions where IP is licensed to entities in order to pursue commercialisation, preference needs to be given to non-exclusivity deals with South African SMEs, as well as BBBEE accredited firms. If IP holders are not able to license the IP within this framework, evidence to this effect needs to be submitted to NIPMO for approval. All IP transactions are subject to the condition that unsuccessful commercialisation will entitle the State to exercise the rights specified in Section 14 of the IPRPFRD Act.

Section 12: Restrictions on offshore IP transactions

Here the requirements related to IP transactions with non-South African firms are detailed. For example, IP holders that intend to pursue offshore transactions need to declare these transactions to NIPMO. Furthermore, IP holders wishing to undertake an IP transaction offshore in the form of an assignment or exclusive licence must satisfy NIPMO that there is insufficient capacity in South Africa to develop or commercialise the IP locally, as well as the benefit to South Africa that such an offshore transaction will have.

Section 13: Intellectual Property Fund

This section of the IPRPFRD Act establishes an Intellectual Property Fund, to be managed by NIPMO. An institution may recover some of the costs incurred in obtaining statutory protection for IP from this fund.

Section 14: Acquisition of intellectual property rights by State

According to the Act, NIPMO must conduct reviews of non-commercialised IP in consultation with the IP holders. If these reviews reveal that the IP can be commercialised, NIPMO may require that the IP be licensed to any person on reasonable terms. Lastly, if an IP holder fails to disclose this IP to NIPMO, NIPMO may demand the assignment of rights to the State.

Section 15: Co-operation between private entities or organisations and institutions

This section of the Act dictates that a private entity may become an exclusive licensee of IP emanating from publicly financed R&D, if such a private entity has the resources to manage and commercialise the IP in a manner that benefits South Africa. Furthermore, such a private entity may become co-owner of the IP if it has contributed background IP, there was joint IP creatorship, arrangements for benefit-sharing have been established, and an agreement is concluded for the commercialisation of the IP. Any R&D undertaken at a public institution and funded by a private entity on a full cost basis (defined as all applicable direct and indirect costs), shall not be subjected to the provisions of this Act.

Section 16: Confidentiality by NIPMO and TTOs

Employees of NIPMO and TTOs may not disclose any information related to matters covered by this Act, which have come to their attention. It also discusses exclusions to this stipulation, such as a court order.

D.4. TIA Act Overview Information Brochure

Below the survey companion website's TIA Act information overview brochure, created in order to summarise the domains covered within this Act, is given. Here also great care was taken during the creation of the brochure to objectively reproduce the essence of the different domains within the Act, without including any subjective statements that could lead to interviewer bias during the surveys of both phases of the research.

Information Overview Brochure:

TIA Act (Act No. 26 of 2008)

Source:

Republic of South Africa (2008). Technology Innovation Agency Act. Available online from http://www.info.gov.za/view/DownloadFileAction?id=92827

Goals of the IPRPFRD Act:

- *Establish the TIA to provide for the promotion of the development and exploitation in the public interest of discoveries, inventions, innovations and improvements.*
- *To define the TIA's powers and duties, as well as the manner in which it must be managed and controlled.*

Domains covered by the Act (excluding purely administrative sections related to, for example, the definition of terms, board composition, CEO appointment, remuneration of board members, meetings of the board, employees of the TIA and the Act title):

Section 2: Establishment of Agency

This section of the Act establishes the TIA as a juristic person, subject to the Public Finance Management Act, 1999 (Act No. 1 of 1999).

Section 3: Object of Agency

Here the objective of the TIA is defined as supporting the state in stimulating and intensifying technological innovation in order to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations.

Section 4: Powers and duties of Agency

This section of the Act states that the TIA's authorities include the following (for brevity, not all authorities noted in the Act are listed here):

- *Provide financial and any other assistance to any person (for the purpose of enabling that person) to develop any technological innovation.*
- *Establish a company (on its own or in collaboration with any juristic person) for the purpose of developing or exploiting any technological innovation.*
- *Acquire any interest in any juristic person undertaking the development or exploitation of any technological innovation supported by the TIA.*
- *Merge the management of different technological innovation, incubation and diffusion initiatives in South Africa.*
- *Develop national capacity and infrastructure to protect and exploit IP derived from R&D it has financed.*
- *Acquire rights in (or to) any technological innovation supported by the TIA from any juristic person (or assign any juristic person any right in (or to) such technological innovation).*

- *Apply for patents, or the revocation thereof, and institute any legal action in respect of any infringement of IP rights.*
- *Where the TIA enters into a transaction with a juristic person it may elect to be represented in the board of such juristic person.*
- *Where a right in (or to) any technological innovation has been acquired by the TIA, or assigned by the TIA to any juristic person, the TIA or such juristic person must be regarded as the assignee of the discoverer or the inventor of the technological innovation.*

Section 18: Transitional provisions and savings

In this section of the TIA Act the South African Inventions Development Corporation, established by section 2 of the Inventions Development Act, 1962 (Act No. 31 of 1962), is dissolved. This impacts the CSIR, since the TIA Act require that all the rights, assets, obligations and liabilities of this corporation vest in the CSIR, and that all personnel of the corporation be transferred to the CSIR in accordance with section 197 of the Labour Relations Act, 1995 (Act No. 66 of 1995).

