How do prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University?

Insights from a comparative regional case study of the Life Sciences disciplinary area: Stockholm and Vienna

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ABSTRACT

Increasing university contribution to innovation systems could potentially contribute towards increasing economic growth and competitiveness within EU Member States. The role of universities has been changing over the years, with the move from first mission (teaching) and second mission (research) activities, towards embracing third mission (closer connections with society), as more emphasis is placed upon universities connecting with society at large. Universities have to do more with less, whilst also expanding their reach to society, and justifying their overall existence to the public. Nevertheless, basic university funding has been decreasing over the years, requiring universities to respond to their changing funding environment. This has required a professional response from university management in order for universities to become more entrepreneurial, and function more efficiently within their contextual environments, which has become a central mission for some universities. Therefore, understanding how prevailing regional and national innovation systems affect university contribution and transformation towards becoming more entrepreneurial is paramount. This study explored which actors, mechanisms, organisational barriers and enablers are present within the system that affect university contribution, and how universities are transforming in response to interactions within the innovation system. Interviews were carried out with a variety of university and external innovation system actors, to gain insights, and compare this anomaly within the Stockholm and Vienna regions. Aside from the influential nature of industry and bridging organisations, it is clear that government and its associated agencies have a strong influence on how universities interact and transform. This results from university interaction with a variety of government funded programmes (and their attached rules), and prevailing legislation which affects how autonomous universities are within their given environments. Nevertheless, a lack of available funding and infrastructure was considered a major barrier towards increasing contribution to the innovation system. Therefore, an increase in venture capital to overcome the “Valley of Death”, further mechanisms to promote interaction, the implementation of more long-term initiatives such as Competence Centres, and the triangulation of policies areas are needed to stimulate development of technology-transfer. Universities must also analyse their current organisational structures, both formal and informal, in order to stimulate cross-disciplinary working, embed entrepreneurialism, and create a professionalised business model which is more accessible by external innovation actors. This requires well-designed transformation processes phased over the long-term, and implemented through strong leadership and the propagation of trust within the university system. Addressing these issues should alleviate current blockages within the system, and thus promote efficiencies and economic growth.

STATUTORY DECLARATION

I, Ms. Anne Christina Swanson, born on 14.05.1985 in Thurso, Highland, Scotland (UK), hereby declare,

1. that I have written my Master Thesis myself, have not used other sources than the ones stated and moreover have not used any illegal tools or unfair means,

2. that I have not publicized my Master Thesis in my domestic or any foreign country in any form to this date and/or have not used it as an exam paper,

3. that, in case my Master Thesis concerns my employer or any other external cooperation partner, I have fully informed them about title, form and content of the Master Thesis and have his/her permission to include the data and information in my written work.

ACKNOWLEDGEMENTS

I would like to take this opportunity to first and foremost thank my Supervisor, Professor Karl-Heinz Leitner, for his invaluable input and guidance throughout this project. I very much appreciate your critical feedback throughout the course of this project, and your help in making important contacts for carrying out this research endeavour. I would also like to thank my second Supervisor, Dr. Attila Pausits for his very useful comments and suggestions during our Master's thesis seminars, in addition to his help regarding the practicalities of this project, importantly, sourcing contacts to make this research possible. These expert opinions and directions have enabled the production and completion of this research project, and for this, I am most grateful.

I am extremely thankful to all interview participants in the Vienna and Stockholm regions for their invaluable insights, time given for the benefit of this project, and the genuine interest conveyed during the process of this project. You have all inspired my very deep interest in this topic, and as a result, I hope to pursue this subject area further in future. Many thanks also to all interview participants for very kindly recommending potential interviewees. This was incredibly helpful, especially given I am neither an Austrian or Swedish national, meaning I entered each country 'cold' and had to rely on the support of others to provide me with the appropriate contacts within their organisations and indeed sectors, when my initial attempts failed. Without this help I fear the project would not have come to fruition so I am deeply grateful to you all.

I am very grateful to Mag. Georg Panholzer at the RTI-Strategy and International Research and Technology Cooperation Department and the Federal Ministry of Science, Research and Economy in Vienna, Austria. You provided extremely useful information and contacts, and I very much appreciate your kindness, time, and effort in doing so! I would also like to extend my thanks to Danube University Krems Rector Mag. Friedrich Faulhammer for kindly contacting the Ministry on my behalf to help source a respondent for interview. Thank you to Mag. Astrid Egger and her colleagues at Wirtschaftskammer Wien for kindly providing a list of industry contacts around Vienna.

I am very grateful to all experts who commented on the progress of my work during our seminar sessions. Professor Henry Etzkowitz, your insights and suggestions were incredibly helpful, and I very much appreciate your time in considering my research. Dr. Pavel Zgaga, Dr. Manja Klemencic, Dr. Martina Vukasovic, and Professor Juyan Ye, you each provided unique ideas and perspectives which enriched my thought processes as this work developed. I would also like to thank my peers who underwent this process with me. Our meetings and discussions were extremely beneficial, and always shed light on new and alternative perspectives, which only benefited the direction this project took. Just discussing the process itself helped to build confidence in our approaches, and encouraged us to keep going! Thank you!

Many thanks also go to Ms. Astrd Kurzmann and Mr. Florian Reisky for all their help, support, and guidance throughout the Master's Thesis process. We would have been lost without you!

Finally, I would like to thank my mother and father for their continuous love, support, and encouragement. I am extremely grateful for your strong belief in me to achieve my goals. You were always there to push me on when I needed it, and provide comfort and direction when challenges inevitably presented themselves. I very much appreciate your support, and I dedicate this thesis to you both.

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ABBREVIATIONS AND ACRONYMS

BOKU	University of Natural Resources and Life Sciences, Vienna
E&R	Enterprise & Research
HE	Higher Education
HEI	Higher Education Institution
GERD	Gross Expenditure on Research and Development
GDP	Gross Domestic Product
IP	Intellectual Property
IPR	Intellectual Property Rights
KICs	Knowledge and Innovation Communities
KTH	KTH Royal Institute of Technology, Stockholm
NIS	National Innovation System
NPM	New Public Management
R&D	Research & Development
RAE	Research Assessment Exercise
RIS	Regional Innovation System
RTD	Research, Technology & Development
STI	Science Technology and Innovation
TH	Triple Helix
TTO	Technology Transfer Office
UBC	University-Business Cooperation

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CHAPTER 1: INTRODUCTION

1.1 Background and Rationale

The Higher Education (HE) sector has undergone radical changes over the past decades, with the implementation of New Public Management methods in the 1980s; massification of HE in the early 1990s; and ongoing reductions in public funding which have forced universities to not only find diversified sources of funding (Clark, 1998), but to increase their contributions to society to reflect the level of public funds received. As such, universities have had to become more entrepreneurial in their approach to acquiring funds, whilst meeting the variety of demands placed upon the sector through extending their core functions to incorporate third mission activities, and meet the demands of an array of stakeholders. Universities are recognised as being central to society, with the power to shape society and create a valuable labour force. Yet the dawn of the Knowledge Economy has elevated the demand for universities to meet current and future challenges, as countries strive to become more competitive through exploitation of their knowledge assets. Nowadays, due to increased visibility, HEIs are measured upon their contributions to societies and economies, due to the public financial commitments governments make to fund HEI endeavours (Bleiklie, 2005). As such, HEIs are expected to produce many outputs in the form of public goods in order to substantiate their existence and position within society, whilst also maintaining their core functions.

It is widely recognised that universities can contribute more towards economic and social development through these aforementioned third mission activities in the modern knowledge society (Etzkowitz, 2004). Studies since the late 1990s have focused on the changing role of the university in this regard, with the move from first mission (teaching) and second mission (research) activities, towards embracing third mission (closer connections with society), as more emphasis is placed upon HEIs contributing measurable results to justify the amount of public funding received (Edwards, 2013), thus requiring universities to abandon their "ivory tower" status (Hershberg, Nabeshima and Yusuf, 2007), and become more connected with society at large. Generally, "third mission" activities comprise three dimensions performed by universities in relation to external environments: technology transfer and innovation, continuing education, and social engagement (E3M, 2010). As such, the term "entrepreneurial university" (Etzkowitz, 1983) has been adopted by both academics and policy-makers to describe universities that deliver upon their "third mission" activities (Clark, 1998; Van Vught, 1999; Lambert, 2003).

National governments are increasingly aware of the economic benefits of knowledge, whereby the 'products' of knowledge are perceived as economic resources and human capital, which are central to nation building and development. This commodification of knowledge into products, services and assets, obviously has a great impact for the orientation and transformation of the HE sector. Valimaa and Hoffman (2008) noted the benefits of knowledge production acknowledging how it supports growth in industrial production, and creates new business activities in knowledge societies. Khatun (2012) extended this notion, highlighting that Higher Education serves as the engine of growth for a nation's economic and social development, whereby the products of HE help run a country by leading all mechanisms of a state and all areas of expertise. The fact that HE has the capability to generate financial returns, makes it a central part of the economy (in the eyes of government), especially given ICT and globalisation have created a global competitive market place where such knowledge products are traded, and the need for highly skilled human capital is paramount to develop the skills in science and technology required to develop home nations, and those abroad.

As such, universities are recognised by governments globally, as key players in developing national innovation systems and, subsequently, contributing to economic growth (Bercovitz and Feldman, 2006; Etzkowitz et al., 2000). This is reflected in the literature surrounding the development of the Triple Helix Framework (Ranga and Etzkowitz, 2013; Leydesdorff and Zawdie, 2010), whereby the interactions between government, industry and academia are fundamental within the so called "knowledge triangle" to enhance systems of innovation nationally (Etzkowitz and Leydesdorff, 2000). This concept has been given great precedence within the European Union, whereby the necessity to intensify links between research, innovation and education (the knowledge triangle) has been repeatedly stressed since it was put forward as a central element of the Lisbon Strategy in 2000 (FarHorizon, 2010). This is due to the

belief that in an increasingly knowledge-based economy, the quality of university-industry linkages is important for growth (Conti and Gaulé, 2009a). The aim of the EU, for example, is to make Europe, '*the most competitive and dynamic knowledge-based economy in the world*', which is a central objective of the Lisbon Strategy (NFER, 2008).

As a consequence, these developments have pushed HE towards becoming an extension of the market model, whereby the rise in market forces is a strong driving force for the future reformation of HE policies. As such, it is clear that HE policies have become much more integrated with the economy, which has led to universities having to become much more entrepreneurial in their approach within these new quasi-markets in which they now find themselves. Etzkowitz and Leydesdorff (2000) assert that the previously isolated institutional social spheres of university, government and industry have become increasingly intertwined, which has subsequently brought academic, economic and wider networks of social actors together in new constellations comprising triple helix knowledge dynamics. Therefore, overall, the Knowledge Economy comprises competing spheres of interest whereby the marketisation and commodification of research plays in opposition to the freedom and development of knowledge for the sake of knowledge generation, due to the difficult funding landscape in which universities now function. As Tuunainen (2004) aptly points out, '*these trajectories are shaped by the multiple historical, political and cultural characteristics of the contextual setting'*, which ultimately influences its adoption, and the development of activities.

Taking these factors into account, it is clear that the Knowledge Economy is having a fundamental effect on how National and Regional Innovation Systems develop. On one hand, universities are facing increasing challenges in the face of reducing public funds, to do more with less, causing great tensions in the sector through managerial efforts to create greater efficiencies; diversify sources of funding; and also manage the play off between servicing the needs of basic and applied research. On the other hand, national and supra-national governments are aiming to solve the European Paradox (European Commission, 2007) whereby not enough R&D funds are being realised into tangible products thus providing a poor return on public investment, and impeding the competitiveness of the EU as a whole.

What is apparent is that within nation states, systems of innovation are incredibly complex, encompassing many independent and integrated entities, namely universities, government, industry; those operating within the innovation system which may not necessarily be attributed to one of the aforementioned categories; and competing drivers within each system subset. Many authors have explored the phenomena associated with innovation systems as demonstrated through literature pertaining to National Innovation Systems (e.g. Lundvall, 1992), Regional Innovation Systems (e.g. Cooke, Uranga & Etxebarria, 1997), and developments surrounding the Triple Helix (e.g. Etzkowitz and Leydesdorff, 2000), which will be explored in greater depth in Chapter 2. With the rise of the Knowledge Economy, national and supra-governments are paying close attention to the performance of innovation systems, and subsequently designing policies and initiatives in a bid to enhance performance for increased economic growth.

1.2 Problem Statement

The European Commission has argued that while European research institutions are good at producing academic research outputs, they are not successful in transferring these outputs to the economy – the so called 'European Paradox' (European Commission, 2007). To improve competitiveness, an array of EU funded projects has been implemented across the 13 regions established for transnational cooperation and development activities. Nevertheless, there is a realisation that, *"Too much of the research conducted in the region is not transformed into products and services for the market. There is still more to be done on building links between business and knowledge institutions and this is particularly urgent for SMEs, which often do not have the networks or capacities to access new research results"* (The North Sea Region Programme Secretariat, 2013. p.5). Recognition exists that policies for the knowledge triangle are insufficiently joined-up, an example being the relatively minor role that the education and training dimension of higher education receives in policies for the European Research and Innovation Area (FarHorizon, 2010). There are various underlying structural problems concerning technology-transfer existing in Europe. A lack of coordination of policy instruments for research and innovation is causing problems within the enabling environment, which suggests that research must be carried out in order to measure the factors at play (Conti and Gaulé, 2009). Further research is also required to explore the internal organisation dynamics and external

innovation ecosystem (IKTIMED, 2013), given university technology-transfer is underutilised in many National Innovation Systems.

Yet Etzkowitz noted as far back as 2004 that universities can contribute more towards economic and social development through third mission activities in the modern knowledge society. This agrees with Bercovitz and Feldman (2006) who concluded that an understanding of the evolution of the role of the university in systems of innovation certainly warrants further attention. They believe that if we are to think creatively about public policies towards increasing university technology-transfer, a focus on the larger innovation context is necessary. This also agrees with Marxt and Brunner's (2013) findings that more research needs to take place to determine the measurability of higher education in relation to innovation at national level. Van Looy et al. (2011) found during their study that detailed studies are needed at university level to analyse the differences in strategic orientation, incentive arrangements and support structures (TTO), in order to determine the entrepreneurial practices deployed in universities (e.g. Debackere and Veugelers, 2005; Rothaermel et al., 2007). They also identified a gap in the documentation and analysis of the impact of (national or regional) innovation system characteristics in which universities are embedded, as an important complementary research endeavour. They contend that considerable opportunities for growth in the European Research Area is possible, on the basis that future research confirms the crucial role of national innovation system characteristics on the entrepreneurial performance of universities.

This is particularly interesting given Gunasekara (2006) highlighted the importance of understanding policy perspectives for university engagement at regional level, regarding the sustainable operation of universities. He suggests that there may well be heightened interest in how university engagement at a regional level can provide a basis for the sustainable operation of universities themselves. This suggests that there is a gap in knowledge regarding university transformation in relation to the regional system in which it functions. Nevertheless, Allinson (University Industry Innovation Network, 2013) succinctly pointed out that universities have to be many things to many people, and are facing a lot of challenges which require complex decisions. She highlighted that it is important for universities to protect and maintain their core mission, as this element needs to be strong for the future, as well as the need to protect fundamental research. This signifies the complexities universities face internally, through trying to balance core activities with those arising from interaction within innovation systems.

Drawing together the lessons learned from the literature, it is recognised that universities can play an important role in university technology-transfer activities within innovation systems. However, it seems that it is not easy for industry to collaborate with universities, and vice versa, given the variety of disciplinary orientations and missions of different universities, and the differing aims and goals of industry. This means universities have to become more entrepreneurial through professional transformation in order to ease collaboration processes, and attract diversified sources of funding. Nevertheless, further research is required to explore organisational dynamics and bottlenecks, both internally within universities, and with external innovation ecosystem actors, in order to fully understand how the innovation system is influencing university transformation, and which bottlenecks are most restrictive towards transformation and output. This is certainly recognised as an important element to investigate to potentially enhance innovation systems, and understand how universities are responding to such changes, whilst also servicing their core missions.

1.3 Research Gap

Overall, it is clear that a gap exists within the literature to understand how prevailing National and Regional Innovation Systems affects university contribution, and university transformation towards becoming more entrepreneurial, both at national and transnational level. Figure 1.1 illustrates the focus of this research, targeting the research endeavour at the interface between the overarching National and Regional Innovation System, and that of university transformation.

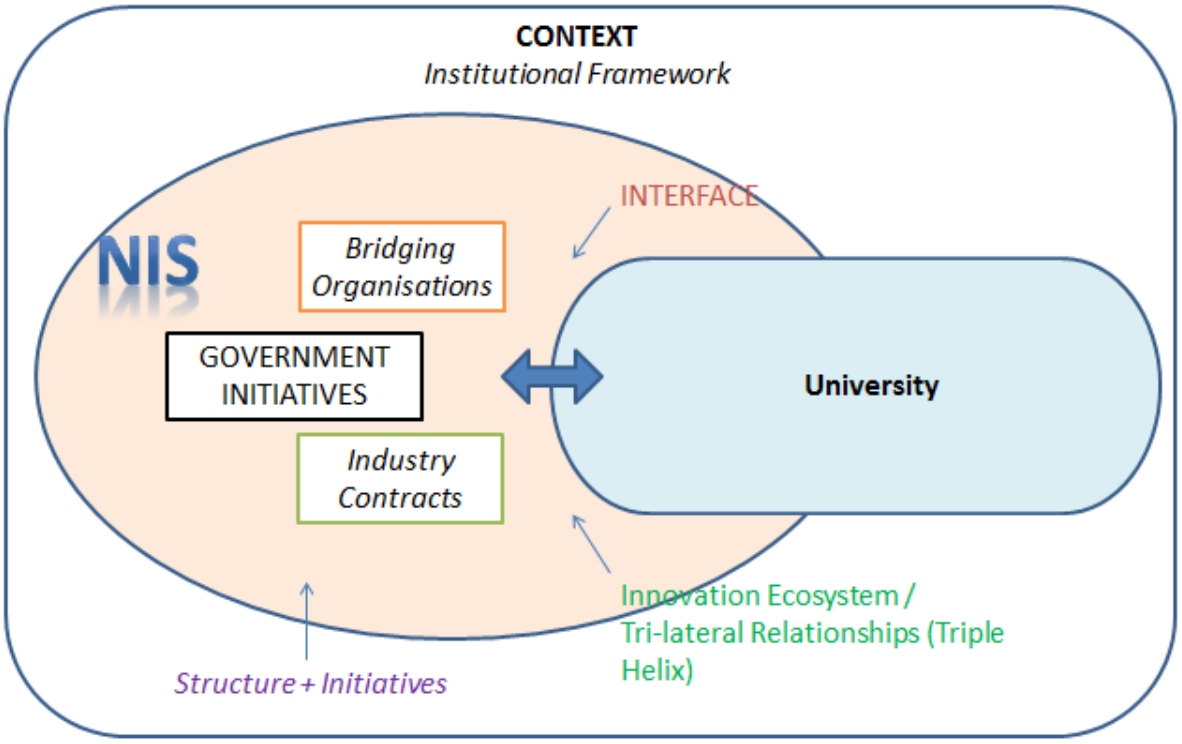

Figure 1.1 Research focus at the interface between the prevailing NIS, and its impact on university contribution, and transformation towards becoming more entrepreneurial. Source: Own depiction

There is a need to understand how prevailing innovation systems affect university contribution and transformation from several perspectives. This is especially important given collaboration between nodes in the Triple Helix has proven to enhance potential output, and create symbiotic benefits for collaborators (Etzkowitz, 2003). Research by Mazzucato (2013) also sheds new perspectives on the role of government within innovation systems, suggesting that government play a pivotal role within the US context as key financiers of high risk knowledge intensive activities, which have led to lucrative economic returns. Additionally, given the reduction in public funds, it is important to improve efficiencies. Therefore an elevated understanding of the impacts of innovation systems on universities is required to enable insights into the response measures taken by universities to function within regional and national innovation systems; the types of structural barriers that reduce university engagement in the NIS; the actors who have influenced universities to become more entrepreneurial; and the mechanisms which exist to harness university contribution.

1. Gaining university experiences of interaction, and the subsequent actions they have taken to function within their innovation system, should expose barriers to, and promoters of, interaction.

2. It is pivotal to understand which actors have the greatest influence on these changes, both internally within universities, and within the broader innovation system, and understand how such change is perceived from each side (i.e. internally versus externally). This type of information will fill a gap by enabling governments to better understand the impact of the current system, and how existing mechanisms are functioning to harness university contribution within the innovation system.

3. This information will enable other universities to benchmark their transformation processes (in conjunction with their individual perceived inhibitors towards interaction) for internal learning and improvement.

Such a study will begin the process of mutual understanding between universities and actors within the innovation system. As a result, it is anticipated such evidence will highlight the functionality of the relationship between these two phenomena. This will enable governments to gauge their impact on university collaboration and contribution within innovation systems, taking account of the vast array of demands placed upon universities (UNESCO, 2005, p.97; OECD, 1996; OECD, 2008; World Bank, 2002); and enable universities to compare their developments with other

universities' approaches. This could highlight symbiotic measures that better suit each actor for the overall efficiency and output of each selected node of the Triple Helix, and the prevailing innovation system as a whole. Importantly, adopting a comparative regional dimension to the study will enable this scenario to be compared trans-nationally, thus yielding deeper insights by exposing differences in functionality, as imposed by the prevailing regional and national innovation systems. It will also highlight potential successes and challenges which can lead to discussion at governmental level in each case.

According to the Austrian Council, Austria aims to move from its current position as an Innovation Follower, according to the EU's Innovation Scoreboard (European Commission, 2014), and position itself as an Innovation Leader by 2020 (Austrian Council, 2009). To meet this ambition, the Council clearly state that work needs to be done to improve linkages between academic R&D and industry, and to make structures more flexible. This highlights the need for further foresight in this area to harness the power of the Triple Helix, and make instrumental use of all "tools" of economic potential, and in context of this proposed study, university transformation and contribution to innovation systems through third mission activities. In addition, it is proposed to explore the case of Sweden, another small country, in conjunction with Austria, as an exemplar of an Innovation Leader- something Austria aspires to be. Aside from the many similarities between Sweden and Austria, one important difference is the adoption of a National Innovation System approach to innovation strategy in Austria, while a Triple Helix approach is adopted in Sweden. This provides an excellent platform to pinpoint the differences between each case country, whilst also enabling a holistic overview to take place. In addition, each country's current position within the Innovation Scoreboard provides representation of being an Innovator Follower towards being an Innovation Leader, which could help to create a roadmap in this respect. No studies exist which comparatively compare Austria and Sweden in terms of the relationship between prevailing innovation systems and transformation within universities.

1.4 Research Question

The aim of this study is to understand how prevailing regional and national innovation systems affect university contribution, and transformation towards universities becoming more entrepreneurial.

Therefore, an understanding of which actors, mechanisms, enablers and barriers affect university transformation should highlight how regional and national innovation systems impact university contribution and transformation. This should pinpoint successes and challenges within the system; and secondly, determine similarities and differences through comparatively analysing these findings at regional level.

Within this thesis, the term National Innovation System is defined as, "*the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state."* (Lundvall, 1992).

The term Regional Innovation System is broadly defined from a regionalisation approach, *"relating the region to its competence (jurisdiction) capacity, valuing its degree of autonomy to develop policies and manage the different elements that make up the regional system, as well as financing capacity for strategic investments in infrastructures absolutely necessary for the development of innovation processes."* (Cooke, Uranga and Etxebarria, 1997).

The term Triple Helix is defined by Etzkowitz and Leydesdorff (2000) as the *"network overlay of communications and expectations that reshape the institutional arrangements among universities, industries and governmental agencies"*. This concept focuses on the relationship between academia, industry and government, as a stimulus for enhanced participation in "third mission" activities.

The term Entrepreneurial University is defined as an institution which transforms itself to become more adaptive organisationally through collective entrepreneurial action (Clark, 1998). Etzkowitz's (1983; 2003) observed that these universities look for new sources of funds, utilising third mission activities as a means to attract diversified funding sources. Importantly, Sporn's (2001) observation of how universities adapt to environmental changes within their surrounding environment, are particularly pertinent given the orientation of this study.

The definition of 'region' in this study refers to the city regions of Vienna and Stockholm in this case. It is important to consider both national and regional dynamics in this study, given the complexity of overarching national drivers being coupled with activities taking place at regional level.

The Main Research Question

How do prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University?

Sub Research Questions

1. How and which **actors** of the innovation system have influenced universities to become more entrepreneurial?
2. What **mechanisms** (funding, platforms, programs, regulation etc.) exist in the NIS / RIS to harness university contribution to innovation and economic development?
3. What are the **organisational barriers and enablers** for university engagement to become more entrepreneurial?
4. How do actors and mechanisms of the innovation system ease contribution processes by universities?

The following propositions are suggested:

1. Following the logic of Triple Helix relations, the higher the interaction of actors representing different nodes of the Triple Helix, the higher the likelihood that universities will contribute to the innovation system.
2. The more funding opportunities provided for universities through mechanisms designed to stimulate innovation within the innovation system, the more likely universities will:
    a. participate in order to achieve funding allocations
    b. transform organisationally in order to take advantage of funding opportunities, thus becoming more entrepreneurial in their structure and functionality
3. Barriers such as ear marked funding, legislation, disjointed policy design, and non-entrepreneurial internal structure and orientation may inhibit university interaction and contribution.
4. Greater synergies between actors and the designing of mechanisms will ease the interaction and contribution processes of universities within the innovation system

1.5 Methodology: Brief Introduction

The study will take the form of a qualitative comparative case study utilising the example of the Life Sciences disciplinary area. This has been identified as an important sector economically within the Stockholm and Vienna regions (Stockholm Business Region Development, n.d.; Vienna City Administration, n.d.). As such, four universities specialising in this type of research have been specifically targeted as case examples within these regions. They are as follows:

- The Medical University, Vienna
- University of Natural Resources and Life Sciences, Vienna
- Karolinska Institute, Stockholm *(Medical University)*
- KTH Royal Institute of Technology, Stockholm

Two medical universities have been included given they function exclusively within the life sciences, and two universities encompassing a broader array of disciplinary areas (beyond their focus on life sciences) have also been included to understand whether differences in strategy towards organisational change exists from this perspective. This should enable a fair comparison by selecting universities functioning similarly in the two regional contexts.

The study will comprise primary and secondary data collection. Primary data collection will take the form of individual semi-structured interviews conducted with representatives from each university, and various key actors within the prevailing regional innovation system. A total of 20-24 interviews will take place. Secondary data collection will be utilised to provide contextual data to describe the prevailing regional and national innovation systems, and also describe the universities under review. Data will subsequently be triangulated to explore anomalies at regional and trans-national level, and against pre-existing literature on the topic to highlight interesting findings.

Further details regarding the proposed analytical framework and methodology employed are discussed in Chapter 3.

1.6 Significance and Contribution of the Study

This novel study will fill a gap in knowledge relating to how prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University. Case studies exist exploring aspects of internal transformation processes towards universities becoming more entrepreneurial (e.g. Clark, 1998; Martinelli, Meyer and von Tunzelmann, 2008; Jacob, Lundqvist and Hellsmark, 2003; Bramwell and Wolfe, 2008; Oleksiyenko, 2002; Glaser, 2012; Woollard, Zhang and Jones, 2007). However, no studies were found which adopts this particular perspective of transformation processes, particularly from a comparative perspective across regions trans-nationally, against prevailing regional and national innovation systems. As such, this study provides an alternative perspective, shifting the focus from internal entrepreneurial transformation processes and university technology-transfer activities, towards examining universities transformation relationship to its prevailing innovation system and enabling environment. In addition, the methodology employed will build upon previous pre-existing academic literature and EU projects, to extend work carried out to date.

This study will be useful for policy makers, as it presents an insight into the current situation at a regional level. This could potentially highlight barriers and inefficiencies in policy processes, which reduce the expected output from the university node of the Triple Helix within National and Regional Innovation Systems. It will also be useful for university leaders and managers for benchmarking purposes, given it will enable universities to compare transformation processes within the Life Sciences sector regionally, and trans-nationally. This study will also be useful for governmental representatives and other bridging organisations aiming to increase interaction between universities, industry and the wider social community, as a means toward economic and social development. Given Austria aims to improve their position in the European Innovation Scoreboard from being an 'Innovation Follower' to an 'Innovation Leader'(Austrian Council, 2009), the comparative analysis with Sweden (itself an 'Innovation Leader', as defined by the European Innovation Scoreboard (European Commission, 2014), will yield insights regarding how this particular sector is transforming in relation to its Regional and National Innovation System, thus yielding important insights and potential lessons for future formulation of strategies in Austria.

Importantly, analysing transformation processes from this alternative perspective will contribute literature to the field from an angle which is currently under-developed to date. Not only will this study provide a detailed snapshot of specific university transformation within two EU countries; but it will act as a pilot project which can be extended in the future to provide significant information which could potentially help case countries and neighbouring countries in the region develop instruments within innovation policies to better utilise universities for integrated development.

1.7 Limitations and Delimitation of the Study

This study focuses on one particular issue, specifically, the effect prevailing regional and national innovation systems have on university contribution, and transformation processes towards becoming more entrepreneurial. This is extremely relevant given the changing financial landscape universities find themselves operating within, and governmental need to yield return on public investment. As such, the conceptual framework will provide background information to supplement and contextualise the study (see Chapter 2).

It is important to set boundaries for the course of the study, given the scale and level at which the analysis will take place, and the limited time and funding available to carry out this project. As such, the study will focus on four university case studies (two per region), which have been specifically selected to narrow the focus towards university

developments within the Life Sciences disciplinary area. The focus has been further narrowed to incorporate two regions (Stockholm and Vienna), given this sector plays a fundamental role in innovative activities and subsequent economic development for these regions in particular. As such, universities have been selected based on their location and activities within the Life Sciences sector. The focal point rests at the interface between prevailing regional and national innovation systems and the universities located within these regional and national contexts; specifically, the causal relationship between this innovation environment and its agent (the university).

Nevertheless, the author notes that a number of limitations exist when carrying out a study of this nature, given numerous other internal and external factors will also contribute to universities decisions to become more entrepreneurial. However, given funding and legislation is noted to be serious issues in such transformation processes, it is suggested that this study can draw useful insights despite potential supplementary reasoning behind transformation. As such, actors will be asked to address this particular point in order to address these issues within the data collection phase, thus improving the validity of the data.

My main constraints will be time and language issues. Therefore focusing on data gathered for supra-national level should be available in English, enabling comparative studies to take place; however, a brief overview of the literature available at national level proves that research carried out in the English language exists. In addition, documentation used for secondary data analysis has been sourced exclusively from official sources, which are publically available online.

Managing to secure interviews with the right people is an important limitation of this study, given the orientation of the research requires high level policy representatives and university managers to contribute their knowledge on the subject. In addition, these interviewees mother-tongue (in most cases) will either be German or Swedish. However, it appears that a high number of potential candidates have excellent English skills, according to publically available information online.

The small number of interviewees and representatives from the selected organisations may raise concerns. However, time restrictions, geographical location, participation rates, and data collection costs impacted volume of data which could be collected through individual interviews. Nevertheless, primary data has been collected from experts in their field, thus ensuring the reliability of the information gathered. In addition, although carefully selected against the aforementioned criteria, a small number of institutions have been selected for this comparative study. Therefore, overall, the results gained will not be generalizable. Nevertheless, this study acts as a pilot project, and provides insights into current trends within the life sciences sector in these particular regions, which has the potential to be extended in future.

Despite these limitations, acknowledgement of these has helped shape the orientation of the study, and also set limits regarding the scope and potential outcomes of the research. As such, the author believes that the objectives of the research will provide targeted insights of the current contextual situations which can be used in conjunction with other pre-existing studies in the field. This will give a holistic reflection upon which policy makers and university leaders can deliberate and strategize in order to find mutual understanding for the efficiency and development of universities in respect to their core and third missions; and the enhancement of the prevailing innovation system, which depends on the knowledge products and labour output provided by universities.

1.8 Organisation of the Study

This study has been organised into six chapters as follows:

Chapter 1 introduces the background and rationale of the topic in order to contextualise the development of this study. This is followed by a statement of the research problem, exposure of the gap in the literature, and associated research questions arising from the gap are defined. A brief introduction to the methods employed has been discussed, together with the significance and delimitations of the study.

Chapter 2 is designed to give an overview of the key concepts and theories related to the study, drawing upon relevant literature from the broad fields of innovation systems and entrepreneurial universities.

Chapter 3 focuses on the methodology employed to carry out the study. The selection of qualitative methods utilising comparative case study design will be justified, and the research design for the collection and analysis of primary and secondary data will be explained in more depth. In particular, the criteria for selecting the case studies and the interview design will be further explained.

Chapter 4 presents the results obtained from the primary and secondary data collection. It first outlines the national and regional context of the case countries, and the selected case universities. This is followed by the main findings arising from the study.

Chapter 5 is devoted to discussing the results in more depth by comparatively analysing the findings, to highlight similarities and differences between the Regional and National Innovation Systems under analysis.

Chapter 6 draws the study to a close by highlighting the major findings arising from the study, and formulating conclusions to address the research question. Policy recommendations are presented here, as well as potential areas for future research.

CHAPTER 2 LITERATURE REVIEW

This chapter examines the existing literature related to the phenomena under investigation. It explores the main theories and concepts relating to the overarching themes: innovation systems and the evolution of the entrepreneurial university. As such, literature has been consulted to form the foundation upon which this research endeavour aims to build. In particular, exploration of the concepts relating to culture in universities is important given the current empirical study does not cover this concept in depth.

2.1 Innovation Systems

It is apt to first explore the overarching situation in Europe regarding the 'European Paradox' which relates to performance of national innovation systems contributing to the competitiveness of the European Union as a whole. This is particularly relevant to the current study given the emphasis placed on Research & Development (R&D) activity, and return expected on public investment in research endeavours. Therefore, it is important to provide a holistic picture of the impact of this important driver in creating change. Theoretical studies relating to National Innovation Systems, Regional Innovation Systems, and the Triple Helix and Trilateral Relationships have also been explored in order to understand innovation dynamics under differing analytical frameworks.

2.1.1 National Innovation System

The concept of the National Innovation System (NIS) was originally developed by Freeman (1987), Lundvall (1992) and Nelson (1993), whereby the overall notion was defined to describe the interaction of elements and relationships to produce and diffuse knowledge which is economically useful within a country's borders (Lundvall, 1992). It is clear that much of the work carried out pertaining to the NIS was targeted to small countries such as Sweden ,Norway, Denmark, Finland, Japan, and Cyprus for example, which is evident in various author's work (e.g. Lundvall et al., 2011; Kapetaniou and Lee, 2013). Interestingly, (Lundvall et al., 2011) found that these small countries prosper because they have a highly developed capacity to absorb and use new technology used elsewhere - something they have in common with developing countries.

The literature to date can be split into two categories, encompassing a narrow or broad approach (OECD, 1999). The narrow approach focuses on institutions and policies directly involved in innovation such as the STI policies (Science, Technology and Innovation). This can be categorised into five separate categories namely, Governments (local, regional, national and international – with differing levels of power per country) that play a key role in setting broad policy directions; Bridging institutions, such as research councils and research associations, which act as intermediaries between governments and the performers of research; Private enterprises and the research institutes they finance; Universities and related institutions that provide key knowledge and skills; and other public and private organisations that play a role in the NIS (public laboratories, technology transfer organisations, joint research institutes, patent offices, training organisations and so on) (OECD, 1999). Porter and Stern (2001) also note the importance of these elements, highlighting the importance of human and financial resources allocated to scientific and technological advances; the level of technological sophistication; public policies affecting innovation related activities; intellectual property protection; and fiscal incentives for innovation; as providing the prevailing conditions and infrastructure for innovative activity to take place. Nevertheless, they also state the importance of clustering activities, which compounds earlier findings regarding the innovative capacity generated through relationships between actors.

Whereas the broad approach takes into account the social, cultural and political environment (institutional system / framework) of the country context. This includes a nation's financial system; its monetary policies; the internal organisation of private firms; the pre-university educational system; labour markets; and regulatory policies and institutions; as well as the aforementioned narrow components (Feinson, 2003). The relationships among these components, is a central feature within the concept of the NIS. Figure 2.1 illustrates the components and relationships in a typical NIS.

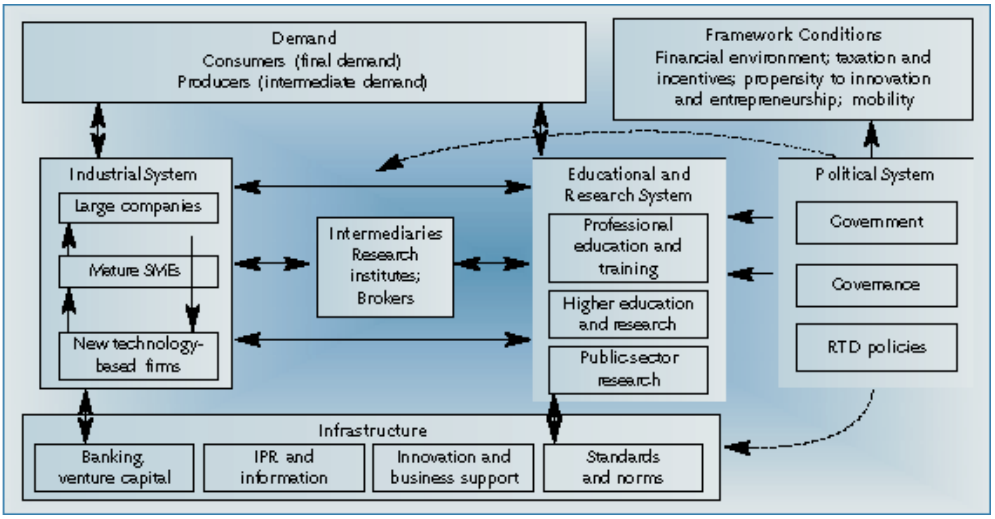

Figure 2.1. A National Innovation System Model. Source: Arnold and Kuhlman, 2001.

Fagerberg and Sapprasert (2011) highlight that literature regarding the systems approach towards innovation has grown rapidly since 2003 across a range of disciplinary areas. What is clear is that such systems must respond to needs, thus the coupling of mechanisms and policies is a bid to achieve a well-functioning NIS which delivers upon the technological and social innovation needs of a nation (Godin, 2010). Lundvall et al. (2011) point out that old style hierarchical modes of organising work may increasingly become barriers for the kind of intra-organisational interaction that is necessary to become a lead innovator. Lundvall (2005) noted that some of the conceptual openness of the concept of a NIS refers to the fact that historical and local context affects where the limits of innovation systems are set. These findings highlight the importance of fully understanding the historical context and existing framework of a NIS, when designing and implementing changes within the system. Within Europe, the current emphasis tends towards a bias of the utilisation of Science, Technology and Innovation (STI) policies and benchmarking policies, and components of innovation systems that aims to generalise 'best-practice'.

It is clear that innovation processes are evolutionary and path dependant (Johnson, Edquist, & Lundvall, 2003), meaning you cannot easily transplant a 'high performance element' from one system to another and expect similar results (Lundvall, 2005). This highlights that using qualitative analysis (not just stats relating to performance), as well as the use of social, political, and cultural history, is required to holistically understand the problem. In addition, differences exist in micro structures of Innovation Systems, which will be discussed in *2.2.2 Regional Innovation Systems*. It seems that the NIS literature focuses predominantly on firms, but the logic is transferable to universities given their evolutionary role is now to function similarly to other nodes in the Triple Helix (discussed in section *2.2.3 The Triple Helix & Trilateral Relationships* below), thus blurring the boundaries between nodes. Lundvall (2005) noted that the NIS highlights importance of interaction with universities on the innovative capabilities of SMEs, which is important for innovation and regional and economic development. Yet gaps exist in understanding how the formation and openness of the NIS affects how universities interact, and indeed contribute towards economic development within the system.

Importantly, Johnson, Edquist and Lundvall (2003) note that systems of innovation can be delimited in a number of ways: spatially, geographically, sectorally, or according to the particular activities they focus upon. This has significant relevance to the results arising from research, given the dependence on the orientation of the study. In addition, how the innovation system is perceived is equally important. For example, whether a NIS approach is adopted, or whether it is compartmentalised and explored via the integration and interaction of actors via the Triple Helix approach. Lundvall and Freeman adopted a broader perspective to innovation, given their focus on small countries as case studies required a more holistic analysis, thus emphasising that contextual setting is important in this case.

National Innovation Systems require strategies and policies if they are to achieve a nation's innovation potential. As such, EU member states have designed national reform plans and economic strategies, coupled with specific national

innovation strategies, national education strategies, and national research and development strategies (Galabova , 2012). These measures echo the goals and aims set forth in The Europe 2020 Strategy, and The Lisbon Strategy, by translating these measures to the given country context in a bid to contribute towards the EU's overarching goal of competitiveness on the global stage. Again from a small country perspective, Galabova (2012) shows through comparison of national innovation strategies it is important to understand a national country's understanding of innovation in such strategies, how they are implemented, the structures put in place to enable this implementation, and the financial resources required to bring reality to such strategies. Interestingly she found that the methods of adoption and the language very much differs between country contexts, ranging from those playing lip service to supra-national ideals forced upon countries; those exhibiting great aspirations, but lacking the strategic path on how to achieve such goals; and those who take a pragmatic and practical approach, clearly stating the intended actions required to deliver such goals. This is reflected in these particular case countries performance in the European Innovation Scoreboard, with these particular countries ranging from the "Moderate Innovator" status, through "innovation Follower" status, to "Innovation Leader" status, respectively. This reflects the lack of joined up thinking in some country contexts, due to fragmentation in the system, and the prevailing cultures of commitment towards reaching such goals. As a result, the design of such innovation strategies has an impact upon how the Triple Helix *(2.2.3 The Triple Helix & Trilateral Relationships)* functions on the ground. This highlights a need to take a more pragmatic approach when linking policy aims and goals, with its practical implementation, thus increasingly showing the need to understand how individual actors function and interact to deliver upon such goals.

In sum, one could contest that the NIS provides the environment for an innovation ecosystem, which is a relatively new concept in itself (Durst and Poutanen, 2013). Importantly, this particular terminology also points towards the importance of economic relationships between economic agents, coupled with non-economic components such as technology, institutions and sociological interactions (Mercan and GöktaŞ, 2011). As a result, Durst and Poutanen (2013) suggest that an innovation ecosystem is a hybrid of different networks or systems. Nevertheless, Yawson (2009) contends that traditional innovation models which are systemic in nature have the inability to identify the successful policy strategies that drive innovations at national level. This particular line of thought is extended by Papaioannou et al. (2007) who argue that the Schumpeterian tradition of innovation thinking (tied to complex economic, political and social factors), fails to adequately capture the distinction between structures and innovation events. As such, they feel there is a need to go beyond these traditional lines of thought towards looking at the integration of innovation activity in companies and organisations. This relates somewhat to Triple Helix theory (explained shortly), whereby such integration leads to greater cross-pollination of ideas. Yet it is clear that prevailing innovation structures are pivotal as a foundation for activities to take place. Durst and Poutanen (2013) note the central role of the governance dimension within innovation ecosystems, given they must somehow try to stimulate interactions and overcome communication challenges between the variety of innovation actors in a system. As a result, they argue that more research is needed to first, evaluate innovation ecosystems in order to improve measures by which actors allocate resources to different operations, through addressing all involved actors and their individual concerns, going beyond organisational boundaries; and secondly investigate the role of people in innovation systems. In particular, they deem country comparisons to be important, in order to determine which factors are likely to remain constant under differing contextual conditions. From this perspective, it is clear that literature pertaining to the NIS is evolving in new ways, and influenced by a range of economic and sociological perspectives. This is pertinent given such evidence points towards the growing need to employ interdisciplinary approaches in order to study such complex phenomena.

2.1.2 Regional Innovation Systems

Given the regional focus of this particular study, it is apt to consider innovation systems from a regional perspective. Johnson, Edquist and Lundvall, (2003) declare that systems of innovation may be delimited in different ways, whether spatially or geographically, sectorally, or according to the range of activities they focus upon. As such, systems of innovation with a geographical emphasis can be considered at the local level, regionally, nationally, or at supranational level. Interestingly, Lundvall, et al. (2011) extended the notion of geographically (or in terms of language and culture) analysing a system, given proximity in geographical terms could potentially compensate for the uncertainty that characterises the innovation process. In this particular study, emphasis has been placed at the regional level. To

clarify this further, Cooke, Uranga and Etxebarria's (1997) definition of a regionalisation approach is particularly apt, given it limits the focus to its competence (jurisdiction) capacity.

Governments, particularly those situated within advanced economies, realise the potential of regional innovation systems. As such, clustering policies and regional innovation have been promoted as a means to boost national competitiveness (Cook and Memedovic, 2003). Several examples of successful clustering exist at the regional level, including the biotechnology cluster in Oxford as an example. The success of these regions is recognised as having an important role to play in economic development policy (Cook and Memedovic, 2003). Yet, the authors also point towards the problems of underdevelopment in some areas, given the high dependence on public support, and posit a combination of public and private governance to promote systemic innovation within a region.

Universities' role within RIS has evolved considerably over the last 20 years, given the extension towards partaking in 'third mission' activities *(2.3.1 Funding, Transformation, and the Third Mission)* has transformed how universities function internally, but has also transformed how they are perceived within innovation systems (Gunasekara, 2006). By way of a comparative university case study, Gunasekara (2006) noted the importance of understanding the policy perspective for university engagement at regional level, with particular regard to the sustainable operation of universities. He argues that the distinctions highlighted through the Triple Helix model and university engagement literatures are material, given the need for real evidence to inform policy as to how university engagement at regional level can provide an appropriate basis for the sustainable operation of universities themselves. This statement highlights the need to bridge existing theories regarding these phenomena with real life situations, thus compounding the need for the current research endeavour.

Interestingly, Gunesekara (2006) noted that a combination of institutional and economic factors determine the role universities perform in the development of a RIS. Despite this, the general university engagement approach (which emphasises universities contribution towards the economic and social development of a region) plays down the differences in university missions; path dependent evolution and positioning within a region; and also oversimplifies the willingness and indeed capacity of universities to adapt their functions in response to external signals (Gunesekara, 2006). Farinha and Ferreira (2013) extend this notion, arguing that future research requires better alignment of the regional perspective of competitiveness with the Triple Helix methodology. This highlights the importance of selecting the Life Sciences sector for this current study as a means to identify anomalies within this specific knowledge cluster. In addition, these arguments also compound the identified need to do so through a targeted lens (through utilisation of a model such as the Triple Helix), as a means to magnify the situation within a given knowledge base, and actor relationships.

When considering the regional dimension, and the role of universities within regional development, one must consider the levels of interaction between universities and SMEs within a region. Lundval, (2005) identified international differences in the level of interactions, but found within their study of Denmark that low interaction was present. This has implications for the innovative capabilities of SMEs. Interestingly, the authors also noted differences in the microstructures of innovation systems under analysis, stating that such differences could be considered interdependent with the wider social setting with regard to the prevailing education systems, labour markets and welfare regimes in place.

2.1.3 The Triple Helix and Trilateral Relationships

The Triple Helix theory, developed by Etzkowitz and Leydesdroff (1995) explores the relationship between university-industry-government as sub-dynamics within innovation systems. It is imperative to understand the complexity of each node, given government can be considered at local, national, regional or supra-national level (Marginson and Rhoades, 2002); industry can be classified into different sectors and type of business (Metcalfe, 2010); and universities can be further classified by various sub-dimensions such as public or private control, size, geographic location, and institutional ranking, to name a few (Metcalfe, 2010). Therefore, the Tripe Helix thesis can be considered as widely applicable, yet it can also enable a narrow focus on specific elements within an innovation system through appropriate selection and analysis. The Triple Helix explores the 'systemness' of an innovation system and thus benefits from the confines of geography to delimit particular empirical case studies under investigation (Leydesdorff,

2012; Leydesdorff and Zawdie, 2010). It highlights the potential for innovation and economic development through the generation of new institutional and social formats for the production, transfer and application of knowledge (Ranga and Etzkowitz, 2013). It focuses on innovation systems at various levels in terms of institutional and functional categories, which can potentially contribute towards the improvement of the effectiveness of innovation policies at regional and national levels (Leydesdorff and Zawdie, 2010). Etzkowitz (2002) defines the first dimension of the triple helix model as the internal transformation within each of the helices, in the case of the university this could constitute the progression towards an economic development mission. He states that the second dimension pertains to how one helix influences another. Lastly, he contends that the third dimension deals with the creation of a new overlay of trilateral networks and organisations, which evolves from the interaction between the three helices. Therefore, this creates a spiral model of innovation, which acts to capture multiple reciprocal relationships at various points throughout the process of the capitalisation of knowledge. Nevertheless, Leydesdorff (2012) argues that the definition of a system is no longer what it used to be, and remains in transition given dynamics relating to local, regional and supranational environments and actors. In addition, he contends that when more than two helices are in operation, this opens the possibility for chaotic behaviour, which requires stabilisation along a trajectory, with government tending to provide this stabilisation through ongoing interactions, and perhaps domination in some contexts.

Throughout Triple Helix theory's development, differing perspectives have been explored including the (neo) institutional perspective, the (neo) evolutionary perspective, from the perspective of the Entrepreneurial University, and through the concept of Triple Helix Systems of Innovation (Stanford University, 2014). Regarding the current study, the (neo) institutional perspective and perspective of the Entrepreneurial University are most relevant for further exploration. The (neo) institutional perspective examines the growing prominence of the university among innovation actors through national and regional case studies, which reflects the current methodology employed in this study. In addition, this particular perspective focuses on various aspects of the university 'third mission' of commercialization of academic research and involvement in socio-economic development (Stanford University, 2014). As such, it takes into account the variety of stakeholders, drivers and barriers, benefits and impact, university technology transfer and entrepreneurship, contribution to regional development, government policies aimed to strengthen university-industry links, and so on. (Stanford University, 2014). Importantly, it differentiates between three main configurations in the positioning of government, industry and university in relation to each other, including the statist configuration, the laissez-faire configuration, and the balanced configuration; whereby the intersection of these three spheres in this balanced configuration is perceived to provide the most favourable environment for innovation (Etzkowitz and Ledesdorff, 2000).These configurations are illustrated in Figure 2.2, and highlight the dominance of State control in the statist model, the disconnection between individual spheres in the laissez-faire model, and the favourable overlap between spheres in the balanced Triple-Helix model. This overlap is particularly important, given the development of trilateral networks and hybrid organisations which have developed in order to enhance interactions between and among spheres. This is of course essential to produce, accumulate, and diffuse knowledge for promoting competitiveness through innovations (Lundvall and Johnson, 1994; Archibugi and Lundvall, 2001). Metcalfe (2010) notes the importance of trilateral networks which operate in the spaces between the three nodes of the Triple Helix. She argues that the Triple Helix is an evolutionary process encompassing three strands that form inter-organisational bonds. As such, trilateral networks (often non-profit organisations) function to provide cooperative interaction which strengthens links and provides a bridge between each node, thus providing multiple paths for inter-agency cooperation (Metcalfe, 2010). It is worth noting that the Triple Helix itself is not stable, and thus remains in transition, yet the model enables relevant categories for observation to be identified (Leydedorff, 2006; Etzkowitz and Leydesdorff, 1998).