Appendix E - Questionnaire for Phase Two

E.1. Overview

This appendix presents the informed consent statement and questionnaire which was made available online during Phase Two of this research project. The questionnaire presented here was based heavily on Pateli's questionnaire (Pateli, 2009), used during the evaluation of the original VMG model for technology-based alliances within the Greek wireless service provider industry. The three formative measurement indicators for the perceived IPRs regime strength construct, identified during Phase One's investigation into the South African IPRs legislative framework for publicly financed R&D, have been amended to Pateli's original questionnaire (Pateli, 2009).

E.2. Survey Invitation Email

The following text represents the invitation email that was sent to current and potential CSIR partners and clients, requesting their participation in this phase of the study:

Dear Business Professional,

As part of my MBA studies with GIBS, I am doing research on factors that drive decision making during the creation of alliances with publicly financed R&D organisations, such as the South African Agricultural Research Council (ARC) and the CSIR. More specifically, I am interested in finding the relationship between such driving factors and the preference for specific research alliance structures, ranging from once-off contracts to full equity joint ventures. This decision making process is called "Governance Mode Decision Making" in academic literature.

As a past, current or potential partner/client/consultant of such publicly financed R&D organisations, you are kindly requested to partake in an online survey which will assist us in understanding the impact that several well-known driving factors have on governance mode decision making for alliances/partnerships/interworking with these organisations. This survey is available online at the following link:

https://spreadsheets.google.com/viewform?formkey=dHBuNVNRN0NTQ2NfMk1OZHdEeDExNEE6MQ

Please note the following:

- *Participation in this survey is completely voluntary and you can withdraw at any time without penalty.*
- *Completing the survey should not take you more than 20 minutes.*
- *Your contact details will not be distributed.*
- *All information captured via this survey will be kept confidential and the reporting of results will not reveal any personal details of respondents.*
- *By completing this survey, you indicate that you voluntarily participate in this research.*
- *The closing date for the survey is 22 October 2010.*

Thank you for investing time in reading this email. Should you have any questions, please contact me using the details given below.

Kind regards,
--
Leon Staphorst
Pr.Eng, B.Eng, M.Eng, SMIEEE, SMSAIEE

Fax: +27 86 505 0473
Cell: +27 82 857 1135
Email: leon.staphorst@gmail.com

E.3. Informed Consent Statement

The following text represents the consent statement that was included with the Google Forms online survey containing the questions in Table 29:

Dear Business Professional,

As part of my MBA studies with GIBS, I am doing research on factors that drive decision making during the creation of alliances with publicly financed R&D organisations, such as the South African ARC and the CSIR. More specifically, I am interested in finding the relationship between such driving factors and the preference for specific research alliance structures, ranging from once-off contracts to full equity joint ventures. This decision making process is called "Governance Mode Decision Making" in academic literature. As a past, current or potential partner / client / consultant of such publicly financed R&D organisations, your participation in this survey will greatly assist me

in understanding the impact that several well-known driving factors have on governance mode decision making for alliances / partnerships / interworking with these organisations.

This survey should not take more than 20 minutes of your time. Your participation is voluntary and you can withdraw at any time without penalty. Please note that all data will be kept confidential. By completing this survey, you indicate that you voluntarily participate in this research. If you have any concerns, please contact me or my research supervisor using the details provided below.

Researcher name: Leon Staphorst
Email: leon.staphorst@gmail.com
Phone: +27 82 857 1135

Research Supervisor Name: Mike Holland
Email: mholland@pricemetrics.co.za
Phone: +27 82 495 1283

Please note that this survey closes on 22 October 2010.

E.4. Questionnaire Questions for Phase Two

Table 29 presents the structure, questions, scaling and measurement variable names for the online Google Forms survey distributed as part of Phase Two of the study. Most of the survey questions, with their associated scales, were based on the survey used by Pateli (2009). Part B through Part I measured the indicators for the constructs defined in Table 1, while Part J measured indicators for the perceived IPRs regime strength, created from Phase One's identified impact domains related to the South African IPRs legislative framework for publicly financed R&D.

Table 29: Questionnaire for Phase Two of the study (adapted from Pateli (2009))

Survey Section	Survey Questions and Statements	Variable Name
Part A: Demographics ***Help text supplied for this part:*** Please note that this information is captured in order to perform industry sectorised analyses and	A.1 Please supply the name of your firm *(Open-ended question)* A.2 Please describe your firm's primary industry in which it operates *(Open-ended question)*	DEMOG1 DEMOG2

will not be reported in the final results.		
Part B: Firm Size ***Help text supplied for this part:*** This part of the survey captures information regarding your firm's size	B.1 Indicate your firm's size in number of employees *(Options: 1 = 0-9, 2 = 10-49, 3 = 50-249, 4 = 250 + employees)*	SIZE1
Part C: Preferred Alliance Governance Mode ***Help text supplied for this part:*** This part of the survey captures information regarding your preferred research alliance structure with South African publicly financed R&D organisations	C.1 Select from the list the type of alliance that your firm prefers based on the level of desired interdependence with South African publicly financed R&D organisations, such as the CSIR *(Options: 1 = Once-off contract, 2 = Recurrent contract, 3 = Relational contract, 4 = Minority investment, 5 = Joint venture)*	GOV1
Part D: Strategic Orientation ***Help text supplied for this part:*** Please rate the following items related to your firm's corporate strategy	D.1 Indicate the degree of importance that the your firm's corporate strategy assigns to the strategic goal of related diversification (i.e. diversifying on existing products/services) *(Scale: 1 = extremely low to null, 7 = extremely high)*	STRAT_OR1
	D.2 Indicate the degree of importance that your firm's corporate strategy assigns to the strategic goal of unrelated diversification (i.e. diversifying on new products/services) *(Scale: 1 = extremely low to null, 7 = extremely high)*	STRAT_OR2
	D.3 Indicate the degree of importance that your firm's corporate strategy assigns to the strategic goal of vertical integration (i.e. creating alliances with suppliers/distributors) *(Scale: 1 = extremely low to null, 7 = extremely high)*	STRAT_OR3
	D.4 Indicate the degree of importance that your firm's corporate strategy assigns to the strategic goal of horizontal integration (i.e. creating alliances with peer firms) *(Scale: 1 = extremely low to null, 7 = extremely high)*	STRAT_OR4

Part E: Competitive Position ***Help text supplied for this part:*** This part of the survey captures information regarding your firm's competitive position, based on its resource, market and performance positions	E.1 Resource Position - Rate your firm's competitive strength in terms of the following resources: E.1.1 Financial resources (e.g. capital, investments) E.1.2 Human resources (e.g. employees' experience, inter-firm contracts) E.1.3 Physical resources (e.g. geographic location, equipment, access to raw materials) E.1.4 Technological resources (e.g. equipment, networks, devices, standards) E.1.5 Organisational resources (e.g. patents, copyrights, registered designs) E.1.6 Tacit know-how (e.g. efficient organisational processes, managers' insight) E.1.7 Market knowledge (e.g. market intelligence, info about your customers) E.1.8 Technological knowledge (e.g. capabilities in technology usage/development) E.1.9 Management systems (e.g. control and coordination systems, strategic planning) *(Scale: 1 = far below the average, 7 = far above the average)*	 RES_POS1 RES_POS2 RES_POS3 RES_POS4 RES_POS5 RES_POS6 RES_POS7 RES_POS8 RES_POS9
	E.2 Market position - Rate your firm's competitive strength in terms of the following market position advantages: E.2.1 Low production costs (choose 4 if not applicable) E.2.2 Time-to-market (choose 4 if not applicable) E.2.3 Product/service quality E.2.4 Low prices E.2.5 Quality of after-sales support (choose 4 if not applicable) E.2.6 Product/service delivery E.2.7 Promotion/advertising (choose 4 if not applicable) E.2.8 Technological superiority of products/services *(Scale: 1 = far below the average, 7 = far above the average)*	 MARK_POS1 MARK_POS2 MARK_POS3 MARK_POS4 MARK_POS5 MARK_POS6 MARK_POS7 MARK_POS8
	E.3 Performance position - Rate your firm's competitive strength in terms of the following performance related advantages: E3.1 Brand name E3.2 Differentiated products/services E3.3 Market share E3.4 Return on assets *(Scale: 1 = far below the average, 7 = far above the average)*	 PERF_POS1 PERF_POS2 PERF_POS3 PERF_POS4
Part F:	F.1 Cultural compatibility - Rate your firm's cultural	

Partner Compatibility ***Help text supplied for this part:*** This part of the survey captures information regarding your firm's compatibility with South African publicly financed R&D organisations, based on culture, operations and resources	compatibility with South African publicly financed R&D organisations, such as the CSIR: F.1.1 Their organisational values and social norms resemble our own F.1.2 Their executives' philosophies/approaches to business dealings are consistent with those of our own executives F.1.3 Their strategic goals and objectives do not hinder ours *(Scale: 1 = strongly disagree, 7 = strongly agree)*	 CULT_COMP1 CULT_COMP2 CULT_COMP3
	F.2 Operational compatibility - Rate your firm's operational compatibility with South African publicly financed R&D organisations, such as the CSIR: F.2.1 The technical capabilities/solutions of these organisations and our firm are compatible with each other F.2.2 The organisational procedures of these organisations and our firm are compatible F.2.3 Employees of these organisations have similar professional or technological skills as our own employees *(Scale: 1 = strongly disagree, 7 = strongly agree)*	 OPER_COMP1 OPER_COMP2 OPER_COMP3
	F.3 Resource complementarity - Rate your firm's resource complementarity with South African publicly financed R&D organisations, such as the CSIR: F.3.1 Both companies need each other's resources to accomplish their strategic goals F.3.2 The resources contributed by both firms are significant for serving the principal purpose of the alliance F.3.3 Resources brought into the alliance by each firm are / will be very valuable for the other firm *(Scale: 1 = strongly disagree, 7 = strongly agree)*	 RES_COMP1 RES_COMP2 RES_COMP3
Part G: Competitive Relationship ***Help text supplied for this part:*** This part of the survey captures information regarding your firm's competitive relationship with publicly financed R&D organisations, such as the CSIR, based on location and market	G.1 Please choose from the list your firm's geographic position relative to that of South African publicly financed R&D organisations, such as the CSIR: *(Options: 1 = Same country, 2 = Same continent, but different country,3 = Different continent)*	LOC_OVER1 (Set to 1 only if option 1 was selected. For all other options it was set to 0)
	G.2 Please choose from the list the market sector best describing the primary space within which your firm operates: 1 = Government funded R&D institutes 2 = Government funded universities performing R&D 3 = Public sector R&D firms 4 = Professional services firms	MARK_OVER1 (Set to 1 only if option 1 was selected. For all other options it was