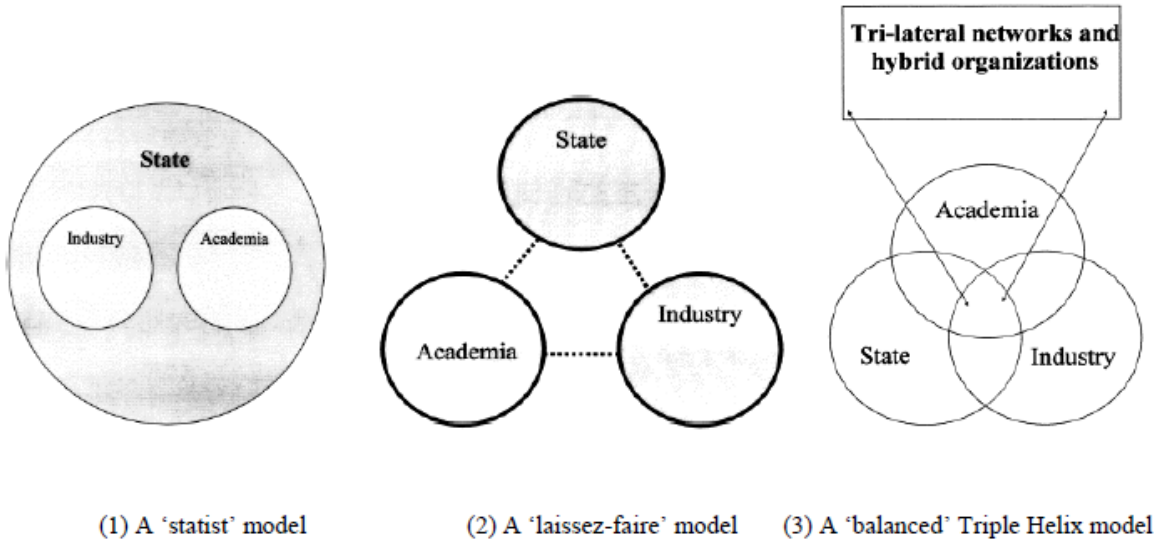

Figure 2.2 Triple Helix Configurations. Source: Ranga and Etzkowitz, 2013.

Of particular relevance, is the concept of the Entrepreneurial University, which is a central concept within the Triple Helix model. Academia's role in creating and applying new knowledge through 'third mission' activities *(2.3.1 Funding, Transformation, and the Third Mission)* is a salient feature of the Entrepreneurial University. This is because socio-economic development is a fundamental outcome associated with its activities and role within the Triple Helix, particularly given intellectual assets are considered renewable and thus a strong source for continued regional development (Etzkowitz and Dzisah, 2008). As such, the economic impact of universities through R&D effort to GDP is noteworthy (Farinha and Ferreira, 2013), however, Kapetaniou and Lee (2013) and Hazelkorn (2006) argues that a university needs to be directly linked to the industry in order to maximize the industrialisation of knowledge. A number of authors have argued the importance of these three institutional spheres (university – industry – government) as fundamental components to enhancing regional and national innovation systems (Etzkowitz, 2003a; Etzkowitz, 2003b; Etzkowitz and Leydesdorff, 2000; Leydesdorff and Meyer, 2006; Cooke and Leydesdorff, 2006; Smith and Bagchi-Sen, 2010; Etzkowitz and Dzisah, 2008; Huahai et al., 2011; Galindo et al., 2011). Importantly, it is recognised that universities may indeed perform an elevated role in innovation within the context of knowledge based societies (Etzkowitz, 2003a; Etzkowitz, 2003b; Leydesdorff and Meyer, 2006; Etzkowitz and Dzisah, 2008; Etzkowitz and Leydesdorff, 2000). This is especially true as nations aim to move from industrial economies to knowledge based economies. Further, the formation of collaborative links between innovation actors is a central concept of the Triple Helix model, and universities have found themselves at the centre of such developments through their valuable production of scientific research. Leydesdorff and Meyer (2006) posit that when three selection environments are involved, namely academia (novelty production), industry (wealth generation), and government (public control), complex dynamics are to be expected through interactions involving bi-lateral and trilateral relations. Leydesdorff and Meyer (2006) also noted the importance of this model for analysing Triple Helix dynamics from a historical and evolutionary perspective, given it enables analysis of how institutions and institutional arrangements carry out certain functions, but also enables an overview of selection environments in terms of outputs. This is particularly apt for the current research study, given national systems tend to be path dependant, encompassing historic conditions which can impact current functionality and evolutionary behaviour, particularly if multi-level governance models are present within national systems (Leydesdorff and Zawdie, 2010).

Within the Triple Helix, government is considered as a key dimension to ensure cooperation, partnership and institutional support between social and economic networks, thus promoting stable interactions (Farinha and Ferreira, 2013). As mentioned previously, governments recognise the economic benefits of knowledge, and as such support the political and local economic frameworks to enable growth within stable prevailing innovation environments, through utilisation of relevant policies and incentives (Etzkowitz, 2003a; Sunitiyoso et al., 2012).

The role of government seems even more pertinent in small country studies, with national institutional support systems and policy interventions the major channel of interaction. In addition, government is both a catalyst and a facilitator to improving institutional structures and processes of innovation, and are central to promoting Triple Helix relations (Kapetaniou and Lee, 2013; Durst and Poutanen, 2013). Yet it is imperative that governments are well informed in order to design policies which are indeed beneficial to individual actors, as well as collectively for the innovation environment, and thus context is important within this paradigm. However, Kapetaniou and Lee (2013) state that the Triple Helix concept in small countries is still at a primitive stage, and therefore more work is required to understand innovation actors' roles within small country innovation systems, given they determine its overall performance. In addition, the generalizability of such studies must be carefully examined considering the differing socio-political, economic, and industry environments which prevail in each country context.

Nevertheless, one problem of the Triple Helix model is its focus on a top-down system level, rather than on the peculiarities of individual actors **(**Leydesdorff and Zawdie, 2010). This is pertinent given no two universities are the same, or indeed follow any typical path towards becoming entrepreneurial. Therefore, this highlights the need to better understand the impact of interaction on university transformation. In the case of Norway (Leydesdorff and Strand, 2012), it is clear to see that regional differences exist in relation to the sub-dynamics of the Triple Helix model, with substantial government intervention in the northern part of the country changing the dynamics of the regional economy.

As can be seen through the balanced Triple Helix model in Figure 2.2, additional sets of tri-lateral actors also work in conjunction to improve and enhance conditions for innovation locally, and can take the form of industrial organisations, academic institutions and political entities (Etzkowitz, 2008). Therefore the innovation landscape becomes quite complex providing a web of possibilities as interactions between all innovation actors increase. This is also stimulated by the physical location of such actors, with the development of Science Parks providing close proximity and a platform for actors to meet and collaborate. In addition, the provision of strong infrastructure through regional clustering activities around particular industry sectors and regional competences, also encourages interactions (Farinha and Ferreira, 2013). Nevertheless, two main trends are shaping the developments of university-industry relationships; basic research financed by research entities and councils and industrial projects where universities are subsequently invited to participate; or through the formulation of joint research programmes enabling access to multiple sources of financing (Etzkowitz, 2008). The flow of resources, commerce, actors are central to the influence of intermediary organisations within tri-lateral networks (Metcalfe, 2010). The importance of such interactions still plays an important role in literature to date with Lundvall et al. (2011) noting its effect on economic development. In particular, they emphasise the development potential of R&D collaboration with SMEs, and as such, the need to understand and raise awareness of what takes place within the university node of the Triple Helix.

Notably, they highlight that this lack of awareness within the university node could be due in part to the uptake of the Triple Helix theory at policy level, as well as at the functional level of the institution. They believe that the orientation of the prevailing NIS, and how EU innovation policies are translated to national contexts, has a strong bearing on how universities are integrated within the system. As such, interactions, and the learning that takes place as a result, seems to be dependent on the prevailing national context and the characteristics of the organisations who engage in R&D activities. Therefore, as Lundvall et al. (2011) conclude, economic development hinges on enhancing the capability and opportunity to learn at all levels. This suggests room for improvement in the understanding of how transformational characteristics in institutions such as universities in its interaction with the NIS could hold important learning opportunities. From the perspective of the university, Slaughter and Leslie (1997) have explored the concept of academic capitalism, noting the motivation of individual academics for driving towards commercialisation of research endeavours. These change agents are required in a system if knowledge exchange is to take place. As such, the role of trilateral networks in this instance creates efficiency within the process, and aids organisational survival and success within this evolving knowledge economy (Metcalfe, 2010).

Latest developments by Ranga and Etzkowitz (2013) highlight that their conceptual framework (which aims to identify blockages or gaps within these complex Triple Helix relationships) offers new insights into innovation dynamics, given

its broad perspective for understanding the sources and development paths of innovation. They foresee the framework providing an attractive paradigm at regional level for regions aiming to enhance their knowledge base and create 'steeples of excellence' around specific research themes promoting commercial potential, in conjunction with innovative firms (Ranga and Etzkowitz, 2013). Building upon this concept, the current study aims to focus on such barriers to interaction through analysis from an alternative perspective, in order to understand the paradigm of the university, and the dual set of demands placed on this institution, namely from the wider innovation system, and internally through transformation, and its effects on the functionality of the university in today's innovation environment. This is particularly pertinent given Martynovich (2011) argues that a need exists to perform empirical research on bilateral university-government and industry-government relations from the perspective of the Triple Helix model, suggesting deeper understanding into specific nodes of the Triple Helix is required. Mêgnigbêto (2014, p.1) found that, *'mutual information is interpreted as the extent to which a system is controlled by an actor, or self-organized and mutual redundancy as the positional counterpart of the generation of uncertainty in relational communications'*. This suggests that there is a need to establish the power and influence of individual actors on the internal dynamics and organisation of other actors within an innovation system, particularly within the thesis of the Triple Helix.

Overall, it is clear to see how integrated theories pertaining to national and regional innovation systems are with the logic of the Triple Helix model. Farinha and Ferreira (2013) have depicted this relationship through development of a model, in a bid to describe and clarify the dynamics underlying competitiveness and development (Figure 2.3).

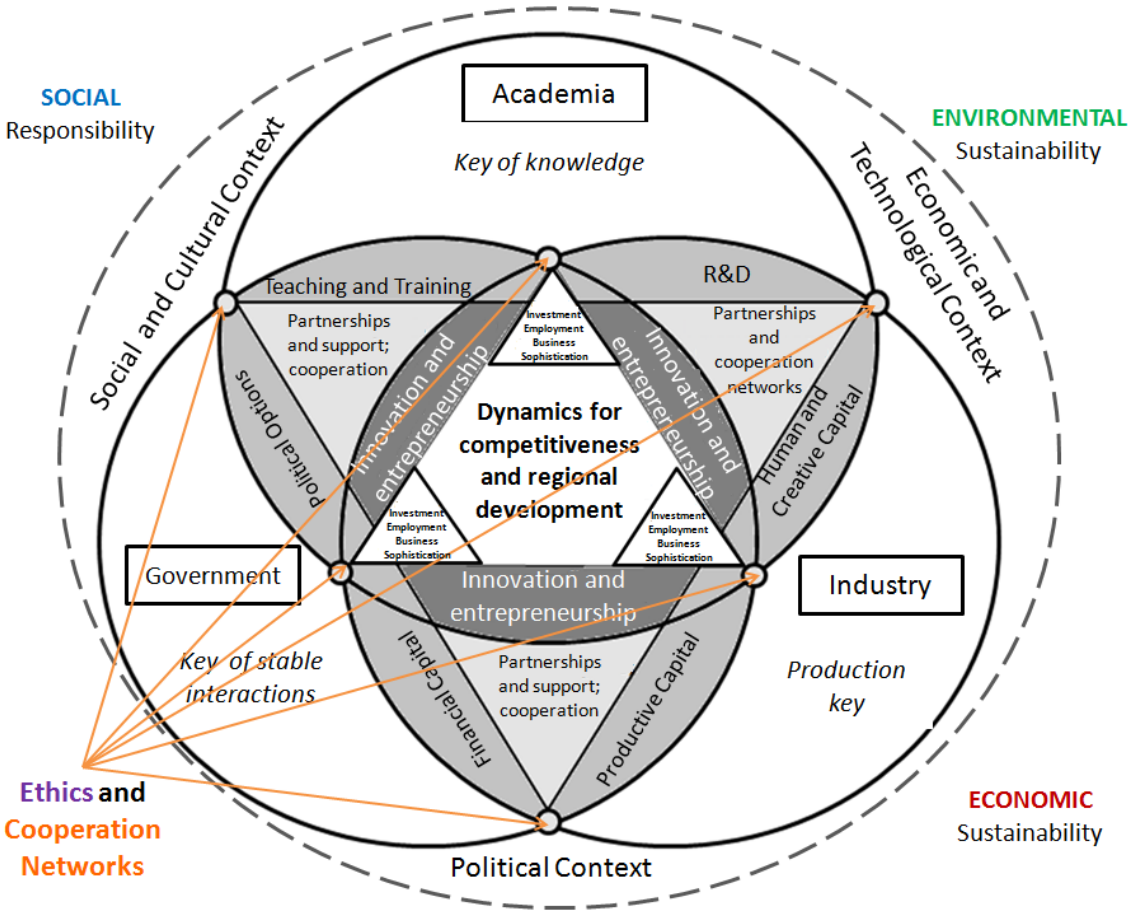

Figure 2.3 Triple Helix Triangulation Model. Source: Farinha and Ferriera, 2013.

This model emphasises the permeable necessity of innovation and entrepreneurship throughout an innovation system, highlighting the contributory elements from each node of the Triple Helix, and their subsequent relationships, embedded within its wider institutional framework. This model graphically illustrates the integration of these elements

well. Nevertheless, given the complexity of this integrated system, it is clear that research on the interface between nodes and this wider innovation environment is required to establish dynamics from this alternative perspective. This type of research will add a three-dimensional perspective to this existing two-dimensional model, and give depth and meaning to the impact of this complex environment on particular actors within the system. Greater understanding could potentially lead to efficiencies and symbiotic benefits within the system.

2.1.4 The European Paradox

It is recognised that Europe needs to improve its efforts regarding transformation of research into new and better services and products, if the EU are to remain competitive in the global marketplace, and improve the quality of life in Europe. At present Europe, on average, is spending 0.8% of GDP less than the US, and 1.5% less than Japan, every year on R&D. Despite the EU market being the largest in the world, it remains fragmented and not innovation-friendly enough (European Commission, 2013). Therefore, it is crucial to invest in innovation, because by achieving an investment target of 3% of EU GDP in R&D by 2020, this could potentially create 3.7 million jobs and increase annual Gross Domestic Product (GDP) by €795 billion by 2025 (European Commission, 2013). As a result, the knowledge triangle has been given great precedence within the European Union, whereby the necessity to intensify links between research, innovation and education (the knowledge triangle) has been repeatedly stressed since it was put forward as central element of the Lisbon Strategy in 2000 (FarHorizon, 2010). This is due to the belief that in an increasingly knowledge-based economy, the quality of university-industry linkages is important for growth (Conti and Gaulé, 2009a). After the inclusion of utilitarian knowledge production and university knowledge-transfer within the Lisbon Strategy, this placed university activities high on the political agenda, with the most relevant communications from the Commission in relation to the development of 'third mission' activities being, "The role of the universities in the Europe of knowledge" in 2003, "Mobilising the brainpower of Europe: enabling universities to make their full contribution to the Lisbon Strategy" in 2005, and "Delivering on the Modernisation Agenda for Universities: education, research and innovation" in 2006 (E3M, 2010). However, the target, as proposed by the Lisbon Strategy 2010 to turn the European economy into *'the most dynamic knowledge-based economy in the world'*, still requires a lot of work, given it has not met its target (Wyplosz, 2010). As a result, the need for continued innovative performance has been highlighted within the Europe 2020 Strategy, through the Innovation Union initiative. Through developing the Lisbon agenda, the Modernisation agenda, and the strategic goals of the EU2020 Strategy, the European Union has recognised the importance of the role of HEIs (through education, research and innovation) in the transfer of knowledge to society and their vital contribution to Europe's economic competitiveness. The need for closer cooperation between academia and the business world is underscored given it provides a range of advantages and benefits for HEIs, students, business and society alike.

On several occasions, the European Commission has argued that while European research institutions are good at producing academic research outputs, they are not successful in transferring these outputs to the economy – the so called 'European Paradox' (European Commission, 2007). Reforms in the organisation of technology-transfer are thus needed to improve knowledge transfer from public research institutions to firms. A background paper for the EU's FarHorizon foresight project points out that recognition exists that policies for the knowledge triangle are insufficiently joined-up, an example being the relatively minor role that the education and training dimension of higher education receives in policies for the European Research and Innovation Area (FarHorizon, 2010). Interestingly, little mention is made to universities' role in technology-transfer, except outlining the forthcoming Research and Innovation Plan, which will be a central element of the EU2020 strategy, as it offers an opportunity to re-position innovation within the European policies and is likely to seek to build greater synergies between higher education, research and industry (FarHorizon, 2010). Given the next generation of innovation policy at supranational level requires detailed foresight regarding appropriate instruments and frameworks in which innovation can flourish, it seems apparent that more work is required to probe this particular area of university contribution and transformation, given various authors in the field have identified its current underutilisation, and importance as an instrument for economic growth (The Association of Independent Research and Technology Organisations, 2013; and Taylor, 2013).

2.2 Towards the Entrepreneurial University

The European Paradox and the changing funding landscape nationally have created in important impact on how universities supplement decreasing allocations of public funds. As such, existing literature has explored the evolution of the university in response to such challenges. This is evident in the literature exploring the transformation towards building an entrepreneurial university; and the rise in case study research exploring best practices for developing third mission activities. This section will explore the funding and transformation anomaly in relation to the third mission; entrepreneurial university case studies with a particular emphasis on the cultural aspect (to supplement the current study which does not focus on this particular aspect, but is considered a relevant factor); and university technology transfer.

2.2.1 Funding, Transformation, and the Third Mission

The availability of funding has changed dramatically over the past decades, with reductions in national public funding allocations for universities. There has been an orientation towards linking HE policies with economic innovation strategies (Hoareau, Ritzen and Marconi, 2012), and designing funding mechanisms to increase economic activity. This is likely due to the recognition that universities' are perceived as potentially key actors in processes of entrepreneurial discovery which lies at the centre of smart specialisation processes (ESMU, 2012). As a result, growing political pressure is present for universities to increase their own research funding options through intensifying interaction with industry, given level of competitiveness is likely to be impacted if reducing public funds are not matched by private sources (Muscio, Quaglione and Vallanti, 2013; Hoareau, Ritzen and Marconi, 2012). Koryakina, Teixeira and Sarrico (2012) also noted the importance of income diversification in European universities and found that governments have tested different approaches as a means to attract finance to higher education systems, through providing tools for revenue diversification, and also through the introduction of market mechanisms. In addition, Koryakina, Teixeira and Sarrico (2012) argue that this diversification of income is a potential source to improve the current deficit in innovation, through promoting knowledge transfer within public-private partnerships.

Overall, universities recognise the increasing need to supplement their funds to carry out their multiple missions, with results from Koryakina, Teixeira and Sarrico's (2012) Portuguese case study highlighting that revenue diversification activities were recognised as drivers of institutional dynamics and development. This shows the introduction of market mechanisms has created a more business like environment, given universities now have to compete for research funding and attract tuition fees. This highlights the enormous impact regarding how available funding streams within innovation systems have the power to create transformational change within universities. Yet one must question the opportunistic approaches towards gaining funding, and how this really impacts university transformation. Clark (1998) notes this business-like behaviour in the way universities are changing structurally and also managerially, and uses terminology borrowed from the business world to describe the types of strategic thinking, committed leadership, institutional governance, entrepreneurial culture, and flexible and responsive organisational structure, to illustrate this evolutionary pattern. Clark (1998) found, an entrepreneurial university can be analysed from five dimensions:

1. The strengthened steering core: Universities need to become quicker and increasingly flexible in order to have the ability to adapt and react to changing demands from their wider environment. In addition, greater organisation internally is necessary, requiring a strengthened core (that can take on the design of a variety of differing models). Nevertheless, central managerial groups and academic departments must be embraced in such a way as to reconcile existing traditional academic values with managerial values, so that the university can become operational in its self-steering capacity.

2. The diversified funding base: Universities generally require to increase financial resources through expansion of possible funding sources. Discretionary funds are necessary to maintain a certain degree of independence in how funds are allocated, rather than being predominantly driven by the demands stipulated through a narrow base of support i.e. public governmental funds. Therefore, those universities raising money from research councils, and other third stream sources such as industry, philanthropic foundations, royalties from IPR, student fees, alumni fundraising, and campus services, enable financial diversification. Therefore, such entrepreneurial universities have the opportunity

(due to diversified resources) to act quickly and respond to changing environments, rather than having to wait for system-wide enactments, which are slow in their standardisation.

3. The expanded development periphery: Universities need to forge links with outside organisations more easily and more professionally. As such, the development of professionalised outreach offices creates a bridge between academic departments and external clients. These take on differing functions, including industrial contact, intellectual property development, knowledge transfer, fundraising, alumni affairs, and continuing education. In addition, larger interdisciplinary projects can be developed in research centres as a means to group academic work, and produce an area for cross-pollination of disciplinary research. Therefore, these additional units enable activities to take place that would be difficult to organise through existing academic departments alone. Therefore, they provide the infrastructure and practical assistance needed to cope with rising societal demands.

4. The stimulated academic heartland: The heartland of a university resides with the staff located within a multitude of traditional academic departments, based around a variety of disciplinary areas, whether old, new or interdisciplinary in focus. As such, it is critical that academic staff accept change if significant transformation towards becoming more entrepreneurial is to take place. Therefore, those opposed to change will continue to function within their traditional routines. However, if change is to be achieved, each department and faculty has to embrace the transformation by becoming an entrepreneurial unit itself, reaching out beyond the borders of the university towards generating new third stream income sources. As such, academics must participate in central steering groups, and embrace the increased authority afforded to individuals and collegial groups within the managerial line of the university, if transformation is to take hold. Importantly the aim is to blend firmly rooted traditional academic values with new managerial values in order to create a belief system that will help enact change.

5. Integrated entrepreneurial culture: Universities must develop a culture that embraces change. This can start as an institutional idea which grows into a set of beliefs. If this is subsequently diffused into the heartland, it has the potential to become a university-wide culture. Nevertheless, culture is rooted in practice, and values and beliefs are crucial within the cycle of interaction between ideas and practice. Therefore, an institutional perspective is required given organisational values must be considered in tandem with the structures and procedures through which these values are expressed. Therefore, an entrepreneurial culture is made operative when values and beliefs are put into practice, which thus cultivates new institutional identities as entrepreneurial behaviours develop over time.

It seems that a university not only requires structural change in the first three dimensions, but also requires buy-in at the cultural level described by the remaining two dimensions, especially given universities are people oriented institutions, whereby people are the driving force to enact change. In addition, such transformations occur over the long-term, requiring sustainable collective action, which ultimately leads to new entrepreneurial practises and beliefs (Clark,1998). Embracing cultures of risk and flexibility enables universities to develop in such a way that they will be able to respond entrepreneurially to changes within their given environments.

Interestingly, Kivisto (2007 p.194) noted during his study that in general terms, the government-university relationship seems to contain the essential conditions that should be present in an agency relationship: namely informational asymmetries and goal conflicts. This illustrates the difficult relationship between government and universities by highlighting issues of transparency which lead to issues of mistrust, and also the differences in end goals which persist between these two actors. Literature pertaining to academic capitalism discusses to great length the differences in orientation of academics to pursue third mission activities (Slaughter and Leslie, 1997). There is a tendency in some settings for individual academics to pursue such commercial activities, with strong resistance from the majority of the collegial body to such developments (particularly in the more traditional universities). In other cases, entrepreneurial spirit appears to be more embedded in the organisational culture, with modern universities displaying this type of entrepreneurial drive. Drawing upon Kivisto's (2007) findings, it seems appropriate to draw comparisons between the general relationship between government and universities, the underlying attitudes at institutional level, and the opportunistic behaviour of universities with regard to government governance and resource allocation mechanisms, which perhaps contribute to this anomaly. Despite the weaknesses in utilising Agency Theory (such as its narrow focus on individual relationships and failure to consider additional factors and motives), this suggests that a balance must be found in order to help universities to meet external stakeholder demands, whilst also fulfilling their core

missions. Therefore, it could be suggested that symbiotic understanding is required of each actor in order to design initiatives that are conducive to both parties.

Building upon these theories of the government-university relationship, one can see that the locus of control has shifted somewhat from governments to institutions, through recent reforms in higher education. The successful implementation of greater autonomy granted to universities appears to benefit from incentivisation mechanisms as opposed to mandates at the institutional level, in order to stem resistance, and improve acceptance of such dynamic changes (Varghese, 2004). Nevertheless, such mechanisms are designed to translate policy decisions into achievable targets, so as to achieve the economic and social expectations of society and individuals (Varghese, 2004). Yet, it seems that prevailing environments and funding sources have an impact on how universities organise their activities. This suggests that power relationships are altered, which can be attributed to steering mechanisms associated with governmental control, and the individual autonomy of universities to forge their own paths in market-like conditions. Estermann, Nokkala and Steinel (2011) found that restrictions in financial autonomy are particularly limiting for universities, and therefore greater autonomy in this area is crucial for universities to achieve their strategic aims. As such, a 'one size fits all' approach does not work when trying to stimulate the interaction and contribution of universities to innovation systems, given nuances in prevailing regional environments, and core missions of universities. On the other hand, Hoareau, Ritzen and Marconi (2012) found that incentive mechanisms are seen as a restriction in autonomy. Overall, these evolutionary changes in the dynamics of funding leading to diversification in funding streams, accountability to the public purse, and increasing relationships with a multitude of external stakeholders, have encouraged universities to develop 'third mission' activities.

Over the centuries, the traditional role of the university was primarily to convey learning through teaching; and laterally, through the evolution of the Humboldtian university model, to develop research activities in order to further knowledge for knowledge's sake (Predazzi, 2012). However, the dynamic funding environment and innovation systems in which universities now operate has called for universities to not only have greater dialogue between science and society, but to contribute towards regional development through basic and applied research endeavours, the development of human capital, and the development of cultural capital for social cohesion (UNESCO, 2005, p.97; OECD, 1996; OECD, 2008; World Bank, 2002). Importantly, these demands are being placed on universities to both reflect the public finance element of support through increased accountability, and also to harness the untapped economic potential of this institution to service the needs of economies and governments throughout the world (Gibb and Hannon, 2006; Curley and Formica, 2012; Etzkowitz et al., 2000). Allinson notes (University Industry Innovation Network, 2013) the many pressures on universities to meet the demands of an array of stakeholders, but also recognises the need to protect fundamental research. The emphasis on commercialisation of activities, and allotted funding mechanisms has reduced the available time and finance to direct capital to the pursuit of new knowledge. Therefore, Allinson (University Industry Innovation Network, 2013) contends that a strong strategy and implementation plan is needed which addresses the pressures from the complex environment in which universities operate.

Drawing upon empirical evidence from universities in the UK, France, Germany and Italy, a study by Nelles and Vorley (2009, p.1) argues that the triangulation of teaching, research and third stream activities actually *'reinforces the respective dynamics of each component through their recursive and reciprocal development'*. This indicates that appropriate policy design at governmental level, coupled with strong institutional strategy, implementation, and collegial support, has positive outcomes for the range of stakeholders involved. Nevertheless, further research is required to understand how such relationships function, particularly at the regional level. Muscio, Quaglione and Vallanti (2013) noted that empirical evidence regarding the extent to which government funding affects external funding options available to universities, particularly those relating to research and consultancy, was limited. They found that government funding complements such third stream funding endeavours, thus increasing universities' industry collaboration, and further activating the knowledge transfer process (Muscio, Quaglione and Vallanti, 2013). Not only is the functionality of this funding mechanism important from an operational perspective at institutional level, but it also has a secondary function in that it creates and enhances innovative activities, which subsequently has consequences for regional development, which agrees with Koryakina, Teixeira and Sarrico (2012).

On the other hand, the GOODUEP project (Mora, Detmer and Vieira, 2010), focused on compiling best practices for university-enterprise partnerships (UEPs) through utilisation of eighteen diverse international institutional contexts. During the course of this study, it was found that motivation towards boosting the regional economy in which the university was located was much more important than the motivation to bring additional income as a consequence of partnering in UEPs. Therefore, despite the business oriented attitude within which university structures are operating, it seems that at present within these particular case universities, activities are not currently earning a profit, and in fact, activities of such partnerships have been heavily subsidised by either public, private or a combination both types of funding. Further, Mora, Detmer and Vieira (2010) found that the majority of activities carried out by university technology transfer offices (with some exceptions) are in need of university or alternative external subsidies to maintain their operations. In this instance, the orientation of these universities agrees with Dinapoli (2011), who highlights the regional benefits of universities given they act as catalysers of economic growth and through driving new ideas and technologies, building up a qualified workforce, and establishing partnerships with private sector entities and investors. Farinha and Ferreira (2013), promote the notion that the entrepreneurial university is a powerful development concept consituting the university as a flexible organisation which must interact within and adapt to its econimic and social environment in order to find additional resources. Nevertheless, Etzkowitz (2008) states that not all universities are able to become entrepreneurial, whether due to their orientation towards social welfare, or through their lack of interest in commercialisation. This therefore highlights that the model of the entrepreneurial unviersity does not transcend all HEI activities and strategies, and as such, performance must be contextual to these core missions and aims.

2.2.2 University Transformation

The rise of the entrepreneurial university has become ever more apparent in recent times, with governments delegating further autonomy to universities since the 1980's, which has seen the introduction of New Public Management (NPM) within the HE sector. This has had an effect on the structure and orientation of the activities of universities to varying degrees, and differences in structure and success can be witnessed between traditional and new universities. However, from a practical perspective, reductions in public funding means the Entrepreneurial model of the university now operates in a dynamic international environment where alliances, partnerships, joint ventures, collaboration with industry and commercialisation of knowledge are becoming increasingly pivotal to the financial success of universities, in order to diversify their funding portfolios, and increase their contribution to society through third mission activities. Yet the success of the entrepreneurial model relies heavily on academic staff engaging in the process, and it is clear some tensions exist within this transition from traditional to entrepreneurial activities, leading to varying levels of success achieved within this transition.

Several case studies were explored, including University of Strathclyde, University of Twente, University of Warwick, Chalmers University of Technology, University of Joensuu, University of Sussex, University of Vienna, University of Waterloo, and an anonymous new university (Clark, 1998; Martinelli, Meyer and von Tunzelmann, 2008; Jacob, Lundqvist and Hellsmark, 2003; Bramwell and Wolfe, 2008; Oleksiyenko, 2002; Glaser, 2012; Woollard, Zhang and Jones, 2007), together with findings by Cameron and Freeman (1991). A common discovery was the uniqueness of each particular case, with nuances present depending upon the type, tradition, history, and projected orientation of the universities studied, as well as differences in the external environments in which they were located. Despite these differences, many common problems were highlighted during their transition. Issues relating to globalisation and reductions in public funding led to the subsequent implementation of NPM principles, with steering towards market like behaviour and governance (Clark, 1998). Each university had their own reasons for adopting a more entrepreneurial approach, but generally it was to resolve problems present with their current systems. These included improving financial perspectives, reforming management and leadership, changing the cultural perspectives in relation to the image projected by the organisation as a means to attract the best students and staff, to promote innovation and entrepreneurial activity within the academic staff and student body, and also from the perspective of promoting closer interaction with industry, and indeed society. Overall, survival was the overarching driving force, with each organisation realising it must adapt to its current environment if it was to survive amongst the competition, and within a climate of reducing public funding.

2.2.2.1 University Culture

This shift towards 'academic capitalism' (Slaughter and Leslie, 1997) has created tensions given the creation of competition within the institution, at faculty level, and between departments, for external and internal monies, and the ever increasing need to find own resources (Oleksiyenko, 2002). Shifts in managerial and organisational structures, relating to NPM, has created mistrust among some academics, and has thus impeded progression towards entrepreneurialism. There is also a greater need to collaborate through networks and consortia, and thus adopt an 'outward-facing' (Woollard, Zhang and Jones, 2007) orientation towards activities. However, it is widely accepted that modernisation of the HE sector requires universities to do more at a lower unit cost (Oleksiyenko, 2002). Clark (1998, p.129) argues that *'demands on universities outrun their capacities to respond'*, which is due to external pressures accompanied by exacerbating internal problems that often impair public universities' ability to make an adequate response (Oleksiyenko, 2002). In addition, increases in knowledge production require greater resources.

Reflecting upon the differing outlooks displayed by traditional and new universities, Martinelli, Meyer and von Tunzelmann (2008) recognised that even though universities could share some ultimate goals they have different histories, traditions and organisational structures, which can shape universities' attitudes toward relationships with external institutions and can subsequently affect their outlook on knowledge exchanges, a view shared by Bercovitz, Feldman, Feller and Burton (2001) and O'Shea, Roche, Allen and Chevalier (2005). Oleksiyenko (2002) noted that academics tend to be less focussed on wealth generation and more focussed on gaining income, with frustrations present within faculty with the increasing bureaucracy towards rules and procedures. Therefore, these procedures and requirements stimulate a culture of complaince, rather than encouraging recognition of opportunity (Spender, 2000). This is very much echoed in the fact that the culture present within traditional universities is based on individual autonomy, which can create isolation between academics, and a disregard of the need for overarching strategies within their departments or institution (Davies, 2001). As a result, this individual nature leads to organised anarchies (Perlman, Gueths and Weber, 1988), with any responses to external opportunities tending to be carried out on an individual basis. Given the traditional culture by which academics carry out their activities, accountability tends to be lower, given the input rather than output oriented organisation of activities, and as a result, dealing with the market creates great feelings of distrust amongst traditional academics, especially considering traditional academics are driven by inquisitiveness of the unpredictabilities of new discovery. This is further compounded by (Glaser, 2012), who notes knowledge is still perceived as common property, and (Woollard, Zhang and Jones, 2007), who noted that the very concept of 'academic enterprise' has not been well received by the majority of staff.

In addition, the need for flexibility, adaptability, speed and incentives for motivation is critical for effectively carrying out 'third mission' activities (Morris and Jones, 1999). Woollard, Zhang and Jones, 2007 note that moves towards becoming an entrepreneurial university are driven by the activities of individual faculty. These academic entrepreneurs and their entrepreneurial intent (Prodan and Drnovsek, 2010) are critical to its success, and with it, the development of an appropriate institutional culture is pivotal to successful entrepreneurial activity, as these entrepreneurs require a conducive environment upon which to flourish (Walker, 2012). Therefore, for entrepreneurial cultures to prevail, there must be a willingness of academics to take risks (Gjerding, et al., 2006), shared governance, and appropriate reward systems to fulfil the prestige academics seek through scholarly activity. Clark (1998, p.12) identifies the importance of members of an organization identifying with *'successful entrepreneurial beliefs'* and *'a will to change'*. This culture of individual will is displayed within Chalmers University of Technology (Jacob, Lundqvist and Hellsmark, 2003), where individual initiative on the part of students and/or faculty is highly valued, and has contributed to its successful transformation. Bramwell and Wolfe (2008) note the need for 'Good Community Players' who are engaged in entrepreneurial culture. Interestingly, Bramwell and Wolfe (2008) state that nobody set about creating this culture, it just happened; there is a culture of innovation, where entrepreneurship is valued, and professors who had started their own companies are held in very high regard. It was noted however, that its success was largely dependent on the ability of local actors to collaborate across geographic and social boundaries, thus forming an 'economic community' based on sustainable, collaborative relationships between firms, local institutions, and the community, and mediated by key people and organisations, that afford each of these actors a sustained mutual advantage (Bramwell and Wolfe, 2008). This realisation connects institutional culture with wider societal and environmental culture.

Another challenge presented in the case studies included issues surrounding inter-disciplinarity, which is a key component in promoting entrepreneurial output. Martinelli, Meyer, and von Tunzelmann (2008) noted that schools differ in the way their faculty engage in university–industry collaborations, with further differences observed with respect to faculty attitudes towards technology-transfer and awareness of the university's respective codes of practice. When mapping knowledge exchange relationships of entrepreneurial faculty, the importance of less formal mechanisms between academics and industry was highlighted, as individuals and departments interact differently, depending upon their commitment and attitude to risk. In addition, academic freedom surfaced again as bureaucracy relating to patents, licencing, and anti-commons, affected attitudes and perceptions of staff, given the realisation that exploitation of research results would restrict the number of citations and chances of deeper explorations of the discoveries made. Therefore, tensions between publications and funding affected the level of entrepreneurial culture (i.e. perceptions of university-industry involvement), which developed at the university. However, the depth of entrepreneurial activities staff take part in (and the types of activity), differs between departments and faculties, and is also influenced by the academic discipline and organisational structures present within the university.

Clark (1998) notes that the discipline rather than the institution tends to become the dominant force in the working life of academics. This holds true in many cases whereby the organisational framework did not acknowledge departments or faculties in the traditional sense but only broad schools, which gave rise to a loss of identity in some cases. However, academic disciplines rooted in the natural sciences, technology, engineering and maths, were the obvious leaders within entrepreneurial activities, given the natural links that could easily be forged, and in most cases were already forged through collaborative activity with industry. Traditional disciplines, such as the humanities and social sciences, were underdeveloped in their external collaborations, partly due to the orientation of the subject, which reduced the extent of such linkages. Even so, although small, linkages did exist, which is promising for further development. Therefore, from the evidence, one can learn that entrepreneurial culture, given the right seed-bed, can follow structural reforms, provided the environmental conditions are right. Nevertheless, there is a need to pay attention to the theoretical perspectives regarding entrepreneurial shifts; university professors are still able to choose their subject of research independently, but pressures to compete for third party funding is perceived by academics as a certain limitation, thus encouraging researchers to focus on subjects where they can compete for funding (Glaser, 2012). This is an important element for managers to consider, given this can impact greatly on attitudes towards entrepreneurialism and its effects on academic freedom.

This adaption towards becoming more entrepreneurial indirectly creates forms of isomorphism when universities adopt institutionalised practices and procedures in a bid to increase their survival and legitimacy. This is because the organisation's actions, and indeed culture, are shaped by its environment and societal pressures in the form of rules and laws, as it responds to governmental policies, politics within the HE system, and subsequent change and transformation processes, which have different outcomes depending on academic leadership, structure of the organisation, and overall orientation in activities. Therefore, governments can influence strategizing within HEIs, given their policies can affect the marketplace, and regulations can affect the mission and direction HEIs opt for (Frolich, 2012). In addition, availability and orientation of public resources acts as a steering mechanism within this transformation (Gornitzka, 1999). Established social structures, such as rules, norms and routines within both the institution and wider environment are powerful in that they become authoritative guidelines for social behaviour. This means institutions are relatively homogenous, and remain constant over time, given shared values and norms prevail, and are indeed taken for granted within the given environmental context. As a result this impacts upon transformation processes within universities.

Policies within universities also influence behaviour, attitudes, and proactivity in transitional change, and this has a symbiotic action internally and externally. For policies direct academics on how to perform their duties, and the same policies are construed positively or negatively by society, depending upon the change itself, and how it fits with environmental norms. The example of the University of Waterloo (Bramwell and Wolfe, 2008) noted the critical function of entrepreneurial universities as institutional enablers of a culture that promotes the values explicitly articulated in its vision and goal statements. However Chalmers University of Technology (Jacob, Lundqvist and Hellsmark, 2003) noted levels of role uncertainty for universities, as research practice did not fit with the goals of commercialisation, as

well as a lack of information present about what were actually marketable inventions, echoing the problem of dual culture present between universities and industry, as reflected by (Bjerregaard, 2010).

From a wider perspective, Jacob, Lundqvist and Hellsmark, (2003) noted that culturally, Swedish universities do not exist in a culture where fund-raising activities are taken for granted aspects of university management and there is no perceived conflict between this and other more commercial efforts on the part of the university to raise income, unlike their US counterparts. He went on to state that a shift towards a more entrepreneurial culture within universities will have to be accompanied by a re-education of the population generally, and alumni in particular, as to the changing realities of university funding. In addition, entrepreneurial universities such as the University of Waterloo (Bramwell and Wolfe, 2008) attributed some of their success to the culture of entrepreneurialism in the region, and the virtuous cycle of university–industry linkages it perpetuates. Yet the University of Sussex (Martinelli, Meyer and von Tunzelmann, 2008) found that although they were located in a highly industrial region, there was proof that entrepreneurial success in distant locations proved that success does not primarily hinge on this factor. However, many respondents within all case studies agreed that there is a shared sense of a virtuous cycle existing between local entrepreneurial communities and activities, and the research and teaching activities of the university, which not only boosts the applied output of the university with regard to research, but also adds to the productive labour force, and acts as encouragement for those more opposed to the entrepreneurial model.

Government also has a role to play as a stimulus within the Triple Helix, but also with regard to sensitivity to political ideologies found by Jacob, Lundqvist and Hellsmark, (2003), who argue that not all universities have the potential to become entrepreneurial, thus, a common policy for the university sector such as that which now exists in Sweden may not be the most appropriate steering instrument for national RTD policy. Therefore, depending upon policies implemented by government, universities find that through coercive, mimetic and normative mechanisms, activities within the institution must change, which harbours resistance with those actors required to implement the change. Therefore, it does not become integrated and a 'norm', but rather a bolt on requirement. In addition, although the Triple Helix emphasises new opportunities through the interplay between actors in the environment promoting innovation, wealth generation and new demands for educational products, some academics hold a somewhat pessimistic view, seeing the university and its fundamental academic values and thereby the culture of 'open science' under threat (Dosi, Llerena and Sylos-Labini 2005; Ziman, 2000).

The Triple Helix model also promotes the view that active relationships, within similar innovation systems, encourages an entrepreneurial culture within universities (Etzkowitz et al., 2000). Given this changing economic environment, and the continuous production of specific governmental policies aimed to directly influence university strategies, academics cannot avoid the realisation that they are now operating in an era when most funding agencies, at both national and European level, view partnership as the primary mechanism for delivering economic development and promoting market-oriented transformation within the governance of higher education. This has implications for teaching, given the reduction in time to carry out activities, and reductions in core funding to carry out teaching activities. Thus academics are required to diversify their funding portfolios. In addition, the need to meet labour market needs through the development of business-led curriculum and linkages with industry to increase income and prestige, also acts as a driver to meet the needs of society.

2.2.2.2 University Organisational Structure

Organisational structure plays an important role in the successes of entrepreneurialism. Considering that adhocracy and market quadrants dominate in entrepreneurial universities, flexible organisational structures are required for responding to the external environment more quickly, which is particularly important given the competitive nature of this environment. Therefore, universities must be strategic and adaptable to change (Spanier, 2010), and the easiest way to aid change is through the hierarchy and organisational structure in place. Although dynamism is important, the complexity of structures present can also aid or hinder change, which then has an impact on organisational culture, given universities also act as social spaces, where traditions and cultures impact how new structures will function. Glaser (2012) argues that the internal and external governance structures of the university have shifted and become more entrepreneurial, meaning the relationship between the ministry and the universities shifts to vertical steering structures based on negotiated objectives and performance contracts. Concurrently, internal institutional structures

move from representative decision making to strong rectorates and decision making bodies, consisting of members representing businesses and other external stakeholders.

Traditional universities are more ridged in their structures, encompassing old fashioned chains of command with each faculty being very autonomous in its activities, representing a closed system of working, which does not integrate with the wider environment, and places much less emphasis on interdisciplinary goals between faculties. Therefore, the traditional university follows a very rigid, hierarchical structure. Mintzburg (1980) also describes the rigidity of traditional structures, showing the effects differentiated organisational design can have on the functionality of an organisation. However, since the 1980's the introduction of NPM has created tensions within traditional universities, as autonomy is challenged by the demands of meeting budgets, efficiency measures, and further administrative burdens delegated by centralised governance. These problems are further exacerbated by the role of consultants in implementing change, which traditional academics perceive as fads, and thus do not 'buy in' to it, thus impeding its likely success. Another problem, highlighted by Clark (1998, p.67) is that steering capacity of traditional universities is usually weak as a result of a lack of *'a clear view of what they [want] to do'* and *'the necessary structure to effect adequate rates of change and the will to produce it'*, with decision making processes slow and ineffective, and preferences rooted in the former binary system. The differences between loose coupling (Meyer and Rowan 1977) and tight coupling very much reflect the leadership and bureaucracy present within the institution. However, problems that occur within units in loosely coupled systems are less likely to impact other units, unlike in tightly coupled systems.

Conversely, entrepreneurial structures are designed to enable greater flexibility, although they become more complex as a consequence. In this case, formal and informal, non-divergent, lines of command are important, with coordination mechanisms required to ensure academics and supporting staff are working in the same direction harmoniously, creating unity. However problems exist with informal command, given it is not easy to see, and also has effects on subcultures within organisations. It has been noted that during transformation processes, calculated risk, associated with trying something new, is tested in one part of the organisation. In addition, decentralisation measures give more freedom, can increase motivation, flexibility, and responsiveness to change, and places great emphasis on the division of labour to achieve end goals. However the right mix of centralised and decentralised governance is the reality within entrepreneurial universities, designed to address the complexity of institutional goals, and respond to the cultures and traditions present within the organisation. These entrepreneurial models work in an open system, however the boundaries to the environment can be unclear, thus requiring organisational interfaces and support units to assist basic institutional units interact with the environment. The complexities of this open system can be seen in Figure 2.5, which shows a fictitious representation of a general entrepreneurial model. In the process of transition, double loop learning is essential to gauge how well change is taking place, as changes in one subsystem affects all other subsystems. In some institutions, strategic incrementalism, whereby bureaucracy is introduced to break down barriers, has had varying affects as a tool to promote change.

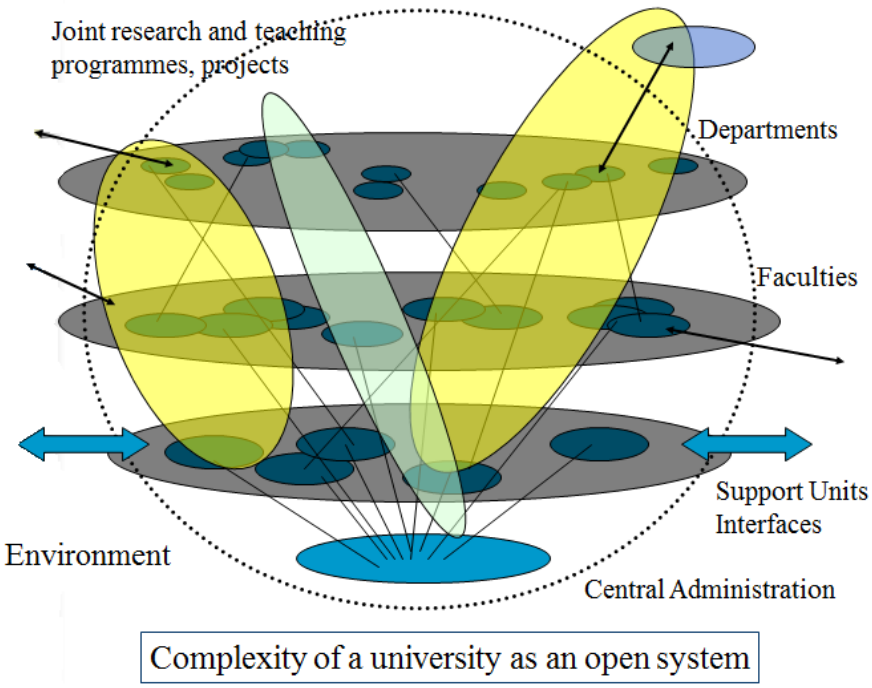

Figure 2.4: Complexity of a University as an Open System (Entrepreneurial Model). Source: Hölttä (2013).

Nevertheless, Martinelli, Meyer and von Tunzelmann (2008) argue that differences in motives and organisational structure can lead to conflicts due to cultural differentiations in how administrators and academics carry out their activities, with the former too aggressive in bargaining, or acting in an excessively bureaucratic fashion. In addition, Martinelli, Meyer and von Tunzelmann (2008) found that individual characteristics and perceptions about potential risks of external links for scientific values may explain the personal propensity to different types of entrepreneurship better than university policies and organisation. The importance of networks as organisational structures, and less formal mechanisms between academics and industry, is considered pivotal within the entrepreneurial model given individuals and departments interact differently, which depends upon their commitment and attitude to risk, inter-disciplinarity, and commercialisation versus publication. Within the wider institutional setting, loss of identity was another cultural component which had adverse connotations, as some organisational frameworks did not acknowledge departments or faculties in the traditional sense, but only broad schools (Martinelli, Meyer and von Tunzelmann, 2008).

Woolard, Zhang and Jones (2007) found that most academic enterprise activity takes place in sub-departmental 'centres' which are largely isolated from mainstream teaching, and that academic enterprise activity is concentrated in three of the seven faculties present within this particular case. In addition, although some very enterprising individuals and groups are driving the transition forward, contradictions between centralisation and de-centralisation, and a uniform 'one-size fits- all' approach to structure and systems, have resulted in a lack of reference to examples of outstanding enterprise practice, which in turn gives rise to concerns about the long term effectiveness of the current transitional approach. Glaser (2012) noticed that the University of Vienna's entrepreneurial shift affected internal structures of university management and the general university strategy in terms of research and study program development, the performance criteria and measurement, the administration, and the university's financial strategy, as well new modes of human resource management. This has increased structural cooperation with private and state-led enterprises and start-up foundations. Overall, a commonality across all case studies was the levels of ambition in relation to goals, which very much determined the structures and leadership approaches adopted. Therefore, greater leadership and clearer goals and missions are pivotal to align activities within complex structures and processes; as well as proper incentives for academics, as a whole, to engage with regional economic development. As such, these factors will inevitably influence institutional strategy, and cultures within the institution.

A mix of approaches and systems are required in order to maintain overall missions and goals, and also enable flexibility and the possibility for risk. As can be seen, no model explains the whole organisational structure in reality;

however Birnbaum's (1988) model of cybernetic management takes account of the complexities of the institution and environment, and as such is compatible with decentralisation, deregulation and coordinating management mechanisms. In addition, issues surrounding bounded rationality are also taken into consideration, given organisational cultures are influenced by the values, social ideas and beliefs which members of the organisation share. Therefore, increasing autonomy of faculties and departments increases self-regulating management processes, which again affects perceptions, attitudes, and subsequently organisational culture, and promotes the bottom-up approach favoured by academics.