	5 = Product development firms (e.g. design houses) 6 = Commodity services firms 7 = Manufacturing firms 8 = Other	set to 0)
Part H: Alliance History ***Help text supplied for this part:*** This part of the survey captures information regarding your firm's history with South African publicly financed R&D organisations, such as the CSIR	H.1 Has your firm been engaged with publicly financed R&D organisations in the past, such as the CSIR? *(Options: Yes, No)*	PREV_PAST1
	H.2 If you answered "Yes" in H.1, H.2., estimate how many interworking arrangements your firm has with South African publicly financed R&D organisations	PREV_NUM1
	H.3 If you answered "Yes" in H.1, estimate for how many years your firm has worked with these organisations	PREV_DUR1
	H.4 If you answered "Yes" in H.1, what is the dominant type of alliance governance structure you currently have with these organisations? *(Options: 1 = Once-off contract, 2 = Recurrent contract, 3 = Relational contract, 4 = Minority investment, 5 = Joint venture)*	PREV_GOV1
Part I: Expected Alliance Value ***Help text supplied for this part:*** This part of the survey captures information regarding your expected value of your firm's current or potential future alliance(s) with South African publicly financed R&D organisations, such as the CSIR	I.1 Risk reduction - Indicate the level of your expectations for the benefits from risk reduction that an alliance may incur I.1.1 Share market risk (i.e. production of new or differentiated products/services) I.1.2 Share technological risk (i.e. development of technologically advanced products/services) I.1.3 Increase flexibility to rapid market and technological changes *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	 RISK_RED1 RISK_RED2 RISK_RED3
	I.2 Vertical integration (i.e. integration with suppliers/distributors) - Indicate the level of your expectations for the benefits from vertical integration that an alliance may incur I.2.1 Enable providing of products/services at lower prices I.2.2 Improve the quality of after-sales support (choose 4 if not applicable) I.2.3 Expand service delivery to new channels (choose 4 if not applicable) I.2.4 Benefit from South African publicly financed R&D organisations' strong brand names I.2.5 Reduce time-to-market (choose 4 if not applicable)	 VERT_INT1 VERT_INT2 VERT_INT3 VERT_INT4 VERT_INT5

	(Scale: 1 = extremely low expected, 7 = extremely high expected)	
	I.3 Complementarity - Indicate the level of your expectations for the benefits from complementarity that an alliance may incur I.3.1 Exploit complementary resources I.3.2 Extend products/services range (new products/services) *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	 COMPLEM1 COMPLEM2
	I.4 Learning - Indicate the level of your expectations for the benefits from learning that an alliance may incur I.4.1 Gain access to South African publicly financed R&D organisations' resources I.4.2 Internalise South African publicly financed R&D organisations' capabilities (e.g. R&D capabilities) I.4.3 Deploy new skills and knowledge I.4.4 Improve quality of products/services *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	 LEARN1 LEARN2 LEARN3 LEARN4
	I.5 Co-option (i.e. the creation of a temporary alliance with selected partners, even if they are in competition with your firm) - Indicate the level of your expectations for the benefits from co-option that an alliance may incur I.5.1 Differentiate existing product/services (new features) I.5.2 Deter entry of competitors into the market *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	 CO_OPTION1 CO_OPTION2
	I.6 Economics - Indicate the level of your expectations for the economic benefits that an alliance may incur I.6.1 Economise on the sum of production and transaction costs I.6.2 Increase your firm’s return on assets I.6.3 Increase your firm’s market share *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	 ECONOM1 ECONOM2 ECONOM3
	I.7 Social expansion - Indicate the level of your expectations for the benefits from social expansion that an alliance may incur I.7.1 Increase your knowledge of South African publicly financed R&D organisations and their social network (e.g.	 EXPANSION1

	suppliers) for the formation of new alliances in the future *(Scale: 1 = extremely low expected, 7 = extremely high expected)*	
Part J: Perceived IPRs regime strength	***Help text supplied for this part:*** South African publicly financed R&D organisations, such as the ARC and CSIR, are subject to a new legislative framework for IPR. This framework consists of the new IPRPFRD and TIA Acts. This part of the survey captures information on the impact of certain aspects of these Acts on the overall strength of the new IPRs regime within which such organisations operate. Additional information regarding these Acts are freely available from: https://sites.google.com/site/mbasurveycompanionsite/ J.1 Perceived IPRs regime strength - Please rate the impact that you perceive the following domains in the new legislative framework has on the overall strength of the IPRs regime within which these organisations operate:	
	J.1.1 A public sector R&D organisation can choose the ownership of the IPRs obtained for IP it had generated (with the potential assistance of financing, resources and services of other R&D organisations) from partial or full government funding	IPR_STREN1
	J.1.2 The state is granted walk-in rights on the IPRs for IP that was generated through public financing, but was not properly declared to government	IPR_STREN2
	J.1.3 IP creators at publicly financed R&D organisations are granted a specific right to a portion of the revenues that accrue to the organisation from the IPRs *(Scale: 1 = extensively weakens, 7 = extensively strengthens)*	IPR_STREN3

References

3gpp (2010). *3G Partnership Project Home Page.* Retrieved 2 April 2010 from http://www.3gpp.org/.

Abdi, H. (2010). Partial Least Squares Regression and Projection on Latent Structure Regression (PLS-Regression). *Wiley Interdisciplinary Reviews: Computational Statistics*, 2, 97–106.

Albright, S.C., Winston, L.W. & Zappe, C.J. (2009). *Data Analysis and Decision Making with Microsoft Excel*. 3rd Edition. Mason:South-Western Cengage Learning.

Anderson, J.C. & Narus, J.A. (1990). A Model of Distributor Firm and Manufacturer Firm Working Partnerships. *Journal of Marketing*, 54(1), 42-58.

Ansoff, H.I. (1965). *Corporate Strategy.* New York: McGraw-Hill.

Bagozzi, R.P., Yi, Y. & Philipps, L.W. (1991). Assessing Construct Validity in Organizational Research. *Administrative Science Quarterly*, 36, 421–458.

Baloyi, J., De Jager, P., Debba, P., Kotze, L., Lehmann, J., Mabuse, M., Mophuti, L., Msimang, N., Nel, W.A.J., Ngwato, P., Ntene, T., Sithole, H., Skosana, S., Steenkamp, K., Swartbooi, A., Tshikomba, J., Van der Merwe, C., Weerts, S., Wise, R. & Woodborne, M. (2009). *The TIA and the IPR Acts: Implications for the CSIR* (CSIR SLP03 Report). Retrieved on 1 April 2010 from ftp://ftp.csir.co.za/RD/CiLLA/SLP0309/GroupAssignment/.

Barney, J.B. (1986). Strategic Factor Markets: Expectations, Luck and Business Strategy. *Management Science*, 32(10), 1231–1241.

Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99–120.

Baron, R.M. & Kenny, D.A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic and Statistical Considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182.

Black, F.& Scholes M. (1973). The Pricing of Options and Corporate Liabilities. *Journal of Political Economy*, 81(3), 637–654.

Canonical (2010). *Canonical Home Page*. Retrieved on 12 August 2010 from http://www.canonical.com/.

Chen, H. & Chen, T.J. (2003). Governance Structures in Strategic Alliances: Transaction Costs versus Resource-Based Perspective. *Journal of World Business*, 38(1), 1-14.

Chin, W.W. (1998a). The Partial Least Squares Approach to Structural Equation Modeling. In G.A. Marcoulides (ed.), *Modern Methods for Business Research* (pp. 295–336), Mahwah: Lawrence Erlbaum.

Chin, W.W. (1998b). Issues and Opinion on Structural Equation Modeling. *Management Information Systems Quarterly*, 22(1), 7–16.

Chin, W.W. & Newsted, P.R. (1999). Structural Equation Modelling Analysis with Small Samples using Partial Least Squares. In R. Hoyle (ed.), *Statistical Strategies for Small Sample Research* (pp. 307-341), London: Sage Publications.

Clandinin, D.J. & Connelly, F.M. (2000). *Narrative Inquiry: Experience and Story in Qualitative Research.* San Francisco: Jossey-Bass Publishers.

Coase, R. (1937). The Nature of the Firm. *Economica*, 4(16), 386–405.

Coase, R. (1960). The Problem of Social Cost. *Journal of Law and Economics*, 3, 1–44.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences*. Hillsdale, New Jersey: Erlbaum.

Cohen, W., Florida, R., Randazzese, L. & Walsh, J. (1998). *Industry and the Academy: Uneasy Partners in the Cause of Technological Advance. R. Noll ed., Challenges to the Research University.* Washington, D.C.: Brookings Institution Press.

Contractor, F.J. & Lorange, P. (2002). Why should Firms Cooperate? The Strategy and Economics Basis for Cooperative Ventures. In F.J. Contractor and P. Lorange (eds.), *Cooperative Strategies*

in International Business: Joint Ventures and Technology Partnerships between Firms (pp. 3-30). Oxford: Elsevier Science.

Creswell, J.W. & Miller, D.L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice*, 39(3), 124-131.

CSIR (2010a). *CSIR Home Page*. Retrieved on 22 July 2010 from http://www.csir.co.za.

CSIR (2010b). *CSIR Annual Report 2009.* Retrieved on 24 July 2010 from http://www.csir.co.za/publications/pdfs/annualreport_2009/FULL_VERSION_CSIR_AR_200809.pdf

CSIR (2010c). *CSIR Contract Research and Development Partnerships.* Retrieved on 24 July 2010 from http://www.csir.co.za/research_and_development/strategic_partnerships_alliances.html.

CSIR (2010d). *The Global Research Alliance.* Retrieved on 24 July 2010 from http://www.csir.co.za/research_and_development/global_ra.html.

CSIR (2010e). *The Regional Research Alliance.* Retrieved on 24 July 2010 from http://www.csir.co.za/research_and_development/regional_ra.html.

CSIR (2010f). *The CSIR's Role in the National System of Innovation.* Retrieved on 24 July 2010 from http://www.csir.co.za/research_and_development/national_system_innovation.html.

Das, T.K. & Teng, B. (2000). A Resource-Based Theory of Strategic Alliances. *Journal of Management*, 26(1), 31-61.

Day, G.S. & Wensley, R. (1988). Assessing Advantage: A Framework for Diagnosing Competitive Advantage. *Journal of Marketing*, 52, 1-20.

Denzin, N.K. (1978). *The Research Act: A Theoretical Introduction to Sociological Methods*. New York: McGraw-Hill.

Dierickx, I. & Cool, K. (1989). Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science*. 35(12), 1504–1511.

DST (2006). *IP Rights from Publicly Financed Research Framework.* Retrieved on 12 June 2010 from http://www.naci.org.za/OECD/IPR_from_PRF_Policy_Framework.pdf.

Ellis, C. (2004). *The Ethnographic I: A Methodological Novel about Autoethnography*. Walnut Creek, CA: Rowman & Littlefield Publishers, Inc.

European Commission (2003). Commission Recommendation of 6th May 2003 Concerning the Definition of Micro, Small and Medium-sized Enterprises. *Official Journal of the European Union*, L124, 36-41.

Falk, R.F. & Miller, N.B. (1992). *A Primer for Soft Modeling.* Akron, Ohio: University of Akron Press.