2.2.3 University Technology Transfer

Work by Bercovitz and Feldman (2006) on university-industry links emphasises universities' role in regional systems of innovation as the primary driver of economic development. This ideology agrees with Palmintera (2005), who believes there is no doubt that university technology-transfer and commercialisation activities are impacting local, state, and national economies. Van Hemert and Nijkamp (2010) have also identified that the components of a system of innovation include not only private firms and their R&D activities but also public organisations such as universities, public research institutes, science parks, and so on, whereby each play a key role in the overarching innovation system, given they enable the accumulation and diffusion of advanced knowledge in the innovation system. As such, they too point out in their qualitative meta-analytic comparative study the importance of fostering connections and interactions within the system, as private R&D activities are by no means the sole element within the competitiveness of an industrial system. This statement is of particular importance, given the levels of research and project work concentrating predominantly on SME knowledge-transfer development.

Findings made after an overview of the literature showed that many academic papers explore the technology-transfer topic from several overarching perspectives, including improvement of SME knowledge-transfer activities; and how universities can extend beyond their normative roles of teaching and research, and contribute to competitiveness and economic growth. The GOODEUP project (Mora, Detmer and Vieira, 2010) has highlighted that it is difficult to gain a true representation of the types of entrepreneurial activities relating to technology-transfer, as quite often, activities are not noted or made examples of, given existing unconducive perceptions, even within some faculties, regarding such activities. This study did, however, try to establish a clearer picture of the technology-transfer landscape at national level, focusing on particular governmental policies affecting University-Enterprise Partnerships (UEPs); institutional level, observing the development of such relations and the institutional support structures put in place to promote, facilitate and manage them; and partnership level, identifying good practices and analysing the key variables which affect the successful development of UEPs. The utilisation of OECD data and national reports provided much of the quantitative data for the study, which was bolstered by qualitative data for more depth of explanation to reasons behind such activities. This study was based on a selection of 6 countries, and 18 institutions in total, to give a broad representation of differing contexts, institutions and locations in Europe. Given very few comparative studies were found relating to technology-transfer, this project has provided an excellent platform to explore methodology and data capture in these particular cases, however, it is difficult to draw concrete lessons, given the small representation of the sample.

A Europe wide study carried out by Davey et al (2011) aimed to quantify subjective perceptions and behavioural issues relating to university-business cooperation, by utilising quantitative methodology to measure potential reasons, influencing factors, drivers and barriers to university-business cooperation, in a bid to move away from objective quantification and concrete outcomes, such as measuring number of patents, and so on. Their aim was to capture individual personal perspectives of academics, with findings conveyed through descriptive and interpretive analysis. The findings of this project have revealed interesting insights into the internal functioning of university-business cooperation, highlighting an underdeveloped and highly fragmented European university-business collaborative environment, with large variations between countries, types of institutions and even disciplines, given the tendency that concentrated groups of academics or HEIs seem to be engaging in university-business cooperation.

As Bercovitz and Feldman (2006) conclude, an understanding of the evolution of the role of the university in systems of innovation certainly warrants further attention. They believe that if we are to think creatively about public policies

towards increasing university technology-transfer, a focus on the larger innovation context is necessary. This also agrees with Marxt and Brunner's (2013) findings that more research needs to take place to determine the measurability of higher education in relation to innovation at national level. Nevertheless, some authors warn about assuming a simple causal relationship between university-led scientific innovation and economic benefits (Fairweather, 1990, Liu and Dubinsky, 2000). Bramwell and Wolfe (2008) conclude that universities can have a much wider impact on regional economic development than simply providing basic research; nevertheless, this effectiveness can be enhanced by aligning the knowledge assets of a university with the multi-variate needs and requirements of local firms. Reflecting upon the principles of the Triple Helix, it is clear that intermediary governmental bodies have a key role in enhancing the external environment through various funding initiatives to catalyse and encourage interactions for knowledge transfer. To this end, the EU recognise that there are countries lagging behind in the effectiveness of exploiting EU funded programs in the field of research, development and innovation; the obstacles including local conditions, resources and assets faceting a specific system.

An EU project (IKTIMED), currently underway, aims to provide the Mediterranean region (as one of its deliverables) with guidelines for universities and other research institutions to improve their links with industry across Europe, as they recognise the need to make better use of publicly funded R&D (IKTIMED, 2013a). Many factors within the external enabling environment have been highlighted as potential barriers, such as, cultural differences between the business and science communities; lack of incentives; legal barriers; and fragmented markets for knowledge and technology; which need to be overcome. They found that, when compared to North America, the average university in Europe, generates far fewer inventions and patents, which is largely due to a less systematic and professional management of knowledge and intellectual property by European universities. This agrees with Conti and Gaulé, (2009b) who carried out a study to determine whether Europe is indeed lagging behind the US in university technology licensing activities. They measured the number of licenses and license income earned by university technology-transfer offices through designing their own survey of European technology-transfer offices, given the lack of good data on licensing outcomes in Europe. Their findings pointed towards gaps in European license income, which may reflect underlying structural problems in the organisation of technology-transfer in Europe, thus requiring further analysis. In addition, a lack of coordination and synergy of research and innovation policy instruments is proving problematic within the enabling environment (IKTIMED, 2013b).

The Austrian Research and Technology Report 2014 (Federal Ministry of Science, Research and Economy and the Federal Ministry for Transport, Innovation and Technology, 2014) illustrates these findings to a certain extent, showing that patent applications were small in number in the Austrian case, with technical universities producing the highest levels of licensing income. However. government intervention through implementation of the Uni:Invent funding programme for university patenting and commercialisation had a massive impact, with patent applications increasing by seven times the pre-funding level, within 2 years of the programme's inception. Figures suggest that government funding is crucial to maintain an increased level of patent outputs in universities, given the second generation of Uni:Invent stabalised the falling numbers of patents once initial funding ceased. Nevertheless, Conti and Gaulé, (2009b) found that European universities are producing less research output than US universities, which is likely due to the fact that the US spends about 3% of GDP on higher education, whereas the average for the EU-19 is 1.3% (OECD 2007). Therefore, findings by Mazzucato (2013) are particularly relevant if applied to the European situation, given the aforementioned evidence points towards governments being particularly important financiers of high risk projects, considering the rise in productivity of IP as a result, and its subsequent decline when this particular funding source disappeared. The existence of problems specific to the organisation of technology-transfer in Europe could also highlight why technology-transfer is so low. Crespi et al. (2008) and Lissoni et al.'s (2008) study highlighted that while Europe lags behind the US in terms of *university-owned* patents, the gap becomes smaller when *university-invented* patents are taken into consideration. This suggests that internal organisational dynamics and external innovation ecosystem must be explored further.

Recommendations from a joint EUA and JRC expert workshop (European University Association & S3 Smart Specialisation Platform, 2013) found that universities and regional authorities have a unique opportunity to form close partnerships that, together with industry and other stakeholders, can maximise the use of EU structural funds for

research and innovation to deliver economic and social development. They recognised universities' role as a key partner in taking forward successful Smart Specialisation Strategies in partnership with other stakeholders in the region, given the multi-dimensional role they play, with their research, teaching and community activities all contributing to the transformation of regional economies (European Commission, Joint Research Centre, 2013). This agrees with UNICREDS (UNICREDS, 2010), another EU project which considers the potentially vital role that universities have in supporting rural development. Interestingly, much of the literature adopts a qualitative methodology for exploring this phenomenon. This is likely due to the fact that although a number of different types of indicators and measurements exist, none truly capture university technology-transfer activities due to the differing ideologies behind choosing indicators, and the fact that some activities are very difficult to capture because there are no records made, as found in the aforementioned literature. Arundel and Bordoy (2006) carried out research concerning the development of internationally comparable indicators for the commercialisation of publicly-funded research. They found that all surveys explored collect data on research expenditures and on three different outputs indicators for the commercial potential of public science discoveries, namely, invention disclosures, patent applications and patent grants. In addition, these surveys also collect data on three indicators for the use of public science by firms, namely, licenses executed, start-ups established, and gross license revenue. However, most surveys pose comparability issues at the International level given the ambiguity of capturing a truly representative target audience including all institutions (e.g. HEIs, government research bodies, hospitals, etc.); differences in variable definitions; and processes of dealing with treatments of missing values. As such, they identified that standardisation in indicators is needed, and that quantitative data in this respect is more comparable.

At present, supranational bodies such as the OECD and Eurostat, the European Union's statistical collection agency, gather data pertaining to national level activities of member countries. The EU's Innovation Scoreboard report uses a number of indicators, however, these provide general overviews of national statistics, which are predominantly based on firms' outputs. University contribution is measured under the 'enablers' indicator, and pertains mainly to publications and human resource output in the form of doctoral degrees. Eurostat (European Commission, Eurostat, 2012) collects similar types of data relating to R&D expenditure, innovation statistics, high-tech statistics, patents, and human resources in science and technology.

A further search was completed to uncover the types of country level studies completed by the OECD, however these mainly related to detailed reports overviewing wider national innovation systems; no detailed reports regarding university technology-transfer appear to have been conducted. In addition, no comparative country studies were found. Data collected at national level, reflects data required by the aforementioned supra-national body indicators, and also national indicators pertaining to national level innovation policies, which of course differ per country. This variety of indicators, again, makes comparability between countries difficult, given governments wish to measure the successes and challenges relating to policies implemented to service the needs of their overarching mid- to long-term strategies. In addition, data collected at university level is utilised primarily internally by university management to inform practice and forward strategy planning endeavours. University representative organisations such as the European Universities Association, Proton Europe, Association of European Science and Technology Transfer Professionals, also collect data; however, overall, it appears that all organisations generally have a specific focus, whether at supra-national, national or institutional level, again reducing the ability for comparisons to take place.

Given the importance placed on Innovation Union within the Europe 2020 Strategy, exploration of regional trans-national projects has been useful as a guide to identify critical areas where experts foresee opportunities to make progress and fill gaps in knowledge and productivity. An important example is the E3M project completed in 2012. This project was specifically designed to measure third mission activities, and piloted in 6 case study universities in 6 different countries. E3M identified two main reasons for limitations in identifying and collecting comprehensive third mission data; first, the dependence on contextual factors for the development of third mission activities (national, regional, institutional, disciplinary, and also at individual level); and secondly, the nature of data needed to track third mission activities (regarded in same cases as invisible, unquantifiable, informal, and not available in university units) (E3M, 2010). Therefore the project aimed to define and validate comprehensive indicators for the sub-dimensions of 'third mission' activities.

2.3 Summary

Overall, it is clear that numerous studies exist which probe the main concepts pertaining to the study from numerous different angles. Economic development has proven to be a common theme, particularly in the innovation system literature. However, exploration of the literature relating to university funding and transformation also pays attention to this factor. This is particularly relevant within the specific case university studies focusing on internal transformation, as each qualitative study highlighted the changing funding, and indeed innovation landscape, which was impacting upon such transformation processes. Despite this array of findings, it seems a gap exists to explore the relationship between prevailing innovation systems and its effect on university transformation. This is particularly true given the lack of joined up thinking currently, and the need to solve the aforementioned European Paradox. As a result, there is a need to improve the relationships and functionality within the system, and indeed within each particular node of the Triple Helix, in order to find conducive solutions which could potentially create efficiencies, and create mutual understanding between nodes.

Exploration of the quantitative measures of university technology-transfer has highlighted that this particular methodology is under-developed. Nevertheless, this also illustrates the importance of qualitative data capture, as described in (2.3.2 University Transformation), whereby qualitative case studies of the transformation of Entrepreneurial Universities were carried out to capture the rich detail specifically pertaining to each particular case. As mentioned earlier, no two universities are the same, and although quantification enables comparability, it fails to illustrate a depth of reasoning behind processes and outcomes. In the context of the current study, a qualitative approach is thus favoured, given the type of information sought requires the richness of explanation which cannot be captured quantitatively. However, such reports and statistics will prove useful to capture a snapshot of prevailing innovation systems.

CHAPTER 3: METHODOLOGY

3.1 Research Method

The empirical part of this study is qualitative in nature as it provides rich descriptive accounts of first-hand experience. Ary et al (2010, p.29) define the goal of qualitative research to build a, *'holistic picture and depth of understanding rather than a numeric analysis of data'*. This is particularly important given the orientation of the study requires an overview of the specific problem from the perspective of those involved; thus highlighting, that analysis of numerical data will not suffice to answer the proposed research questions in this particular study. As such case study design has been employed given this method is designed to focus on a specific problem, in order to determine the characteristics of the selected case within a bounded system, through utilisation of multiple sources of data (Ary et al., 2010). Based on Yin (2009), Bray, Adamson and Mason (2007) and Creswell (2007), this case study is designed as an empirical enquiry. It utilises a pragmatic yet holistic approach, to investigate this phenomenon in-depth within its real life context, through abductive reasoning.

This collective case study explores two bounded systems (the regions of Vienna and Stockholm), thus enabling an in-depth analysis to take place (Creswell, 1998; Ary et al, 2010). Predominantly qualitative primary and secondary data will be utilised, given the study is heavily context based. The limited focus of this study is designed specifically to cope with the numerous variables which are likely to present themselves, given data is designed to be obtained from multiple sources. Nevertheless, multiple source data will be useful for triangulation purposes. This study will benefit greatly from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2009).

Focusing on Level 2 of Bray and Thomas's (1995 as cited in Bray, Adamson and Mason, 2007) Cube, emphasis is placed primarily at regional level, with a broader focus to capture the prevailing context of the national innovation system, given this has a strong bearing on what takes place at regional level. Perspectives from the concepts of National Innovation Systems (Lundvall, 1992), Triple Helix (Etzkowitz, 2002), and Entrepreneurial Universities (Clark, 1998) have played an important role for the formation of the analytical framework and consequently, the formulation of interview questions and data analysis, which will be discussed shortly. A comparative approach has been utilised to study the problem through a combination of two theoretical lenses (discussed in The Analytical Framework sub-section), in order to deduce explanations of relationships identified, and thus provide insights to the problem.

It is suggested that transformation within Entrepreneurial Universities acts as the dependant variable, and the prevailing National and Regional Innovation System acts as the independent variable. To this end, the focus of analysis is based on the contribution and transformation of universities within the innovation system. Data pertaining to the National and Regional Innovation System is included for contextual purposes.

To begin to frame the study, Maxwell's (2005) interactive model of research design was consulted given it considers research as a reflexive, rather than linear, process (Figure 3.1). This has been particularly important given data gathering can shed new perspectives during the course of collection, which can enrich and shape this qualitative study. Maxwell (2005) model considers interdependencies of these elements, placing the research question as the central component, influencing and being influenced by the goals, conceptual context, methods, and validity of the study. In addition, the author is aware that other contextual factors can influence this model, including those which are specific to the given situation, such as data, time, and the individual setting; and those specific to the researcher, such as skill-set and logic employed.

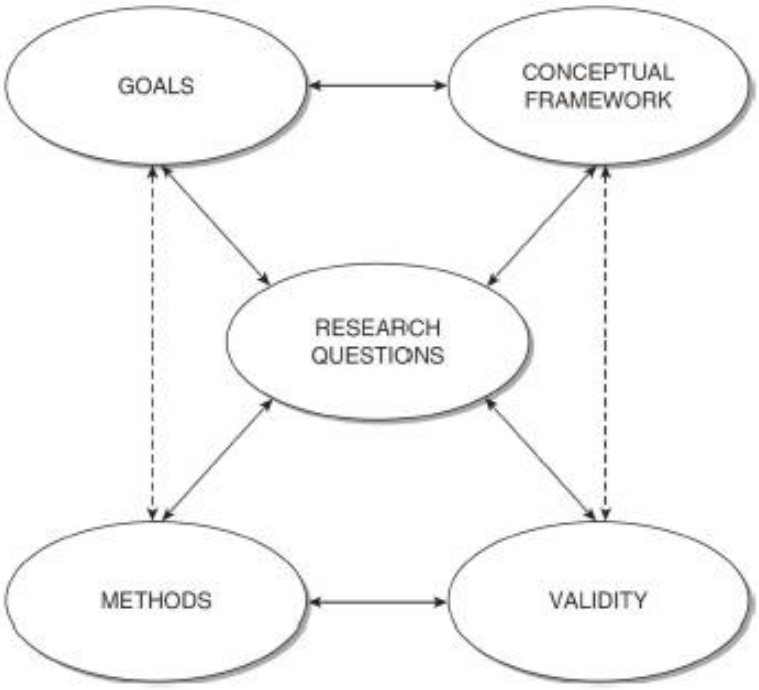

Figure 3.1 An interactive model of research design. Source: Maxwell, 2005.

Table 3.1, based upon Maxwell (2005) and Chaykina, (2012), initially frames this research study.

Table 3.1 Components of the interactive research model.

No.	Element	Questions to Consider	Current Research Study
1.	Goals	What issues does the study include and why are they relevant? How will the acquired results be useful?	Innovation is a national and supra-national priority for governments; reducing public funding and the subsequent diversification of funds for university activities is a priority for universities. The long term goal is to further harness the potential of universities within innovation systems; however, this must be carried out in a manner which is conducive to each actor. The study aims to probe the actors, mechanisms, and organisational barriers and enablers that have a bearing on how universities are transforming and subsequently interacting with innovation systems; ultimately leading to potential economic growth, and increased funding allocations for university endeavours. Results will draw attention to the current state of play at the interface between university contribution within innovation systems, and the transformation places undertaken to ease this process. Results can be used to create efficiencies within the system at governmental level (for the redesign of policies and programmes taking into account the barriers facing universities for interaction); and within universities for benchmarking purposes. It could stimulate increased mutual understanding of the

			issues faced for university interaction in innovation systems, whilst trying to also maintain core missions.
2.	Conceptual Framework	What theories, prior research findings, personal experiences and ideas guide the research?	National and Regional Innovation Systems; the Triple Helix; and Entrepreneurial University theories.
3.	Research Questions	What does the research investigate? What is intended to be understood? What questions does the research attempt to answer?	University transformation processes and barriers to interaction within innovation systems. How prevailing innovation systems impacts university contribution and transformation. How do prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University? How and which **actors** of the innovation system have influenced universities to become more entrepreneurial? What **mechanisms** (funding, platforms, programs, regulation etc.) exist in the NIS to harness university contribution to innovation and economic development? What are the **organisational barriers and enablers** for university engagement to become more entrepreneurial? How do actors and mechanisms of the innovation system ease contribution processes by universities?
4.	Methods	What techniques of data collection and analysis does the research endeavour apply?	Literature review, semi-structured interviews, secondary data collection for contextualisation purposes, and thematic based analysis through utilisation of the proposed analytical framework.
5.	Validity	How might the results and conclusions be wrong? How does the data support or contradict the initial idea? How reliable are the results?	Misinterpretation of the data collected from interviews; incorrect cause-effect relations due to additional underlying factors out-with the scope of the study. Data supports the initial idea that prevailing innovation systems impact university contribution and transformation processes. Nevertheless, the data has also illustrated the complexity of the situation, highlighting that the situation contains numerous factors which also impact the state of play. Representation of expert interviewees from multiple reliable sources within the study area were consulted; analytical lens is based upon theory grounded in the literature; secondary data was sourced from official reliable sources; cross-checking of data with additional sources took place; interviewees confirmed responses; issues of validity were considered.

It is important to note that case study design has its weaknesses: Although it will provide depth, it inevitably lacks breadth (Ary et al., 2010). Therefore, as each case is unique, it may bear little relationship to other cases, even within the specified case country. Therefore, this study has been designed as a pilot project to deduce whether a wider all encapsulating study is feasible to compound findings and thus make results more transferable. In addition, the narrowness of this particular case means there is potential for subjectivity or even prejudice, given interviews are employed as the main method to gather data. Nevertheless, it is anticipated that the nature of the study and data required should eliminate this problem somewhat, given answers should be based upon factual information from each specific case.

3.2 The Analytical Framework

The analytical framework has been specifically designed to answer the following research questions, and prove or disprove their associated propositions, as stated in Chapter 1:

The Main Research Question

How do prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University?

Sub Research Questions

1. How and which **actors** of the innovation system have influenced universities to become more entrepreneurial?
2. What **mechanisms** (funding, platforms, programs, regulation etc.) exist in the NIS / RIS to harness university contribution to innovation and economic development?
3. What are the **organisational barriers and enablers** for university engagement to become more entrepreneurial?
4. How do actors and mechanisms of the innovation system ease contribution processes by universities?

The following propositions are proposed:

1. Following the logic of Triple Helix relations, the higher the interaction of actors representing different nodes of the Triple Helix, the higher the likelihood that universities will contribute to the innovation system.
2. The more funding opportunities provided for universities through mechanisms designed to stimulate innovation within the innovation system, the more likely universities will:
    a. participate in order to achieve funding allocations
    b. transform organisationally in order to take advantage of funding opportunities, thus becoming more entrepreneurial in their structure and functionality
3. Barriers such as ear marked funding, legislation, disjointed policy design, and non-entrepreneurial internal structure and orientation may inhibit university interaction and contribution.
4. Greater synergies between actors and the designing of mechanisms will ease the interaction and contribution processes of universities within the innovation system

In order to fully elaborate upon the research question, and design the interview guide (Appendix A, B, C, D) and data analysis section, adoption of an appropriate theoretical lens has been pivotal. Nevertheless, given the unique focal point of the study, elements from three concepts have been utilised to design a frame of analysis specifically for this study. As such, Lundvall's (1992) National Innovation Systems, Cooke, Uranga and Etxebarria's (1997) Regional Innovation Systems, Etzkowitz and Ledeдorff's (2000) Triple Helix, Metcalfe's (2010) focus on Tri-lateral relationships within the Triple Helix, and Clark's (1998) Elements of Entrepreneurial University Transformation have been adopted. First, the research question has been framed by considering how the university fits within the National Innovation System, this has helped to identify the focal point of the research at the interface between university and the external

innovation system. Secondly, the actors, relations, and mechanisms have been considered based upon Triple Helix principles, to design the sub-research questions, and ensure the study maintains questions which relate to the innovation system, and connect to the specific actors under study. Finally, three main dimensions from Clark (1998) (Strengthened Steering Core; Diversified Funding Base; and Entrepreneurial Development Periphery) have been adopted specifically to design questions which probe university transformation in relation to prevailing innovation systems. Nevertheless, the remaining two dimensions of Clark (1998) (Stimulated Academic Heartland; and Entrepreneurial Culture) have been considered in conjunction with these elements given transformation lies with the actors who carry out the change, and consequently, these dimensions have an impact. However, given studies already exist exploring this particular phenomenon, this element has taken a minor role in the current research endeavour. Table 3.2 shows which conceptual elements (together with the identified target groups) have been selected to provide a framework upon which the research questions could be probed in depth, and then frame the results and analysis chapters. The table highlights which target groups were probed on which conceptual element.

Table 3.2 Analytical Framework

Conceptual Elements	Identified Target Groups (Interviewees)				
	Government	Funding Agency	Industry Representative	Bridging Organisation	University
Actors	✓	✓	✓	✓	✓
Mechanisms	✓	✓	✓	✓	✓
Organisational Barriers and Enablers	✓	✓	✓	✓	✓
Strengthened Steering Core					✓
Expanded Development Periphery					✓
Diversified Funding Base					✓
Stimulated Academic Heartland					✓
Integrated Entrepreneurial Culture					✓

Source: Own depiction

Methodologically, the case has been studied within its context to analyse the details of the case before any generalisations were made (Creswell, 2007). In order to carry out the comparison, variables measured must be the same, or very similar, in each case, so that associations and links can be made. Therefore, criteria and indicators relating to these theoretical concepts have been pivotal for measuring and comparing transformations, as well as success and challenges within the system. In addition, special attention has been paid to the definitions of existing secondary data, to ensure transparency of the use of the data during analysis. Biases have theoretically been avoided through triangulation of primary interviews, and utilisation of publically available secondary data. Overall, this approach has enabled linkages to be formed between practice and policy with regard to the Triple Helix nexus, and entrepreneurial transformation of universities. In addition, ethnocentrism has been avoided by use of this comparative trans-national approach to ensure contextualisation that befits the target.

Overall, the research aims to covey practical information relevant to current policy design, and benchmarking practices for university transformation. The main focus of the study is to identify solutions for possible changes at national and

institutional level. It is anticipated that the selected analytical framework has dissected the problem in-depth, and provided a clear frame upon which answers can be gleaned.

3.3 Data Collection and Analysis

3.3.1 Data Collection

Data collection was designed to be sufficient to service the needs of the analytical strategy in order to feed the explanation building process, through evaluation of all the evidence; giving consideration to plausible and rival explanations for phenomena; and ensuring data was specifically relevant to the cross-case synthesis (Yin, 2009). As a result, multiple sources of evidence were utilised, with a case study database created to hold and organise all literature, data, raw data, and analysis, as the project progresses. Unique case sampling was the favoured method in order to select specific universities involved in the life sciences sector, to maintain a narrow focus. In this instance, 4 universities and 8 innovation system actors have been selected from 2 regions identified as areas where the Life Science sector is of economic importance, as shown in Table 3.2. This particular selection is based on the need to interview expert trilateral actors as reflected within the Triple Helix literature of the importance of trilateral relationships for stimulating interaction (Metcalfe, 2010). University actors were selected on the basis of ensuring representation from different levels within the university (i.e. management, technology-transfer office, and researchers) in order to understand the impact and implementation of transformation processes at different levels within the university. In addition, the semi structured interview approach was adopted as the primary data capture method, given it enables flexibility to follow interesting paths as they arise, is advantageous as it supplies large volumes of in-depth data, and provides deep insights into that particular person's perspective on the situation. Also, this method enables the possibility to get in touch with the subject at a later date if necessary. Nevertheless, the researcher must be well-prepared when carrying out interviews in order to listen well, and know when to probe further, and remain unbiased in their approach. The aim was to target between 20-24 interviewees, with a minimum of 15-20 considered an acceptable lower limit. As a symbol of appreciation for the subjects' time, the final thesis will be made available electronically for each participant. Care was taken in interview question design given qualitative data has a tendency to be more subjective and highly dependent on the mood and internal viewpoint of the respondent (Yin, 2009). Questions were piloted and amended before use to ensure reliability, and interview guides compiled to address targeted data collection from the variety of actors involved. As such, comparable questions were constructed according to the adopted criteria within the analytical framework to address each indicator.

Table 3.3 Target Interview Candidates

Type of Institution	Target Interviewee	Interview Guide
Medical University	Research Manager Head of Department Researcher Technology Transfer Office (All within Life Sciences)	Appendix A
University (multiple disciplinary areas)	Research Manager Head of Department Researcher Technology Transfer Office (All within Life Sciences)	Appendix A
Government	Representative from Research, Education and Economy department	Appendix B
Funding Agency	Representative dealing with Life Sciences sector	Appendix B
Bridging Organisation	Representative dealing with Life Sciences sector	Appendix C
Industry Representative	Representative involved in promotion	Appendix D

	of university collaboration (within Life Sciences sector)	

(N.B. Tabulated data holds for both Vienna and Stockholm regions to ensure comparability)

Secondary data sources were identified to gather information relating to the national and regional innovation system. National sources (e.g. BMWFW, Vinnova) and supra-national sources (e.g. EU, OECD) have helped to give an overview of the prevailing innovation system in which the case studies are located. In addition, it was noted that indicators used in secondary data can give a limited view. As such, definitions and supplementary qualitative analysis helped overcome any potential erroneous traps. Data collected by Eurostat (e.g. Community Innovation Survey, and Structural indicators - Innovation and research), and OECD (Innovation in science, technology and industry data) will prove useful for national level results and comparisons. I will have to be careful regarding comparability of data sets, and pay particular attention to the definitions, and limitations of the data. In addition, documentation (reports, evaluations, policy documents, and other media reports) and archival records (held at national and supra-national level) will be useful to triangulate information.

Overall, a strict case study protocol was adopted (Yin, 2009, p. 80) to inform, and give confidence to potential respondents with regard to their privacy and confidentiality, and the overall aims of study. In addition, protection of respondents was of utmost importance, and as such, an ethical approach to data collection was adopted to obtain informed consent prior to interview (Silverman, 2010). A "consent to participate" form was drawn up outlining the purpose of the study, in a bid to make individuals fully aware of the research activity, and again give confidence to participants. It was also of paramount importance to have sufficient resources available for the duration of the study. Therefore, a computer, software, recorder, paper and pens, and USB sticks was available to ensure data was backed up and not lost.

3.3.2 Data Analysis

Each semi-structured interview was recorded for accuracy of transcription, and subsequently coded and tabulated to enable comparisons internally, regionally, and trans-nationally. Field notes, kept in a fieldwork journal, were also useful to supplement the data collection phase. Listening is key to discovery, so the author remained adaptive and flexible to newly encountered situations, as well as unbiased, so as to spot contradictory evidence. Various computer programmes were useful to store and analyse raw data. This method had advantages and disadvantages; however, it reduced the amount of time needed to carry out basic sorting, coding, and thematic analysis. Transcripts of interviews were coded so that responses could be grouped and thematicised, in order to gather similar concepts for further coding if considered necessary. Utilising Maxwell's (2005) methods, data analysis began as soon as the first interview was complete in order to fully comprehend the phenomenon under review and follow up interesting leads.

After data was coded, and organised, themes were selected based upon the analytical framework (outlined above). Data analysis took place to first search for significant patterns in the data, and then individually address the selected indicators and ultimately answer the research questions. This enabled a theory to be constructed as the investigation progressed. The author follows Ary et al's (2010) method by first organising and familiarising herself with the data, then coding and reducing the data, prior to finally interpreting and representing the data. Utilisation of a reflective log was important throughout the process to assimilate the responses gained throughout the process. Existing literature in the field was useful to interpret disconfirming evidence, and provide alternative explanations to unexpected findings.

Consequently, the data has been presented by region, and grouped under three categories. First, data pertaining to the prevailing innovation system; second, data gathered from external actors within the innovation system; and third, data pertaining to the universities followed by their results. This has enabled a cross analysis to first consider each individual case, then consider the situation at national level, and then consider these findings at a trans-national level, prior to reflecting upon the literature in the discussion chapter (Chapter 5). As a result, this method has enabled conclusions to be drawn, highlighting the main findings and serendipitous finds, as well as the limitations of the study, and what could have been done differently. Areas for future research have also been highlighted as a result of the analysis.

3.4 Validity

To address issues of validity, an ethical approach to data collection and analysis was maintained throughout the project. Researcher bias was also minimised by selecting cases which are independent of the researcher, thus promoting equality and objectivity in the approaches to each case. Time was spent to holistically grasp the contextual basis of the case study countries, thus enabling deeper empathy and understanding throughout the research process. Checks were made systematically, to ensure avoidance of misinformation, or mistakes during data collection and analysis. Triangulation of multiple source data took place to give substantive evidence from varying perspectives to provide corroborating evidence (Creswell, 2007). Data collected was also peer reviewed by the supervisor, and checked by key informants to ensure an exact replication of the data is presented. In addition, the use of well-known theories as the basis of the study increased external validity (Yin, 2009), whilst the use of rich description enabled readers to make decisions regarding the transferability of the findings (Creswell, 2007).

3.5 Reliability

Reliability of data is of utmost importance to ensure validity of results. Care was taken to ensure the right constructs were measured with regard to the intended outcome. As a result, indicators and criteria were surveyed to fully understand and take account of the definitions utilised by those who primarily collected the secondary data to be used. Data was systematically checked to ensure it was free from random errors, and data collection methods piloted and discussed with peers, to ensure consistency and reliability of what the data collection methods were designed, and intended to gather. As such, a case study protocol was employed as a guide to firstly outline the project, and the field procedures to be carried out, and secondly, to determine the case study questions to be used throughout data collection. A case study data base was set up to organise relevant literature, data, and contacts, as well as the raw data collected throughout the study. To improve reliability throughout the course of the project, the researcher first gained deeper training in data collection methods, and subsequently developed pilot interview questions with several peers, and the supervisor, so as to ensure questions delivered the intended answers. All interviews were recorded and carefully transcribed, to ensure data could be reliably analysed.

3.6 Credibility

To promote credibility of the project, evidence is based upon structural corroboration through the selection of several representatives per university; several representatives from the innovation system; and utilisation of secondary data relating to the universities and innovation system. This has enabled triangulation of data. In addition evidence is based on referential or interpretive adequacy Ary et al. (2010), through conducting interviewee checks, and utilising direct quotations to enable the reader insights into the participant's world. Overall, evidence is based on theoretical adequacy, in order to ensure the research is defensible, as such, triangulation and pattern matching have been important tools in this process (Ary et al, 2010).

3.7 Transferability

Regarding transferability, it is feared that the generalisations of the results cannot be readily applied to all universities within the countries under review, given the sample size is too small. Nevertheless, as cross-case comparisons are being utilised as the core element of this research endeavour, it may be possible to generalise to a small extent, but one must bear in mind the selection effects of the adopted narrow focus on the Life Science subject area. In addition, the results are also contextual, given the regional focus of the study, again affecting the transferability of the results.

3.8 Conformability

Conformability is of utmost importance in this study. As such, the researcher selected cases which were independent, and not connected to the author in any way. In addition, the orientation of the study is primarily based on the experiences of interviewees, and on factual data, thus reducing potential personal bias. An audit trail has been provided to enable other researchers to follow the procedures taken, should they wish to see if they arrive at similar conclusions or otherwise, through utilisation of the same data and context. Triangulation and peer review processes have also been undertaken during the study.

CHAPTER 4: RESULTS

This chapter presents the primary and secondary data results pertaining to the research questions stated in Chapter 1. This chapter is split into two sections, the first section presents primary and secondary data regarding the innovation system in Austria, the case universities under focus in the Vienna region, and the primary data collected from these universities in conjunction with the data gathered from various actors within the innovation system. The second section is structured in the same manner to display the results pertaining to Sweden. This will enable the reader to gain a contextual overview of the situation per country, and also enable comparisons between countries and data sets given the layout of the chapter. Further, the results have been organised to represent the analytical framework adopted, therefore the National Innovation System and Triple Helix indicators have been utilised for all respondents. The three selected dimensions of Clark (1998) have been utilised specifically for the further analysis of university respondents, in addition the remaining two dimensions of Clark have been included to reflect relevant data obtained during data collection.

During data collection, rectors, vice-rectors, deans of school, heads of departments, professors, researchers, and technology-transfer office staff were targeted. Unfortunately, the original aim to secure four interviews per university with representation spanning the various functions within each university failed (except at KTH Royal Institute of Technology in Sweden) given the lack of available time of potential respondents to participate, and some potential respondents feeling their lack of knowledge on the topic was an inhibiting factor towards participation. As such, the representation gained corresponds to a variation of two to four of the above named categories per university, but will remain confidential in order to protect participants' identity. One respondent per external innovation actor (namely, government, funding agency, industry representative, and bridging organisation) was gained from Austria. Unfortunately only two innovation actors were obtained to represent Sweden, with one further actor interviewed given their presence within both the Swedish and Austrian Life Science sector. As there was difficulty recruiting Swedish government and funding representatives, an expert senior consultant with deep understanding of the perspectives of these actors was interviewed instead. The interview guides designed to illicit information from the respondents regarding the phenomenon under focus can be found in Appendix A, B, C and D.

A brief overview of the Austrian and Swedish Innovation Systems is included in order to contextualise findings made during primary data collection. Data has been collected form trusted sources and pertains to the most recent information available (mainly 2011-present). Each selected case study university is described briefly below to give readers a general impression about each institution's background and orientation. This has been compiled to enable the reader to contextualise respondents' views. University rankings of each university have not been employed as part of this study given it is the wider regional dimension that is under focus (as ranked by the EU's Innovation Scoreboard) and therefore interaction, contribution, and transformation within prevailing innovation systems are the important elements under analysis. Secondly, the array of methodologies employed by various university ranking systems does not individually or collectively provide important illustrative data to aid the current study.

4.1 Austria

4.1.1 The National and Regional Innovation System Overview

According to the EU's Innovation Scoreboard at both national and regional level, (European Commission, 2014a; European Commission, 2014b) Austria's research and innovation performance ranks within the 'Innovation Follower' category, performing just above the EU average. Interestingly the innovation performance of the Vienna region has fallen one category in comparison to 2012's results, dropping from the 'Innovation Leader' category down to 'Innovation Follower' (European Commission, 2012). In addition, the economic development of Austria is above the EU average, with input to R&D among the highest GERD/GDP rate in Europe (2.87% in 2012) (European Commission, Erawatch, 2014a). Austria's total investment in R&D in 2012 amounted to € 8.708b or 2.84% of GDP, which is significantly higher than the EU average of around 2% European Commission, Erawatch, 2014b). However, this is still below the Barcelona target of 3% investment in R&D by 2010. The economic recession has impacted upon the previously increasing expenditures on R&D within the country, given the need to consolidate public budgets, and has thus highlighted structural deficits within the system. As such, since 2009 R&D policy has focussed on increasing

efficiency of core elements of the system, as opposed to expanding input measures (European Commission, Erawatch, 2014a). Nevertheless, education, R&D, and innovation are considered priority policy fields, which have witnessed the least impact by recent consolidation measures (European Commission, Erawatch, 2014a). In addition, the political target remains to invest 3.76% of GDP in R&D by 2020, of which 2% is envisaged for the tertiary sector, and 1% dedicated towards basic research (European Commission, Erawatch, 2014b).

The innovation system in Austria follows a National Innovation System approach (as defined by Lundvall, 1992). Figure 4.1 illustrates the current structure of the Austrian innovation system, defining the various levels between the parliament, government, and its respective ministries, its influence on funding mechanisms, and connections to other actors within the system, including universities, industry, and other research institutes.

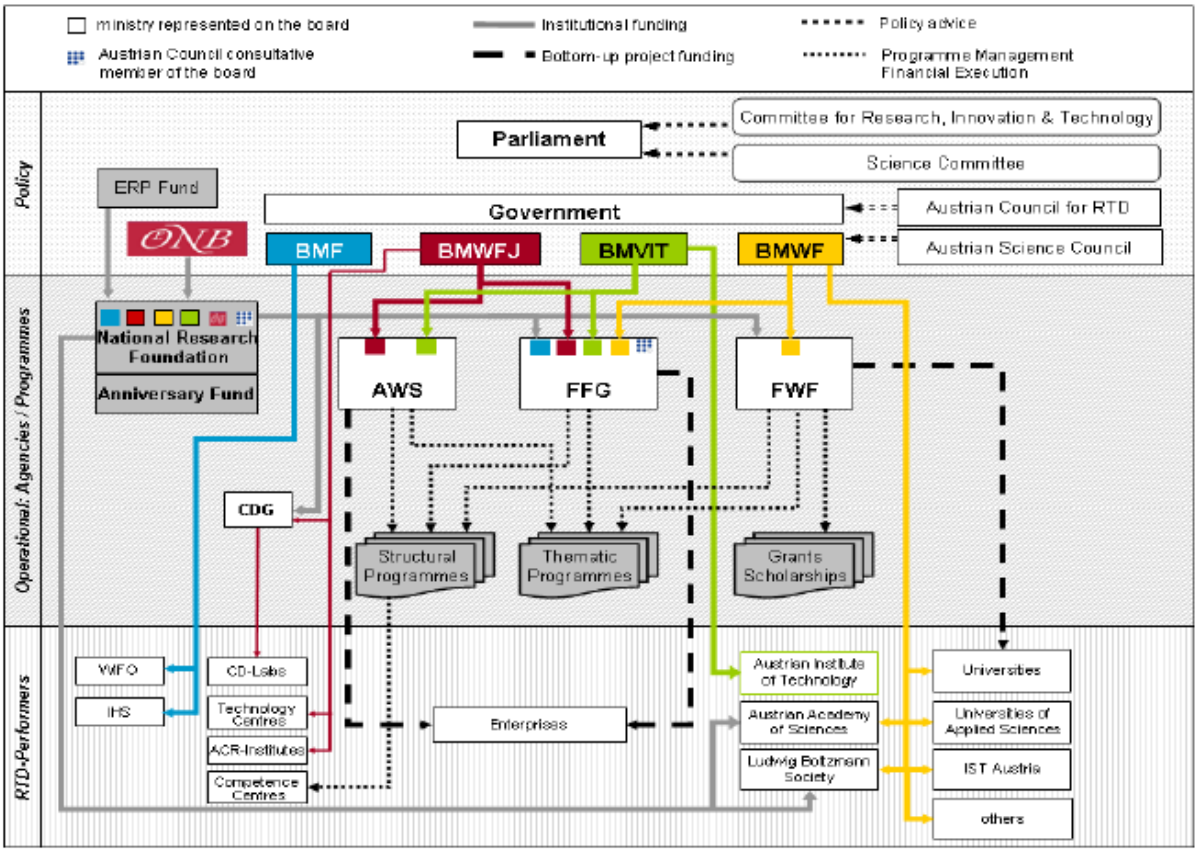

Figure 4.1 The Austrian Innovation System. Source: European Commission, Erawatch, 2014c. Legend: ÖNB (Austrian Federal Reserve), BMF (Ministry of Finance), BMWFJ (Ministry of Economy, Family and Youth), BMVIT (Ministry of Transport, Innovation and Technology), BMWF (Ministry of Science and Research); AWS (Austria Business Service), FFG (Austrian Research Promotion Agency), FWF (Austrian Science Fund), CDG (Christian Doppler Research Society), WIFO (Austrian Institute of Economic Research), IHS (Institute for Advanced Studies), ACR-Institutes (Austrian Cooperative Research Institutes), IST Austria (Institute of Science and Technology Austria)

Legislative power remains with the Austrian Parliament, whereby the Committee for Science and the Committee for Research, Technology and Innovation focus on issues relating to research. However, much of the development of new policy measures in science and technology takes place within the ministries in charge (European Commission, Erawatch, 2014c). Important changes to governance structures occurred recently in 2013, whereby science and innovation policies, together with all budgets formerly governed by the Ministry of Science and Research (BMWF), now run solely within the Ministry of Science, Research and Economy (BMWFW) (European Commission, Erawatch, 2014b). No formal mechanisms of co-ordination exist between ministries, and importantly, the allocation of financial resources, as well as the standards for the design, implementation and monitoring of such programmes, lies with the Ministry of Finance (BMF), which impacts the research policy system (European Commission, Erawatch, 2014c).

Various structural and organisational reforms have taken place over the years, including the implementation of the Austrian Council for Research and Technology Development (Austrian Council) as a strategic advisory body for R&D policy in 2000; and the Austrian Science Board ('Wissenschaftsrat') designed to give advice relating to universities and issues regarding science policy. In addition, the organisational structure of public funding for R&D and innovation has been remodelled, through numerous mergers, to form the Austrian Research Promotion Agency (FFG) and the Austria Wirtschaftsservice (AWS, which targets innovation projects in companies), specifically designed to manage funding for applied R&D and innovation (European Commission, Erawatch, 2014b). FFG's main task is to support business R&D and cooperative research through bottom-up programmes. In addition, they also operate defined thematic priority programmes, which mainly address companies and their scientific partners. Some examples include: GEN-AU (genome research programme); BRIDGE to support and improve links between basic research and applied research; and COMET (competence centre programme) (European Commission, Erawatch, 2014d). It also provides information services with respect to European cooperation, and facilitates numerous EU funding applications. The Austrian Science Funds (FWF) is another major agency for the promotion of basic research. Most of the FWF budget is spent through thematically open bottom-up project applications, which fund individual scientists and research teams (European Commission, Erawatch, 2014d). Much of the research carried out in the country takes place in universities and within the business enterprise sector. In addition, research has increased at non-university research institutes as a result of targeted promotion programmes (European Commission, Erawatch, 2014c). There are three major sources of R&D finance, namely, the public sector, the corporate sector, and international sources. Based on 2011 figures, the public sector financed 35.8% of R&D expenditures, allocating 61.4% of those funds to universities, 25.5% to the corporate sector, and 13% to the public sector; the corporate sector financed 46.2%; the remainder came from international sources, with the EU a considerable source funding just under 10%, showing the importance of the European Research Area (European Commission, Eratwatch, 2014e). Other measures to enhance R&D spending include fiscal incentives to encourage increases in R&D expenditures within the private sector, which have been designed within a tax allowance scheme (European Commission, Eratwatch, 2014b).

Austria aims to transform itself towards becoming an 'Innovation Leader' in the field of R&D and innovation. As a result, ongoing evaluations of the R&D funding system have been taking place since 2009 as a means to strategically identify potential areas for transformation. It is recognised that there is a need to expand the current narrow innovation policy, towards adopting a broader approach to innovation. As such, the creation of linkages between innovation policies and education policies, as well as other social and economic framework conditions, are envisaged. In addition, to ease these linkages, transformation from a fragmented system towards more coordination and consistency in public intervention is required, moving from imitation of strategies, towards more radical strategies in innovation, in order to achieve a common vision and strategy for innovation (European Commission, Eratwatch, 2014b).

4.1.2 Universities' Role

Austrian public universities are considered to be the backbone of basic research in Austria. Although their traditional missions are teaching and research, they have been increasingly expected to partake in third mission activities through cooperation with industry. Importantly, in 2002, the Austrian university system was reformed by implementation of the University Act of 2002, which was designed to grant full autonomy to universities, thus giving freedom to partake in third mission activities, and enable greater decision making power within university management. Nevertheless, performance contracts between universities and the BMWFW were implemented in 2007, meaning public institutional funding is provided through three-year budgetary periods (European Commission, Eratwatch, 2014b). In addition, the Austrian government passed a revised university financing law in February 2013 (coming into operation by 2019), which takes into account the research, teaching and infrastructure demands at Austrian universities, and thus aims to make financing more flexible and transparent (European Commission, Erawatch, 2014f). 2011 figures reveal that slightly more than 56% of research conducted in Austrian HEIs was basic research, 36% applied research, and the remaining 7% was for experimental development (European Commission, Erawatch, 2014g).

In this respect, the “uni:invent” programme, which came to an end in 2009, made a fundamental impact on technology transfer processes for the exploitation and subsequent commercialisation of research results. As a result, 13 university transfer offices were established, which have now become institutionalised within the fabric of these universities (European Commission, Eratwatch, 2014h). As a continuation towards the professional development on universities' intellectual property rights and commercialisation strategies, performance agreements for the period 2013-2015 have highlighted these issues as a priority area for the targeted expansion of knowledge and technology transfer at universities, through establishing clear regulations for dealing with intellectual property (Federal Ministry of Science and Research, 2013). At present, ownership of IP relates to the employment of the inventor. In the case of universities, the 2002 University Organisation and Studies Act stipulates that universities can claim the right to inventions made by the institutions employees; however, the terms written within employees contract are important in this case (European Commission, 2008). Therefore, universities have the ability to negotiate licensing of IPRs with industry partners or other customers (European Commission, 2008). Nevertheless, university employees are obliged to report any discoveries or inventions to the university. The university then has three months to assess the patentability and commercial value of the invention. After this time, the university can either claim all rights to the discovery, or alternatively return the rights to the inventor, who then has the freedom to pursue a patent at their own person cost (Universität Wien, 2012).

4.1.3 Knowledge Triangulation Policies

With regard to interaction between Knowledge Triangle Policies, research is considered a key component of the innovation chain (European Commission, Erawatch, 2014i). As a result, research and innovation policy are strongly interlinked, however, educational policy has not been fully integrated to form a fully functional knowledge triangle (European Commission, Erawatch, 2014i). Nevertheless, these structural problems aim to be addressed in the coming years. At present two out of the three aforementioned ministries deal with research and innovation policy agendas, and as such, address the business sector, as well as university researchers and potential entrepreneurs in association with the BMWFW. Various programmes and initiatives have been designed and implemented in recent years, including the ‘academia+business’ programme (AplusB), designed to support services at universities as well as infrastructure, as a means to aid researchers in the development of new businesses (European Commission, Erawatch, 2014i). To date 9 centres have been set up, which together with 20 technology parks and 88 impulse centres across Austria, provide a stimulus for technology transfer and business development (European Commission, Erawatch, 2014i). The aforementioned ‘uni:invent’ programme also made headway towards enhancing the commercialisation of research outcomes at universities. Although this programme ended in 2009, it has been followed by a number of initiatives including a joint project between the AWS and universities for the design of best practice contract models to enhance the exploitation of university-business cooperation; an IP contact point was set up in 2010 at the BMWFW; and prototype development is supported by the BMWFW’s ‘PRIZE’ programme (European Commission, Erawatch, 2014i). Nevertheless, it is recognised, that although these structural changes have gone some way to ease collaboration processes, efforts are required to further initiate cultural change at universities with respect to IPR’s and their exploitation. Another stimulus for knowledge circulation between academia and industry is encouraged through the ‘young experts’ programme, whereby students have the opportunity to carry out their master or PhD thesis, specifically targeted to address the R&D work of the company (European Commission, Erawatch, 2014i). This flow of human resources provides the seedbed for cutting edge knowledge through the support of academics and industry experts.

Additional policy measures are designed to support innovative SMEs, given structural change towards creating a larger proportion of high-tech industries and innovative companies is needed within the country. The culture of venture capital in Austria is not comparable with that of the United States, and trails behind its EU counterparts in this respect (European Commission, Erawatch, 2014i). Nevertheless, efforts have been made to stimulate this process. FFG organise venture-capital-fora whereby entrepreneurs and potential investors are matched, both within Austria, and through attraction of venture capital from investors in Germany, France and Britain. In addition, some finance is available at provincial level through various funding programmes (European Commission, Erawatch, 2014i).

4.1.4 Life Sciences and the Region of Vienna

Within the Vienna region, a strong research policy focus exists, with the presence of a strong developmental agency for the development and delivery of various measures, programmes and services. Within the Vienna region alone, 34.7% of total R&D expenditures by the Federal States was invested here in 2011, accounting for 3.68% in terms of GERD in % of gross regional product (the average being 2.77% in 2011) (European Commission, Erawatch, 2014j). Vienna is one of 3 of the 9 Federal States in Austria which is registered on the Smart Specialisation Platform. Collaboration, networking, and clustering have been the core concepts of numerous policy measures, with new 'competence centres' among some of the methods employed to stimulate R&D cooperation between public institutions and private enterprises. An example of this includes the Christian Doppler Research Institutes, jointly funded by the BMWFW and industry partners (European Commission, Erawatch, 2014k). The life sciences sector is of particular strategic importance, with the Regional Government of Lower Austria compiling their 'Economic Strategy Lower Austria 2015' which identifies a large number of specific innovation and market niches, including numerous areas within the life sciences, namely: analysis of biological materials, agrobiotechnology and environmental biotechnology, utilization of natural resources, pharmaceuticals, blood purification systems, tissue engineering, cell therapy, cell biology and physiology, medical technology, food safety, as well as bioplastics. (European Commission, Erawatch, 2014l).

Vienna is the centre for life sciences in Austria and is becoming one of Europe's most important locations for research in this field (Vienna City Administration, 2014). The life sciences sector includes research in an array of topically relevant areas including biotechnology, medical technologies, as well as genetic, ecological and agricultural research, to name a few. Within Vienna a total of 404 companies generating revenues of around 1,718 million Euros; and a total of 22 research institutes including 5 universities, 2 universities of applied sciences, 10 non-profit research institutions, and 5 other organisations, are functioning within the Life Sciences field (Lisa Vienna, 2011). The city of Vienna has a variety of funding measures and rewards to support Life Sciences. These include the Technology Agency of the City of Vienna, ZIT, who have launched initiatives to facilitate and encourage the transfer of successful basic research into practical medical implementation; and LISA Vienna, which functions as a cluster management hub for biotechnology, and a central service provider and coordinator for researchers and businesses, particularly focussing on issues relating to patenting and patent marketing, new start-ups, and financing (Vienna City Administration, 2014). Various financing options include 1 million Euro seed financing for the start-up phase of high-tech companies; 200,000 Euros pre-seed funding for the pre-start phase, and 50,000 Euros for the financing of complementary management expertise (Lisa Vienna, 2011).