Folta, T. (1998). Governance and Uncertainty: The Tradeoff between Administrative Control and Commitment. *Strategic Management Journal*, 19(11), 1007–1029.

Folta, T. & Leiblein, M. (1994). Technology Acquisition and the Choice of Governance by Established Firms: Insights from Option Theory in a Multinomial Logit Model. *Academy of Management Proceedings*, 27–31.

Fornell, C. & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Errors. *Journal of Marketing Research*, 18, 39–50.

Geisser, S. (1975). The Predictive Sample Reuse Method with Applications. *Journal of the American Statistical Association*, 70(350), 320–328.

Glasser, B. (1965). The Constant Comparative Method of Qualitative Analysis. *Social Problems*, 12(4), California: University of California Press.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), 597-607.

Goodhue, D., Lewis, W. & Thompson, R. (2006). PLS, Small Sample Size, and Statistical Power in MIS Research, *IEEE Proceedings of the 39th Hawaii International Conference on System Sciences*.

Google (2010). *Google Forms Help Website.* Retrieved on 17 August 2010 from http://docs.google.com/support/bin/answer.py?hl=en&answer=87809.

GRA (2010). *Global Research Alliance Home Page.* Retrieved on 24 July 2010 from http://www.research-alliance.net/.

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.

Guion, L.A. (2002). Triangulation: Establishing the Validity of Qualitative Studies. *FCS6014*. Dept. of Family, Youth and Community Science, Florida Cooperative Extension Service, Institute of Food and Agricultural Science, University of Florida.

Gulati, R. (1995). Social Structure and Alliance Formation Patterns: A Longitudinal Analysis. *Administrative Science Quarterly*, 40(4), 619-52.

Gulati, R. & Singh, H. (1998). The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns in Strategic Alliances. *Administrative Science Quarterly*, 43(4), 781-814.

Haenlein, M. & Kaplan, A.M. (2004). A Beginner's Guide to Partial Least Squares Analysis. *Understanding Statistics*, 3(4), 283-297.

Hagedoorn, J., Cloodt, D. & van Kranenburg, H. (2005). Intellectual Property Rights and the Governance of International R&D Partnerships. *Journal of International Business Studies, Palgrave Macmillan Journals*, 36(2), 175-186.

Hagedoorn, J. & Narula, R. (1996). Choosing Organizational Modes of Strategic Technology Partnering: International and Sectoral Differences. *Journal of International Business Studies*, 27(2), 265-284.

Hamel, G., Doz, Y.L. & Prahalad, C.K. (1989). Collaborate with Your Competitors – and Win. *Harvard Business Review*, 67, 133-139.

Hamel, G. & Prahalad, C.K. (1994). *Competing for the Future*. Boston, Massachusetts: Harvard Business School Press.

Heide, J.B. & John, G. (1992). Do Norms Matter in Marketing Relationships? *Journal of Marketing*, 56(2), 32-44.

Hemphill, T.A. & Vonortas, N. (2003). Strategic Research Partnerships: A Managerial Perspective. *Technology Analysis and Strategic Management*, 15(2), 255-71.

Hertzfeld, H.R., Link, A.N. & Vonortas, N.S. (2001). Research Partnerships and Intellectual Property: Literature Review. Mimeograph. *Centre for International Science and Technology Policy*, George Washington University and Bryan School of Business and Economics, University of North Carolina at Greensboro.

Hertzfeld, H.R., Link, A.N. & Vonortas, N.S. (2006). Intellectual Property Protection Mechanisms in Research Partnerships. *Research Policy, Elsevier*, 35(6), 825-838.

Howarth, C.S. (1994). The Role of Strategic Alliances in the Development of Technology. *Technovation*, 14(4), 243-257.

Hulland, J. (1999). Use of Partial Least Squares (PLS) in Strategic Management Research: A Review of Four Recent Studies. *Strategic Management Journal*, 20(2),195–204.

Jishnu, L. (2008). *Does India need a Bayh-Dole Act?* Retrieved on 2 April 2010 from http://www.business-standard.com/india/storypage.php?autono=328187.

Jöreskog, K.G. (1973). A General Method for Estimating a Linear Structural Equation System. In A.S. Goldberger & O. D. Duncan (eds.), *Structural Equation Models in the Social Sciences* (pp. 85–112). New York: Seminar.

Kim, K-J. (2009). Choosing between International Technology Licensing Partners: An Empirical Analysis of U.S. Biotechnology Firms. *Journal of Engineering and Technology Management*, 26(1-2), 57-72.

Kogut, B. (1988). Joint Ventures: Theoretical and Empirical Perspectives. *Strategic Management Journal*, 9(4), 319-32.

Kogut, B. (1991). Joint Ventures and the Option to Expand and Acquire. *Management Science*, 37, 19–33.

Kotabe, M. & Swan, K.S. (1995). The Role of Strategic Alliances in High-Technology New Product Development. *Strategic Management Journal*, 16(8), 621-636.

Kotler, P. (2000). *Marketing Management.* 10th ed., Englewood Cliffs, NJ: Prentice-Hall.

Leiblein, M.J. (2003). The Choice of Organizational Governance Form and Firm Performance: Predictions from Transaction Cost, Resource-based, and Real Option Theories. *Journal of Management*, 29(6), 937-962.

Leiblein, M.J. & Miller, D.J. (2003). An Empirical Examination of Transaction- and Firm-level Influences on the Vertical Boundaries of the Firm. *Strategic Management Journal*, 24(9), 839–860.

Link, A.N, Paton, D. & Siegel, D.S. (2002). An Analysis of Policy Initiatives to Promote Strategic Research Partnerships. *Research Policy, Elsevier*, 31(8-9), 1459-1466.

McDonald, R. & Siegel, D. (1986). The Value of Waiting to Invest. *Quarterly Journal of Economics*, 101(4), 707–727.

Majd, S. & Pindyck, R.S. (1987). Time to Build, Option Value, and Investment Decisions. *Journal of Financial Economics*, 18(1), 7–28.

Maredia, M.K. (2001). *Application of Intellectual Property Rights in Developing Countries: Implications for Public Policy and Agricultural Research Institutes.* Final Draft Submitted to the World Intellectual Property Organization. Retrieved on 2 April 2010 from http://www.wipo.int/export/sites/www/about-ip/en/studies/pdf/study_k_maredia.pdf.

Martin, S. & Scott, J.T. (2000). The Nature of Innovation Market Failure and the Design of Public Support for Private Innovation. *Research Policy, Elsevier*, 29(4-5), 437-447.

Miller, K.D. & Folta, T.B. (2002a). Real Options in Equity Partnerships. *Strategic Management Journal*, 23(1), 77–89.

Miller, K.D. & Folta, T.B. (2002b). Option Value and Entry Timing. *Strategic Management Journal*, 23(7), 655-665.

Morgan, R.M. & Hunt, S.D. (1994). The Commitment-Trust Theory of Relationship Marketing. *Journal of Marketing*, 58(3), 20-38.

Mowery, D.C., Nelson R.R., Sampat, B.N. & Ziedonis, A.A. (2004) *Ivory Tower and Industrial Innovation: University-industry Technology Transfer before and after Bayh-Dole.* Stanford (CA): Stanford University Press.

Mowery, D.C. & Sampat, B.N. (2005). The Bayh-Dole Act of 1980 and University–Industry Technology Transfer: A Model for Other OECD Governments? *Journal of Technology Transfer*, 30 (1/2), 115–127.

Myers, S.C. (1977). Determinants of Corporate Borrowing. *Journal of Financial Economics*, 5, 147-176.

Narula, R. & Hagedoorn, J. (1999). Innovating through Strategic Alliances: Moving towards International Partnerships and Contractual Agreements. *Technovation*, 19(5), 283-294.

OECD (2003). *Turning science into business: Patenting and Licensing at Public Research Organisations.* Retrieved on 2 April 2010 from http://www.oecd.org/publishing.

Orr, S. (2010). *Post* Global Financial Crisis International Business Strategies. *International Review of Business Research Papers*, 6(4), 324–336.

Osborn, R.N. & Baughn, C.C. (1990). Forms of Interorganizational Governance for Multinational Alliances. *Academy of Management Journal*, 33(3), 503-19.

Oxley, J.E. (1999). Institutional Environment and the Mechanisms of Governance: The Impact of Intellectual Property Protection on the Structure of Inter-Firm alliances. *Journal of Economic Behavior and Organization*, 38(1999), 283-309.

Oxley, J.E. & Sampson, R.C. (2004). The Scope and Governance of International R&D Alliances. *Strategic Management Journal*, 25(8/9), 723-749.

Parkhe, A. (1991). Interfirm Diversity, Organizational Learning and Longevity in Global Strategic Alliances. *Journal of International Business Studies*, 22(4), 579-601.

Parkhe, A. (1993). Strategic Alliance Structuring: A Game Theoretic and Transaction Cost Examination of Interfirm Cooperation. *The Academy of Management Journal*, 36(4), 794-829.

Pateli, A.G. (2009). Decision Making on Governance of Strategic Technology Alliances. *Management Decision*, 47(2), 246-270.

Pedhazur, E. & Schmelkin, L. (1991). *Measurement, Design and Analysis*. Hillsdale, New Jersey: Erlbaum.

Penrose, E. T. (1959). *The Theory of the Growth of the Firm*. New York: Wiley.

Porter, M.E. (2008). The Five Competitive Forces That Shape Strategy. *Harvard Business Review*.

Prahalad, C.K. & Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review*, 79–91.

Rapp, R. & Rozek, R.P. (1990). Benefits and Costs of Intellectual Property Protection in Developing Countries. *Journal of World Trade*, 75/77, 75-102.

Ratsatsi, S. (2009). *The Technology Innovation Agency (TIA): Background, Status and Rollout.* Paper presented at the meeting of the Advanced Manufacturing Technology Strategy Project, Midrand, Johnnesburg.

Republic of South Africa (2008a). *Intellectual Property Rights from Publicly Financed Research and Development Act*. Retrieved on 2 April 2010 from http://www.info.gov.za/view/DownloadFileAction?id= 94343.

Republic of South Africa (2008b). *Technology Innovation Agency Act*. Retrieved on 2 April 2010 from http://www.info.gov.za/view/DownloadFileAction?id=92827.

Reuer, J.J. & Leiblein, M.J. (2000). Downside Risk Implications of Multinationality and International Joint Ventures. *Academy of Management Journal*, 43, 203–214.

Ringle, C.M., Wende, S. & Will, S. (2010). *SmartPLS 2.0*. Downloaded on 2 October 2010 from http://www.smartpls.de/forum/downloads.php.

Roemer, E. (2005). Real Options and the Theory of the Firm. In D. Satish (ed.), *Real Options - Concepts and Applications* (pp.54-73). Hyderabad, India: ICFAI University Press.

Romney, A., Batchelder, W. & Weller, S. (1986). Culture as Consensus: A Theory of Culture and Informant Accuracy. *American Anthropologist*, 88, 313–38.