4.1.5 Results from the Government Representative

4.1.5.1 Actors

The respondent feels that a variety of actors are influential within the innovation system. At the political level, the public administration at the ministry is influential, as well as universities themselves, funding agencies, and business enterprises. Importantly, there is quite a lot of communication among these different groups of actors, and there are a lot of programmes targeted towards bringing together these different actors.

4.1.5.2 Mechanisms

There have been major changes in the governance of the university system. The new university law of 2002 which came into effect 2 years later in 2004 had one basic principle, to provide leaner regulation of universities' so as to give them a maximum of autonomy, at least in the continental European context, whereby traditionally, universities have been State institutions for a long time, operating under a strict legal framework and very strong State control. The new regulation is designed to step away from State dominance, and grant autonomy and freedom to the institution to make them more flexible and responsive to what society need. As such, universities should be able to act in their specific environment be it international, regional, or local, in order to best meet the challenges according to the individual profiles of the institutions. However each institution differs a lot from each other.

Performance contracts between individual universities and the State for periods of 3 years, have been designed to include the level of funding that each institution would get for the period, and the performance elements the State would like to see for this money. Within these contracts, certain elements are targeted to foster cooperation in innovation, knowledge transfer, outreach within the region, and so on. All activities agreed upon in the performance contracts are monitored on a regular basis by the Ministry. Monitoring of the overall strategy is also undertaken for subsequent evaluation.

Research councils and research programmes exist to harness university contribution, as well as some other small funding institutions such as the Christian Doppler Laboratory, whereby their main aim is to foster cooperation between industry and higher education and ultimately knowledge transfer for innovations. Currently, a new programme is in development which is designed to created knowledge transfer agencies at certain higher education institutions in Austria.

In theory, HE policies have been integrated with economic policies, which is evident in the national strategy for innovation. Nevertheless, the respondent felt that, *"in practice, well it might be a bit doubtful whether that link between the overall strategy and the institutional strategies is that strong."* Yet it was perceived that university outreach to society and cooperation with industry has grown constantly over the last 10 to 20 years.

Besides the formal programmes, contract and regulations, the Ministry do not have any specific initiatives or policies targeted towards informal networking. However, a lot of informal networks exist within the innovation system, but the respondent felt that there is room for improvement.

4.1.5.3 Organisational Barriers and Enablers

Comparing the situation to 20 years ago, the respondent felt that it is easy for universities to take part in initiatives, given the overarching system has developed to becoming much more flexible and open. Nevertheless, the respondent felt that when considering challenges within the system, it is important to not only take account of the legal framework, but also the fact that is it , *"more and more difficult for institutions to cope with all the different demands and challenges they are facing…. It's not always easy for institutions to cope with that, especially in terms of funding".* The respondent indicated that government try to support universities to carry out these myriad functions, but argued that it shouldn't be taken for granted that they can be successful in all areas. The Ministry of Science Research and Economy has a clear position to foster university funding, however the Federal budget has very severe restrictions which leaves little room to manoeuvre, which is a basic problem within the system. As a result, the government encourage universities to partake in third mission activities given it is an important source of income for institutions. Yet, the respondent also recognised that running programmes with industry can be a costly endeavour for universities, whereby they run the risk of losing money , and the Ministry do not have the financial leverage to be able to cover these expenses. In addition, the respondent recognised that there is a need for more infrastructure in order to partake in such activities, but indicated again that the lack of funds is a barrier to such developments.

Regarding mechanisms designed to support universities for dealing with administrative hurdles and bureaucracy attached to taking part in such initiatives, the Ministry provides some support; however, much of the work is left to the offices, agencies and administrative units internally within universities. In addition, it is also left up to the autonomy of individual universities to attract third party funding. When asked if formal or informal platforms are available to ease this process, the respondent stated that these are done occasionally, but not in a fixed format, and organised by various stakeholders within the system, to which the ministry may have some involvement.

The respondent feels that the main barrier for universities is to be able to do more with less money, whilst also functioning to service their individual profiles. As such, the respondent recognised that not every institution can cover all aspects and functions at the same time, and consequently this remains with the autonomy of the institution to decide what to pursue.

Overall, the respondent felt that it was clear that *"long term approaches pay off in a better way"*, but argued that available funding restricts the timescale of projects, which only during the course of time, and the financial situation at that time, can influence whether projects will be able to continue for a second phase.

4.1.6 Results from the Funding Agency Representative

4.1.6.1 Actors

The respondent felt that there are different actors who are influential within the system, and made reference to the development of Competence Centres for Excellent Technologies (COMET) which has been funded by two ministries (the Ministry of Innovation, and the Ministry of Economy), which is an important to bring actors together. In addition, the three big agencies active in the field (one dealing with applied research, one with basic research and on with financing in Austria) are also important actors.

4.1.6.2 Mechanisms

The COMET centres are physical legal entities, whereby the universities are also owners. Therefore, they have a certain interest in being involved in this type of research. Nevertheless, the funding agency also asks them to partly finance this, which universities do not always like, but the respondent reported that it actually works perfectly. 5% of the overall project cost is financed by universities themselves as academic partners. This 5% can be contributed through in kind contributions.

With regard to informal networks, the funding agency is not initiating these, however there are several informal networks existing within the innovation system, as well as lots of clusters. The programmes are quite a formal way of cooperation where they have to get together via a funding contract. This forms a bottom-up initiative, whereby actors are not specifically identified by the funding agency. Nevertheless, identification of actors does take place on some thematic programmes. Importantly, the system is evaluated through international peer review processes in order to find out whether consortia are indeed finding each other, and if the right agents and people are gathered. Regardless of this evaluation, applicants are left to their own devices to find each other and form consortia, with no help given by the funding agency in the respondent's particular department.

Other mechanisms include a large fiscal premium, whereby companies can state their R&D activities, and if it qualifies, they can claim up to 10% of their R&D expenses, and that includes all activities where they work together with universities. Importantly, it is very often the case that companies are working with universities. Austrian companies have quite some experience in working together with universities, and the respondent has observed that collaboration has been increasing through these types of projects or programmes running at the agency.

4.1.6.3 Organisational Barriers and Enablers

Considering the programmes the respondent was familiar with, they felt that it was easy for universities to participate, despite some administrative issues that may present themselves within the process. The process of setting up these competence centres as physical legal entities has shown that over time, they were taking over this type of platform function for cooperation between industry and academia. Importantly, collaboration is happening much quicker in this format compared to when industry is having direct contract with universities, given issues surrounding IPR which extends the time needed to reach agreement. In addition, the competence centres are funded for 7 to 10 years, so within the centres there is a lot of knowledge, not only on the topic, but on administrative issues such as setting up the contracts. Evaluation of these types of programmes has shown that these activities are making universities much more entrepreneurial, and that the gap between what universities are doing and what industry needs is closing, which was a goal of the project. Through running these programmes, the respondent noted that they had observed that you need a long time to build trust between the different actors. And the good thing about the COMET initiative is that it is about trust building; *"the university has to trust industry that they are not running their research agenda; industry had to trust the universities to come forward with interesting topics."*

In terms of attracting third party funding, the respondent feels the change in University Law in 2002 made an impact given it provided a stimulus for restructuring within universities and also a change in thinking. This reorganisation means that universities are well equipped to pursue funding at the Austrian and international levels.

4.1.7 Results from the Industry Representative

4.1.7.1 Actors

Organisations such as technology agencies like FFG, AWS, and also ZIT or Vienna business agency are important actors within the system. They are in a position to see the projects of the industry and the projects of academia and can therefore form the link between projects. These organisations foster collaboration between a variety of actors' including universities and research organisations. Additionally, agencies such as ZIT and Vienna Business Agency have a primary focus on companies, whereas organisations such as the Vienna Science and Technology Fund focus on scientific activities in Vienna incorporating universities. Nevertheless, there are dozens of actors and programmes running in the different ministries and regional governments such as COMET, Christian Doppler Laboratories and Dr Poltzman initiatives which makes collaboration between science and industry *"above average for Austrian limits"*. However, when it comes to maintaining contact with actors inside universities, there are a variety of people including the technology transfer offices, management, and individual professors. The respondent argues that *"here in our organisations its pure people business, there is no process or structure that we have to follow by our management"*, meaning that flexibility is key given each university and project will be different. Cluster organisations such as LISA Vienna provide a platform for life science networking in Vienna.

4.1.7.2 Mechanisms

There are some funding programmes and some special grants that are focussed on collaboration between industry and research, not only for universities, but research institutions which include universities as well as non-university institutions. The COMET programme, Christian Doppler Laboratory, and other small project funds available at FFG, AWS and ZIT provide a financial stimulus and support, with packages available specifically for the collaboration with universities. An example focussing on the Life Science sector at ZIT provides over 2 million Euros for R&D life science projects and a bonus of up to 15% is available on the top of the R&D costs if partaking in a collaboration between a university and a SME. There are also bottom-up initiatives whereby funding is not allocated to specific disciplinary areas. In addition there are many programmes and services running in parallel which offer administrative support. The organisations providing such services have some people who have previously worked in universities which means they have contacts readily available and know how to start such collaborations. There are no specific regulations, with the majority of programmes following the European Framework for Research and Development.

4.1.7.3 Organisational Barriers and Enablers

The respondent felt that the variety of university structures makes collaboration difficult, *"in Vienna we have five universities which have life science activities, and I can tell you that every university of this has a completely different culture so there is nothing very similar, they have a complete other structure a complete other level of professionalism in the technology transfer office and so on, so there is not one way to get in contact with a university in Vienna, there are different ways."* The respondent stated that, *"there are many ways we have to organise many different processes, and know many people. If there is not a process there are many different people that you have to know, and we have here, in Vienna only, all the unis have 14,000 employees in life sciences, so it's good to know the vice rectors and the people of them but, it's very difficult."* In addition, the respondent noted a problem concerning communication inside universities, highlighting that there is potential for optimisation of knowledge exchange internally, *"normally the researchers do not know what happens on the next floor above or below or on the next door, so if they don't know inside the university, it's also very hard especially for companies like ZIT or LISA Vienna which is the life science cluster organisation to collect all the information and the news to get the overview of all the activities that are taking place here in the city. This is really much activity especially in the life sciences. Vienna is a life sciences organisation. More than 50% of all scientific output in Vienna refers to medicine and biology, 50% this is amazing and most of them is focussed here in Vienna."*

The respondent also noted barriers regarding financial support and human support as above average in Austria. Also, the poor availability of private capital for financing R&D was perceived as a barrier. Another weakness relating to the lack of a clear strategy for technology and innovation activities within Austria, given there are very different strategies

and goals between the national and regional governments and ministries, and also by the universities and individuals themselves. This could be due to the fact that governments are not collaborating enough with stakeholders when designing these policies. As there are many players within the field, coordination between players needs to improve. LISA Vienna is perceived as good practice, but this concept has not been rolled out across Austria, which perhaps stems from varying cultures present within the various federal states in the country.

Issues regarding the handling of IPRs was also highlighted as an important issues, given it is not particularly easy to collaborate with a university because of the questions surrounding the handling of IPRs. In addition, IPRs generate costs for universities, and although universities are good at carrying out research, it was felt that they are not so good at selling them. Therefore there is a need for people with special qualifications to deal with these issues, and develop systems such as the technology transfer offices.

Additional barriers pertain to the differing cultures between industry and universities, it forms a completely new way of working and communicating. Therefore the first collaboration between SMEs and universities are particularly difficult. In addition, collaboration with the Medical University is particularly complicated given that on one side you have the hospital which is operated by the university, with the doctors employees of the university, and then the nurses employed by regional government. This creates complex cultural problems, given prevailing governments have different cultures and end goals. In addition, Austria has very high administrative overheads, which is money which could be better utilised elsewhere. Therefore, collaborations must include the health care system, however the health care system is not so interested in innovation which makes commercialisation of the product difficult, especially in foreign markets, as potential buyers want to know why innovations have not been utilised in the home market first. In addition, varying actors present a variety of business models, which again creates difficulties when trying to collaborations. The German system is an example of good practice in this case, given the ability to avoid bureaucratic hurdles; whereas in Austria, there is a lack of clear communication on how to bring innovations into the clinics. Nevertheless, bridging organisations help actors to overcome cultural barriers within such interactions.

In order to enable collaboration, the respondent felt there is a need for more “easy money” such as the innovation cheques or technology transfer cheques, in order to help break the barriers to first contact between actors. In addition, improving the success rate of funding applications is required given only 15-30% of applications are successful at present. In addition, there is a need for better collaboration with the healthcare system. The respondent also felt that improvement of access to the availability of information regarding current university research would ease interaction. At present it’s not very easy to find this out, and requires a lot of effort.

4.1.8 Results from the Bridging Organisation Representative

4.1.8.1 Actors

The respondent felt that the AWS is an important actor in bringing together actors within the innovation system. In addition, they feel that FFG are also important in the provision of programmes, as well as the technology transfer offices within universities, given they encourage academics to translate their ideas and innovations into industry. The respondent also feels that these organisations have encouraged universities to become more entrepreneurial, whether structurally, organisationally, or culturally, given the support provided, and the financial money available.

4.1.8.2 Mechanisms

Uni:invent was an important programme to support universities to establish technology transfer at universities. The aim was to establish instruments and strategies, and also to educate people at the universities so they could carry out technology transfer on their own. In addition, financing tools for the development of patent applications has also been important. Organisations such as the AWS also have some finance available through pre-seed funds whereby up to 200,000 Euros is available; a seed programme where up to 2 million Euros is available for the next 3-5 years; and 100,000 – 150,000 Euros for universities to improve their ideas, technologies, or patents, so that they can reach the prototyping stage. Nevertheless, money comes from the government, and of course has rules attached, meaning the money is targeted to a certain extent. However, there is a network of universities, government representatives, and other institutions who discuss future strategies. Therefore, all actors have the possibility to give input on the process.

4.1.8.3 Organisational Barriers and Enablers

Overall, the uni:invent programme has been a great success, but there has been variance in success between different universities and their subsequent performance of technology-transfer activities. The respondent felt that this was due to *"a very strong personality aspect, so which persons act at the universities is one point, and the other point is what kind of university it is, is it a university that is mainly focussed on technical fields for example technical universities…. Or not scientific based fields, they are more in other spaces where patenting and innovation is not that important"* Therefore, how engaged the point of contact is, and the orientation of the university can either enable or inhibit interaction. Nevertheless, the presence of a technology transfer office does ease interaction processes.

An important barrier is the fact that universities are working on basic research and the things that they invent is too far away from industry. Therefore there is a gap that is hard to bridge, because it's necessary to have a lot of money to bridge this gap. The respondent felt that this is the main problem in the life science field. Especially given there is not a culture of risk money in Austria, which makes the situation very different when compared to the US or the UK.

Platforms and networks, both formal and informal are good for improving coordination and communication between actors in the programmes, and there has been a noticeable change in university interaction over the years, although granted, not all universities have increased at the same level. The respondent feels that the development of Knowledge Transfer Centres should be an important improvement for technology transfer and interaction among actors. Nevertheless, availability of funding is always the issue, but there is a need to be sustainable, and educate universities and provide special services in order to ease university interaction.

4.1.9 Results from the University of Natural Resources and Applied Life Sciences (BOKU) University

This university was founded in 1872 in Vienna, and has locations throughout Vienna and Lower Austria. It has developed from its early beginnings as a small agricultural college, incorporating specialisms within the agriculture, forestry, and water management disciplines; towards adding further disciplinary areas since 1945, including fermentation technology, food chemistry, and biotechnology. Latterly, since 1991, it has expanded its teaching and research endeavours to incorporate the fields of landscape planning and landscape management, as well as courses relating to resource management and ecological engineering. (Universität für Bodenkultur Wien, 2014a). The 1980's witnessed the inception of two research centres to function at the cutting edge of scientific development in these specialist fields (now operating as the Department of Nanotechnology, and the Institute for Integrative Conservation Research). Notably, during 1990's, BOKU successfully became involved in university cooperation activities in the field of research (Universität für Bodenkultur Wien, 2014b). The inception of IFA Tulln, in cooperation with two other universities in Vienna, and three local authorities in 1994, highlights the cooperative and entrepreneurial spirit of BOKU at a time when developments regarding the Triple Helix nexus were still in their infancy. What is clear is that since its inception, BOKU has transformed itself to become a modern and internationally oriented university of life science, with a portfolio of undergraduate and postgraduate courses for over 10,000 students. In addition, it has grown in size and impact, hosting 79 research institutes, centres and divisions, within 16 departments, whilst spanning an extensive range of life science disciplines, as well as additional complementary physical science and business disciplines (BOKU, 2014a; BOKU, 2014b).

The University of Natural Resources and Life Sciences perceives itself as a teaching and research centre for renewable resources, which are necessary for human life (University of Natural Resources and Life Sciences, 2014a). Making a considerable contribution to the conservation and protection of resources for future generations through the provision of diverse fields of study is one of the university's main objectives. As a result, through connecting the natural sciences, engineering and economic sciences, BOKU aims to increase the knowledge of the ecologically and economically sustainable use of natural resources. BOKU's research endeavours focus on providing practical relevance, and as such, the recognition of future problems is core to the university's mission. They recognise that innovative problem solving results from the interdisciplinary cooperation of scientists at an international level, which compounds their capabilities to meet future challenges. This is evident in the various scientific initiatives under operation within the Centre for Global Change and Sustainability, BOKU-CAS Centre for Agricultural Sciences, Vienna Institute of BioTechnology, Bio-Resources & Technologies Tulln, and BOKU Network for Bioconversion of Renewables

(University of Natural Resources and Life Sciences, 2014b). In addition, the Centre for Development Research provides a multi-disciplinary network of scientists, which takes part in collaboration activities with partners in Africa, Asia and Latin America (University of Natural Resources and Life Sciences, 2014c). Together with participation in teaching projects abroad, international networks, and partnerships with various international institutions, BOKU aims to strengthen its internationalisation strategy, which bolsters the university's impact and reach (Universität für Bodenkultur Wien, 2014c). This entrepreneurial outlook towards cooperation and development is reflected in the university's managerial orientation. A realisation exists that to meet the objectives set forth, integrated decision making and cooperation based on mutual trust and flexibility are pivotal, thus providing the possibility for decentralised decision making processes. This in turn enables the university to act effectively and respond flexibly to new challenges as they arise. It has an awareness of its external stakeholders, and aims to take responsible action, whilst additionally aiming to elevate its international performance within the realm of teaching, research and cooperation at the regional, national and international levels (University of Natural Resources and Life Sciences, 2014a). BOKU is managed by the rectorate, including the rector, the vice rector for finance, the vice rector for teaching and international affairs, the vice rector for human resource management and organisational development, and the vice rector for research and international research collaboration (BOKU, 2014c). Various staff units support the managerial administration of the university, including the quality management office (BOKU, 2014d). BOKU also has a university council and senate operating within the leadership of the institution (BOKU, 2014e).

Two representatives were interviewed at BOKU.

4.1.9.1 Actors

Industry is an important actor for BOKU, given the importance of industry funding for the survival of certain departments within the university. In connection with this, alumni of the university are also important for the establishment of collaborations with industry. Government is another influential actor, providing instruments to stimulate interaction between universities and industry.

4.1.9.2 Mechanisms

The university has three models of how to interact with companies. They have several funding instruments; direct interaction with a company; and utilisation of public funding instruments (e.g. European funds, and Austrian funds) through participation in various programmes including the Christian Doppler Laboratories and COMET centres, which is a very attractive for the university as *"you can do basic research which can bring unexpected results"*.

4.1.9.3 Organisational Barriers and Enablers

Regarding organisational structure, Respondent 1 (R1) felt that, considering the current university structure, funds available at present, and especially the support structure BOKU have now, it would be difficult to increase the amount of third mission activities. Both Respondents felt that the shortage in staff is the main barrier to increased participation, especially given the increase in student numbers, and unmatched increase in staff numbers. In addition, R1 felt that there is a strong need for good infrastructure in universities for this purpose: *"one important thing is the basic funding of universities. You have to have healthy, good funded universities with basic infrastructure, clear rules, and enough support and service staff"*. At present BOKU's share between administrative staff and research staff is in the lowest range, 20-25% general staff: 75% researchers, which means that researchers have to do much more administrative work. In addition, the fact that the university only has one legal officer was perceived as a problem, given the time it takes to check contracts, meaning industry is not happy with such delays. Respondent 2 noted that there is a need for a well-equipped technology-transfer office displaying competencies in administrative issues including IPR. Nevertheless, R1 also indicated that the need for structural change is not easy within a publicly funded institution. R1 went onto state that there is a need to shift towards more entrepreneurial approaches, and more strategic planning, and a need for cultural change both within universities, and externally within society, given the wrong perceptions of how much universities should contribute with little financial return.

Respondent 2 (R2) felts that one major barrier is the limitation in the basic funding of the university by public money. R2 felt that *"without public funding (we) would completely depend on the budget of the industry, and in such a case if*

industry will say what to do, so then there's no flexibility for the university to bring their own ideas." Therefore, with access to public funds, it means that you can forge a real partnership, and leads to real innovation, *" I think it's very positive for innovation because if industry pays what they need directly for a product or development of procedures, I think there is only quite a small innovation at gradual or incremental innovation. But for real innovations, it comes from basic research because there you get new ideas, and unexpected results."* In addition, the limited availability of researchers through both time and manpower to carry out such activities also influences the extent of BOKU's activities within the innovation process. There is also a need for increasing the awareness of the importance of entrepreneurial activities among staff. In addition, R2 felt that there is a need for government awareness of the importance in the investment in education, research, and innovation, for the development of a country and its regions.

R1 also indicated that problems pertaining to the premarket funding gap exist. University inventions are too early for companies to be interested, and there is no money to develop such inventions to a stage where they can be commercialised by industry.

4.1.9.4 Strengthened Steering Core

R2 indicated that entrepreneurial activities have quite a long tradition at BOKU. Nevertheless, R1 noted the importance of the uni:invent programme, as it was important for the establishment of in-house competences, and in some cases, the extension of TTOs. Importantly, R1 indicated that there is a clear commitment by the rectorate for entrepreneurial activities. R2 stated that BOKU has a development plan which is updated every three years, and has impact on the strategy of the university. The new Horizon 2020 funding framework and strategy papers by both national and European governments have a very important influence on the developments of their approaches for research. In addition, the organisational structure of the university is perceived to be flexible enough to respond to research calls, and enable researchers to form consortia across disciplinary areas, through academic entrepreneurialism.

With regard to autonomy, both respondents felt the new University Law of 2002 has granted enough autonomy, although R2 stated that rules attached to performance contracts has limited this autonomy, but it can be handled. However R1 felt that the indicators associated with such contracts is time consuming for staff, and creates a conflict of interest, *"autonomy is very important, but it makes only sense if it's made serious".* R1 also felt that it is important for government to remain loyal to their contracts, and provide clear funds in order to create a conducive collaboration. Nevertheless, the increase in student numbers is not proportional to the increases in public funding over the same period, meaning in real terms difficulties exist, as currently the federal budget for research is frozen, meaning in real terms the value is decreasing.

4.1.9.5 Expanded Development Periphery

R1 felt it is *"really strongly necessary"* to change the structure of university departments and organisational functions in order to make it easier to compete for funding, the first step of which was the implementation of the new University Law in 2002. R2 indicated that the changing structure at BOKU was not actioned directly to produce a more conducive position to compete for funding, but to form departments that have enough flexibility and focus towards problem settings rather than being set in disciplinary areas, and to have a clear structure to the outside world. R1 felt that for good cooperation with industry, you have to have enough support staff or management staff, and to have clear rules that are transparent and followed.

R2 noted that the technology-transfer office in BOKU is centrally managed, and able to support researchers. However, there is a need for more staff, but due to budgetary reasons, this creates limitations in the extent of work the TTO can carry out, a view shared by R1. In addition, R1 argued that the main problem with funding is that the results are expected too soon, however, in technology transfer, there is a long incubation period, meaning it can take 10 years to see the fruits of programme activities, which maybe only lasted for 3 years in the first place.

BOKU are involved in cluster activities and tri-lateral networks including the AplusB projects, collaboration with other universities, governments, and at European level through the strategy for the Danube region, as well as being members of the Danube Rector's Conference, and various other Life Science Networks. R2 felt that such networks are important for BOKU's future strategy, given the importance of integration of new member states within the EU, and

also the mobility of researchers and students within these countries in a bid to reduce brain drain. R2 noted that interactions take place both formally and informally. R1 stated that cooperation needs time, and time is money, meaning such collaborations are a longer term investment given the time lag in the eventual outcomes from the TTOs. In addition, R1 felt that platforms alone are not enough for collaboration, and that individuals must have and develop good personal networks. In addition, R1 felt that the vice rector for research, and the TTO with the strong competences of the legal expert, as well as certain individuals with experience in various departments, were the driving force towards such collaboration activities. R2 felt that this depended on which interactions were taking place, and felt that a mixture of bottom-up and top-down activities took place, incorporating many people in the process.

4.1.9.6 Diversified Funding Base

R2 indicated that BOKU has been quite successful in using available funding instruments, and collaborating with industry, either directly, or through participation within competence centres. R1 argued that due to lack of funds, additional government funding was needed to develop basic TTO support. Nevertheless, there is a need for more TTO staff in order to secure further funding from EU instruments such as the Horizon 2020 framework programme. In addition, R2 argued that third streams of funding cannot be increased in an unlimited way given the need to match fund projects from internal resources, and the limitations of basic infrastructure, such as rooms, equipment, and personnel, cap the amount of activities they can partake in. Nevertheless, with regard to interaction, R2 felt that although funding instruments provide encouragement for universities to participate in the innovation system, real initiatives are usually coming from within the universities, including some strategic interactions coming from top management. However, bottom-up and top-down networking has a role to play in this, in addition to maintaining contacts within the institutions in Brussels for input towards the development of new programmes and initiatives.