RRA (2010). *Regional Research Alliance Home Page.* Retrieved on 24 July 2010 from http://www.regional-alliance.net/index.html.

Ryan, G. & Bernard, H.R. (2003). Techniques to Identify Themes. *Field Methods,* 15, 85–109.

Rumelt, R. (1984). Toward a Strategic Theory of the Firm. In R. Lamb (ed.), *Competitive Strategic Management* (pp.556-570). Englewood Cliffs, New Jersey: Prentice-Hall.

Santoro, M.D. & McGill, J.P. (2005). The Effect of Uncertainty and Asset Co-specialization on Governance in Biotechnology alliances. *Strategic Management Journal*, 26(13), 1261-1269.

Sarkar, M.B., Echambadi, R., Cavusgil, S.T. & Aulakh, P.S. (2001). The Influence of Complementarity, Compatibility, and Relationship Capital on Alliance Performance. *Journal of the Academy of Marketing Science*, 29(4), 358-73.

Seyoum, B. (1996). The Impact of Intellectual Property Rights on Foreign Direct Investment. Columbia Journal of World Business, 31, 51-59.

Sherwood, R.M. (1997). Intellectual Property Systems and Investment Stimulation: The Rating of Systems in Eighteen Developing Countries. *IDEA*, 37(2), 261-370.

So, A.D., Sampat, B.N., Rai, A.K., Cook-Deegan, R., Reichman, J.H., Weissman, R. & Kapczynski, A. (2008). Is Bayh-Dole Good for Developing Countries? Lessons from the US Experience. *PLoS Biology*, 6(10), 2078-2084.

Sobel, M.E. (1982). Asymptotic Confidence Intervals for Indirect Effects in Structural Equation Models. In S. Leinhardt (Ed.), *Sociological Methodology, American Sociological Association* (pp. 290-312), San Francisco:Jossey-Bass.

Stone, M. (1975). Cross-Validatory Choice and Assessment of Statistical Predictions. *Journal of the Royal Statistical Society*, 36(2), 111–133.

SurveyMonkey (2010). *SurveyMonkey Home Page.* Retrieved on 17 August 2010 from http://www.surveymonkey.com/.

Teece, D. J., Pisano, G. & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, 18(7), 509-534.

Tether, B. (2002). Who Co-operates for Innovation, and why? An Empirical Analysis. *Research Policy*, 35(6), 947-67.

TIA (2010). *Technology Innovation Agency Home Page*. Retrieved on 12 June 2010 from http://www.tia.org.za/tia_index.htm.

Trigeorgis, L. (1998). *Real Options: Managerial Flexibility in Strategy and Resource Allocation*. Cambridge, MA: MIT Press.

VanVoorhis, C.R.W & Morgan, B.L. (2007). Understanding Power and Rules of Thumb for Determining Sample Sizes. *Tutorials in Quantitative Methods for Psychology*, 3(2), 43-50.

Vaquero, I.E., Cruz, N.M. & de la Fuente, G. (2008). *Technological Strategic Alliances: Formation under the Real Options Approach (Working Paper 2008-04)*. Spain: Interuniversity Research Master and Doctorate Program on Business Economics, Universities of Valladolid, Burgos, Salamanca and León. Retrieved on 12 August 2010 from http://www3.uva.es/empresa/uploads/04_08_alianzas_dea.pdf.

Vinzi, V.E., Chin, W.W., Henseler, J. & Wang, H. (2010). *Handbook of Partial Least squares: Concepts, Methods and Applications*. Berlin Heidelberg: Springer.

Wang, E.T.G. & Wei, H-L. (2007). Interorganizational Governance Value Creation: Coordinating for Information Visibility and Flexibility in Supply Chains. *Decision Sciences*, 38(4), 647-674.

Wernerfelt, B. (1984). A Resource-based View of the Firm. *Strategic Management Journal*, 5(2), 171–180.

Wiebe, N. (2009). *Miriam Toews' Experience of Writing "A Complicated Kindness": Implications for how Writing can be Inquiry in Narrative Inquiry* (Chapter in unpublished doctoral thesis). Faculty of Education, University of Western Ontario, London.

Williamson, O.E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. *Journal of Law and Economics*, 22(2), 233-261.

Williamson, O.E. (1981). The Economics of Organization: The Transaction Cost Approach. *The American Journal of Sociology*, 87(3), 548-577.

Wilson, D.T. (1995). An Integrated Model of Buyer-Seller Relationships. *Journal of the Academy of Marketing Science*, 23(4), 335-45.

Wold, H. (1975). Path Models with Latent Variables: The NIPALS Approach. In H.M. Blalock, A. Aganbegian, F.M. Borodkin, R. Boudon & V. Capecchi (eds.), *Quantitative Sociology: International Perspectives on Mathematical and Statistical Modelling* (pp. 307–357), New York: Academic Press.

Wold, H. (1980). Model Construction and Evaluation when Theoretical Knowledge is Scarce: Theory and Application of PLS. In J. Kmenta & J.B. Ramsey (eds.), *Evaluation of Econometric Models* (pp. 47–74). New York: Academic Press.

World Bank (1999). *World Development Report 1998/99: Knowledge and Information for Development.* New York: Oxford University Press/World Bank.

York University (2010). *Theories used in IS Research: Real Options Theory.* Retrieved on 11 August 2010 from http://www.istheory.yorku.ca/realoptionstheory.htm.

Zikmund, W. (2003). *Business Research Methods, 7th Edition.* Ohio: South-Western Cengage Learning.