4.1.9.7 Stimulated Academic Heartland

No particular issues were raised within this dimension of the study.

4.1.9.8 Integrated Entrepreneurial Culture

Prior to the new University Law in 2002, academics formed collaborations on their own, but since then, and the move towards digital applications, the majority of activities go through the TTO. Nevertheless, R1 notes that cultural change is always difficult, however, R1 has not witnessed resistance to change, and believes one factor for this is the inter-disciplinarity and crossover between academics in the technical, scientific, and economic disciplines. As such, people are used to integrating and collaborating across disciplines. R2 believes that change is welcomed at BOKU, and those with reservations about change usually have good reasons. This is usually related to the independence of the university, and the need for a balanced funding system so as to have sufficient public financing to not be dependent on industry. There is a realisation of the importance to extend beyond research and teaching and open towards society and industry. In addition, BOKU adopts a 3-pillar system, whereby teaching programmes provide students with a holistic view by incorporating modules from the technical, scientific and economic disciplines. R2 believes that, *"this is one of the strengths of our alumni, and this is very important for the innovation system because innovation is not one dimensional, innovation is multi-dimensional."*

4.1.10 Results from the Medical University Vienna

The Medical University of Vienna is one of the world's leading medical universities operating at the cutting edge of medical research, and boasts a long history, operating for over 640 years (MedUni Vienna, 2014a). It was originally founded in 1365 as the Medical Faculty of the University of Vienna, but has operated as an independent autonomous university with its own administration since 2004 (MedUni Vienna, 2014b). Today it is the largest medical organisation in Austria, and provides Europe's largest hospital, the AKH in Vienna, which encompasses 31 university clinics providing care for over 100,000 inpatients and 605,000 outpatients annually (MedUni Vienna, 2014c). The university delivers degree programmes encompassing a comprehensive range of human medicine and dentistry subjects ranging from bachelor study through to PhD doctoral degrees. Around 7,500 students study at the university, along with around 5,000 employees of which 1,800 are researchers, 1,600 are medical doctors, and 2,300 are teachers (MedUni Vienna, 2014b). The operational management of the university is led by the rectorate, comprising of the Rector, the

Vice Rector for Research, the Vice Rector for Education, Gender and Diversity, the Vice Rector for Finance, and the Vice Rector for Clinical Affairs (Meduni Vienna, 2014j). They take charge of designing strategic guidelines which are stipulated within the development plan, performance agreements with the Austria Federal Government, and the aims and objectives of its various organisational units (Meduni Vienna, 2014j). The Senate comprises 13 representatives including university professors, teaching and research staff, an administrative staff member, and several students (Meduni Vienna, 2014k). In addition, the University Council is another central governing body comprising members from within the university, and from the Austrian Federal Government (Meduni Vienna, 2014l). The organisational units of the Medical University of Vienna comprise clinics, clinical institutes and centres, which are located in the General Hospital (except the University Dental Clinic). These units act as the clinical centre of the university. The theoretical institutes and the institutions assigned to instruction come into the sphere of the centres and special institutions (MedUni Vienna, 2014d). In addition, a number of Service Facilities exist to provide the facilities required for teaching, research, clinical support, and the general internal and external administrative affairs on the university (MedUni Vienna, 2014e).

The university is structured around its 'triple track' strategy, whereby research, education and patient care represent the three cornerstones of the university's system (MedicalUni Vienna, 2014f). These cornerstones enable the university's developments in medical science to respond flexibly to ever-changing political and societal demands. The development of innovative solutions to today's global challenges within the medical field, together with international competition in the field of medical research, are the core tasks at the Medical University of Vienna. At present the university currently participates in two comprehensive healthcare management projects in Malaysia, Libya and the United Arab Emirates, given the flow of knowledge, international cooperation, and attraction of new financial resources are central tasks of this internationally oriented research institution (MedUni Vienna, 2014g). The linkage of fundamental research with clinical application creates benefits for patients. As such, Inter-disciplinarity and Translational Research approaches are essential elements of the university's development plan. Five research clusters have been formed, namely the Allergology/Immunology/Infectiology Cluster (AIIC); Cancer Research/Oncology; Medical Neurosciences Cluster (MNC); Cardiovascular Cluster (CVC); and the Medical Imaging Cluster (MIC) (MedUni Vienna, 2014h). Over the years, the university has focused its efforts towards finding its market niche. The development of these clusters has been an important step in its entrepreneurial transformation. The university's objective is to establish an international competence centre to work on innovative research concepts at national and international level, through the creation of a 'centre of excellence'. The university aspires to become a leading healthcare player in the future, and as such, measures to support researchers and doctors, and participation in international networks and extra-university cooperation ventures are central components of its success. In addition, in a bid to secure additional sources of funding for future research endeavours, the university will support patenting and the commercial utilisation of research results through 'academic private partnerships'. Importantly, in order to drive this process, the university has also set up its own service organisation for this purpose (MedUni Vienna, 2014i).

Two representatives were interviewed at the Medical University, Vienna.

4.1.10.1 Actors

The AWS are an important partner in the commercialisation process, and FFG provides funding through programmes from government. In addition, interactions with other university rectorates provides a lot of knowledge. Although government is not perceived as the driving force behind commercialisation activities, the programmes they provide is seen as a stimulus. In addition there is some collaboration with industry partners, with some professors heavily involved in some companies. Academic entrepreneurs actively pursue external funding both for the financial benefit of engagement, but also out of academic interest in projects.

4.1.10.2 Mechanisms

The University Act 2002 has provided a mechanism whereby academics can no longer carry out entrepreneurial activities by themselves, but must engage in such processes via the rectorate. The uni:invent programme was considered as an important step forward in the development of staff and infrastructure for technology-transfer and commercialisation.

4.1.10.3 Organisational Barriers and Enablers

Both respondents feel that there is a lack of money available for technology-transfer processes since the uni:invent programme ended, given Respondent 2 (R2) points out that universities in Austria are currently heavily underfunded, with over 90% of the university budget spent on personnel, leaving little resources for IP development, which is a costly endeavour. Respondent 1 (R1) pointed out that if you run out of funds you have to kill the project meaning patents are then abandoned, considering the length of time it takes during the application process, and maintaining such applications. R2 also feels that there is difficulty to convince people to invest money in research, *"we are not Silicon Valley, people in Europe spend money on culture".* In addition, R2 feels that there is a need for seed funds, but also argues that there is a long time gap stretching between 5 and 20 years before you see the outcomes of such investment in technology transfer. This is made especially difficult when such a small proportion of IP actually creates revenues. In addition, R1 points out that the journey from discovery to commercialisation in the life sciences in a long process, consuming both time and money, and therefore availability of funds is the main constraint. In addition, R1 states that not only must inventions be patented before publications are made, it is also difficult to licence out these inventions because they are too early, creating a gap between what industry can use. In addition, R2 pointed out that patents generated are also very specific, and you therefore need a strong input form the inventor, who then also need to think economically. The inventor knows all the contacts in his field, but the TTO officer is a layman, and does not have the specific knowledge.

In addition, R2 pointed out that TTO's in Europe are not comparable to those in the US, given they are an entirely different concept, and have huge investment funds, and a strong brand. R2 succinctly described the situation as follows, *"they are buying brains like FC Barcelona is buying great soccer players- that's their general strategy; but the strategy of most European universities is entirely different, mostly because they're state owned and not private, or government owned and not private."*

Available finance is the main barrier, with R1 arguing that without money they cannot do anything. In addition, R2 indicated that psychological barriers also exist, given it is difficult for young researchers to make their way through all the regulations. R2 felt that overall, the innovation system is quite a hostile environment on the political and administrative level, whereby *"young entrepreneurs are not wholeheartedly embraced"*, and is *"restraining itself from making a great leap forward"*. R2 argued that universities themselves could be better, caused by the unlimited barriers to access of universities (by prospective students), and political influences also impact the system. R2 maintains that you need a lot of other institutions to help *"brains"* in their development, but funding is only opened for a short period of time (e.g. 4 years), and is then terminated, *"it's not a full blown process"*. IP generation is a very long term process, and therefore highlights the conflict between short term and long term goals within the system.

R2 noted that Austria's aspiration is to become an Innovation Leader according to the Innovation Scoreboard, but to do so would require at least a 50% increase in public funding in universities, as well as instruments like seed funding for small spin-off companies.

R2 also noted problems relating to a lack of time to carry out the range of activities academics now must carry out, which in R2's opinion, is too much. R2 also indicated that a lack of available personnel within the university is connected to this problem.

4.1.10.4 Strengthened Steering Core

R2 stated that changes within the political and innovation environment are, *"absolutely interconnected with the mission and strategy of the university"*. R1 agrees that changes in the policy and funding environment have influenced the university's path, and as such, the overall strategy of the university echoes the University Act implemented in 2002. R2 stated that the freedom afforded by the Act means they can develop IP or spin-off companies, which is a good thing. R1 feels that it is good to have autonomy in commercialisation, as it enables the freedom to find appropriate experts and outlets for inventions.

A strategic decision was made to not follow all possible IP generated within the university, given the cost and heavy administrative burden maintenance of such applications incur. Nevertheless, R2 recognises that by limiting the number

of IP applications, they also limit their chances of success later on, creating a difficult situation, but the university simply cannot afford it.

4.1.10.5 Expanded Development Periphery

The uni:invent programme not only helped develop the TTO (which is centrally managed at the university, and works very closely with the legal department), but also trained staff in the appropriate competency areas required. The TTO works closely with the Clinical Development Departure department, Europeburo, and the Department of National Funding in order to help scientists get funding. The university gets out of the TTO what they spend on it, creating a balanced situation. Nevertheless, even 10 years after its inception, the TTO does not make money for the university. R1 pointed out that there is a need for more staff in the TTO to carry out administrative activities, but again a lack of available funds is the main problem.

Overall, no other specific structures have been created, and technology transfer happens as a result of a mainly bottom-up process. However, identification of niche markets have been important for the university to develop a sharper profile, and concentrate on key strengths. Therefore, internal resources have been allocated strategically, to service the areas which are competitive internationally. R2 pointed out that internal clustering has taken place to cluster and concentrate resources on strategic niche areas. They have developed 5 research clusters within immunology, oncology, neuroscience, cardiovascular, and imaging. This was a strategic and deliberate choice, highlighting the key strengths of the university. R1 stated that external cluster activities also take place within regional clusters, with the original network of "scouts" initially developed through the uni:invent programme meeting regularly 3-4 times a year. In addition, trilateral networks are in operation, with the TTO driving interaction within these networks. In addition, the university participates in the AplusB centre.

4.1.10.6 Diversified Funding Base

The university has been very successful when attracting industrial money for projects, with 20% to 25% of the university budget coming from external sources. Nevertheless, R1 argues that it is difficult to find external partners, given industry is short of money. R2 feels this diversified source of income is extremely important in order to be able to steer developments, which they would not be able to do otherwise. Importantly, the university strives to have research teaching funded via third party money, given the fixed amount coming from government means they can do very little. Overall, R2 feels there is a need for more government support.

4.1.10.7 Stimulated Academic Heartland

R1 pointed out that academics were not happy about the changes created by the University Act 2002, as they did their own personal developments through their own connections. Nevertheless, after 10 years, academics are happier with the system. Internal incentives such as *"Inventor of the Year"* and recognition of achievements through publication on the university website, have been adopted to stimulate activities. In addition, the support given by the TTO through presentations and meetings is also designed to encourage academics to become more involved. Another incentive relates to the out-licencing of an invention, as the income is split between the inventor (45%), the rectorate (45%) and the department where the inventor works (10%), which is dedicated towards research. Internal impact points are also used to evaluate academic staffs' performance, which ultimately determines the amount of money the institute will receive. Nevertheless, time is the biggest issue to overcome when finding balance between carrying out contractual research and research as discovery, which also stems from the orientation of the department i.e. if basic or applied research predominates.

4.1.10.8 Integrated Entrepreneurial Culture

The TTO tries to engage academics by giving lectures over 2 days to inform them about the support available through the TTO, share information, and share success stories. PhD students also have to participate in a bid to raise awareness of technology transfer. This is an effort to embed an entrepreneurial culture in the staff and change attitudes. Based on R2's experience, R2 felt that *"the entrepreneurial minds of young, and engaged, and brilliant people, drive the process more than institutions"*, highlighting that individual academics acting as academic

entrepreneurs are important within the technology transfer process at the university, as this concept is not embedded within the institution. R1 also noted that young scientists welcome change, whereas the older academics do not, which is an internal problem for the university. R2 pointed out that entrepreneurial academics are not limited in a regional way, and are open-minded, so go where the resources are. However, R2 also noted that a change must take place whereby an academic entrepreneur must change to becoming an economic entrepreneur. In addition, R2 felt that there is resistance because it is not a realistic strategy to become involved in such effort in Austria currently.

4.2 Sweden

4.2.1 The National and Regional Innovation System Overview

Sweden ranks as an 'Innovation Leader' within the EU's Innovation Scoreboard, a position it has held over recent years. Although some regional diversity in innovation performance is present within Sweden, the Stockholm region also ranks within the 'Innovation Leader' category according to the Regional Innovation Scoreboard (European Commission, 2014a; European Commission, 2014b). The main financiers of research in Sweden are government (investing around €3.4 billion annually), and the private non-profit sector, who collectively account for 5% of total R&D expenditure. In terms of GERD, which was estimated to be 3.41% of GDP in 2012 (European Commission, Eurostat, 2014), the largest proportion of available funding for R&D is within the business enterprise sector, accounting for 63% of available funds. Government account for 27%, private non-profit account for 10%, and funding from abroad accounts for 9%. As can be seen here, most R&D funding is actually internal within businesses, and the total amount of funding transmitted between sectors is very low (European Commission, Erawatch, 2014m). Interestingly BERD amounted to 2.31 % of GDP in 2012. The majority of public R&D expenditure is allocated to the Higher Education sector (70.6%). The remainder is distributed between business enterprise (15.2%), Public Research Organisations (14.3%) and the private non-profit sector (0.4%) (European Commission, Erawatch, 2014n).

The government are very supportive of R&D, and through their recent 'Research and innovation' bill in 2012, they have pledged an additional €455 million for the period until 2016 (European Commission, Erawatch, 2014o). This amounts to a total of almost €1 billion in a period of eight years, which in terms of additional resources, is the largest R&D investment by government in Sweden ever. Importantly, most of this funding will be distributed to universities and other HEIs. Examples of these increases in 2013 through increased appropriations within the quadrennial research and innovation bill include a specific investment of €52 million within the life sciences sector, targeting research in infections and antibiotics, aging and health, treatment research, and drug development, to name a few (European Commission, Erawatch, 2014o). €25 million has been directed towards increased base grant funding to universities and university colleges; €17million of funding for a national centre for life science research (SciLifeLab); €35 million towards targeted funding programs for academic research in the life sciences, as well as €48m for other specially chosen areas of particular importance for Swedish long-term competitiveness; €20 million towards a special program for recruitment of internationally prominent researchers to Swedish universities, and a special program for younger researchers in Swedish universities, channelled through the Swedish Research Council; and strengthening of the research institute sector through an increase in the support to the governmental holding company RISE (Research Institutes of Sweden) (European Commission, Erawatch, 2014o).

The research and innovation bill is prepared every four years by the government, and identifies short and long-term goals for the public research system, as well as the budget framework for the next four year period. The main goal is for Sweden to remain strong in R&D globally, through enhancing the quality and contribution of research to both the economy and society through commercialisation of research (European Commission, Erawatch, 2014p). Research policy development is also driven via various measures including budget documents, regulations, and appointing board members in agencies and foundations. Shortly after the current research bill was issued, it was followed by the National Innovation Strategy for Sweden 2012 outlining the vision for the innovation system, rather than implementation measures. However, it is likely to lay the foundation for Sweden's future participation within the RIS3 strategy for smart specialisation (European Commission, Erawatch, 2014p).

It is clear that a high level of commitment exists for the science and research system, and this is coupled with a high degree of autonomy for actors operating within this system. The governance of the Swedish innovation system is quite unique within the EU, given ministries are relatively small, thus resulting in a high degree of autonomy within government agencies, whereby they are tasked to formulate and implement policies. In addition, the responsibility for the innovation system is split between the respective agencies of the Ministry for Enterprise (who focus on research and innovation in the private sector); and the Ministry of Education (and Research) (who focus on research and innovation in academia) (European Commission, Erawatch, 2014q). Any horizontal coordination largely takes place through informal mechanisms which function at ministry and agency levels. In addition, innovation policy measures and responsibilities are decentralised to regional authorities. Interestingly, a strong division between the public and private R&D sectors exists, and in addition, these sectors are heavily dominated by a few large actors in each case; large research oriented universities in the public sector, and large multinational companies in the private sector (European Commission, Erawatch, 2014q). In addition, a default division of labour exists between the small number of top performing universities who carry out the majority of public sector research, and the remaining large number of HEIs who carry out education-intensive activities. Universities and other HEIs are obligated to formulate their own research strategies. Nevertheless, Sweden has a unique situation whereby the belief is held that universities should be the providers of both curiosity-driven research, and mission-oriented research (European Commission, Erawatch, 2014q). Yet universities have difficulties in fulfilling this function between bridging academic research and exploitation with industry. Although other research institutes operate within the country, this sector is quite small and fragmented, and receives low amounts of basic funding in comparison to other EU countries. From a fiscal policy perspective, Sweden does not provide corporate tax incentives, maintaining a corporate income tax rate at 28%. Some special tax relief was introduced in 2001 for foreign executives, experts, scientists, and researchers, but on the whole, tax has not been used as an incentive (European Commission, Erawatch, 2014q).

The European Research Area is of great importance to Sweden, with the EU's Seventh Framework Programme (FP7) representing around 25% of total R&D funding in Sweden (European Commission, Erawatch, 2014r). In addition, a number of policy instruments exist to attract R&D performing firms from abroad, including the centre of excellence programmes, and regional measures (European Commission, Erawatch, 2014s).

The Swedish Innovation System has aimed to harness the principle of the Triple Helix Model (Etzkowitz, 1997). Figure 4.2 illustrates the current structure of the Swedish Innovation System, highlighting the different levels of policy formulation and implementation within the public and private sectors, and from abroad; and also illustrates the main organisations and institutes functioning at the coal face within the system. The flow of arrows on the diagram shows how interaction takes place within the system, highlighting the connectivity between performers and those implementing policy from each of the aforementioned sectors.

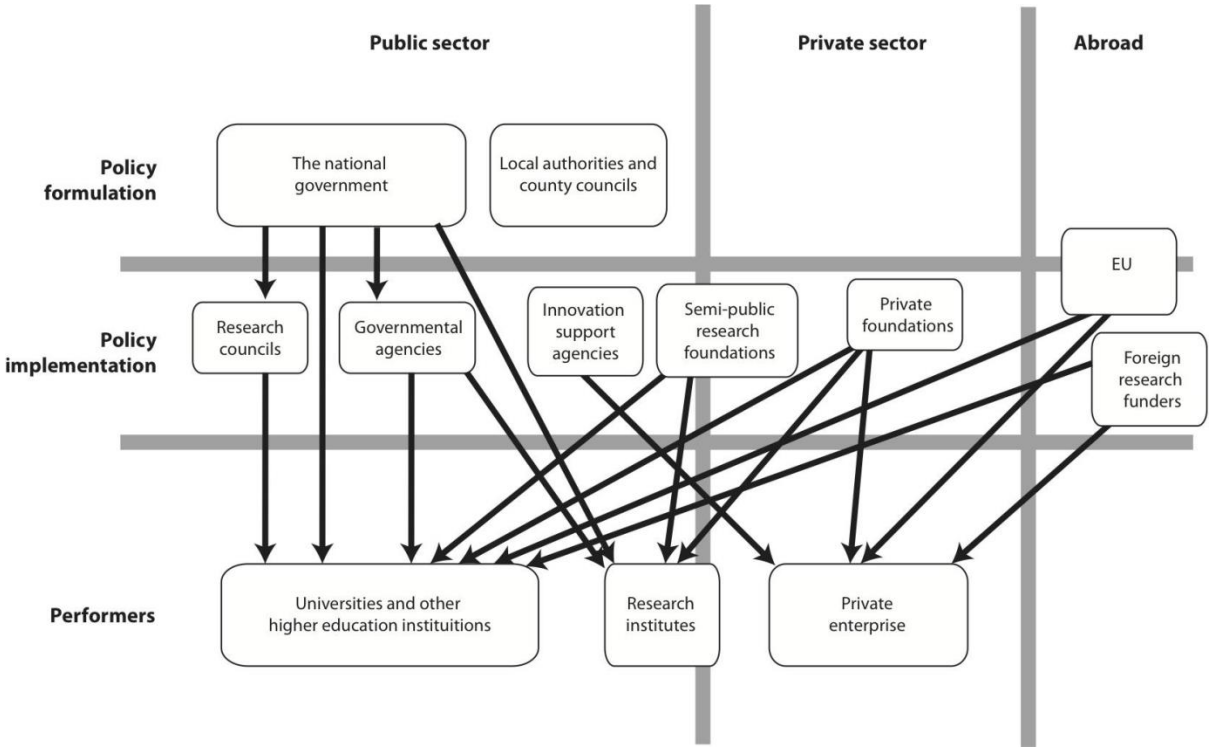

Figure 4.2 The Swedish Innovation System. Source: European Commission, Erawatch, 2014t.

Parliament in Sweden make decisions on research policy by acting on bills prepared by government, particularly the Ministry of Education and Research, the Ministry of Enterprise, Energy and Communications, and the Ministry of Defence. Policies are subsequently implemented at agency level, whereby the research councils and sector agencies have autonomy to act independently within the prevailing framework of white papers and other regulations issued by government (European Commission, Erawatch, 2014t). Therefore, government ensures coordination of policy at the ministerial level, however implementation is fragmented at agency level, with coordination carried out informally. As no formal or obligatory comprehensive coordination platforms exist, this creates a weakness in the Swedish system (a well-known anomaly) (European Commission, Erawatch, 2014u). In Sweden, general policy is formulated by government and several ministries including the Ministry of Education and Research. They are supported by the Innovation Policy Council (part of the Ministry of Industry, Energy and Communication), the Research Policy Council (part of the Ministry of Education) and the agency for Growth Analysis, although these bodies only operate in an advisory role given their lack of formal authority (European Commission, Erawatch, 2014t). VINNOVA (Swedish Government Agency for Innovation Systems) is an important State authority which aims to promote prosperity and growth throughout the country, and plays an important role in policy making. It is particularly focused on innovations linked to R&D, and has an array of programmes that target academia and the industrial sector (European Commission, Erawatch, 2014t). The Swedish Research Council (VR) which is funded by the Ministry of Education and Research, funds an array of research programmes across the natural and social science, medical and educational disciplinary areas. It's main programme targets individual researchers and small research groups working in academia on an annual basis (European Commission, Erawatch, 2014t). Other bodies funding research within the life science area include The Swedish Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS). The funding in this case is provided by the Ministry of Rural Affairs and the Ministry of the Environment (European Commission, Erawatch, 2014t). There are also several other research councils who are the main funders of curiosity-driven research. In addition, semi-public foundations finance strategic research and competence centres. Examples include the Swedish Foundation for Strategic Research which funds research projects focusing on innovation potential, and the Knowledge Foundation which focuses on research and innovation within the small, non-university HEIs (European Commission, Erawatch, 2014t).

Universities carry out the majority of public R&D in Sweden, which is comparably higher than in other EU Member States. This is dominated by 15 universities, whereby their university status enables the right to award doctoral

degrees in disciplinary areas of their choosing. Therefore, by default, they have access to substantial base grant resources for research activities (European Commission, Erawatch, 2014t). 13 university colleges also contribute towards public research, yet their contribution is around one tenth of the aforementioned universities. In addition, they must apply for the right to award doctorates within specific research areas. Importantly, responsibility for basic research is not the only endeavour of the academic sector, and most partake in mission-oriented R&D, and associated technology transfer activities (European Commission, Erawatch, 2014t). Around 30 public mission-oriented research institutes also exist, and account for a small proportion the Sweden's total R&D capacity. They are generally small in size and function as intermediaries between research and industrial application, especially in conjunction with SMEs. Although this sector is moderately small, the aim of the current governmental research and innovation policy is to strengthen this sector through enhancing RISE – Research Institutes of Sweden, an umbrella organisation designed to create stronger connections between academia and industry (European Commission, Erawatch, 2014t). As such, increasing support is being directed to this initiative through governmental policy measures.

Evaluation of research policies and programmes is predominantly undertaken by the funding agencies, whereby the focus is to motivate and increase the effectiveness of on-going measures. Nevertheless, there is no particular systematic approach for carrying out such evaluations, meaning the structure and quality of evaluations are likely to differ depending on which agency or actor is carrying out the evaluation (European Commission, Erawatch, 2014v). In addition, a number of organisations including the Swedish National Audit Office, and the agency for Growth Analysis (who report directly to both government and parliament) play a particular role in the evaluation of innovation and growth policy (European Commission, Erawatch, 2014v).

4.2.2 Universities' Role

As mentioned, universities carry out the majority of public research in Sweden and receive 75% of their funding from the government sector (European Commission, Erawatch, 2014n). Approximately 40% of the total block grant funding to universities is allocated to research, the other 60% to the education mission. In addition, 10% (of the 53% of the GBAORD allocated to block grant funding of academic institutions) is awarded based on a performance assessment, which takes bibliometric measures and the successful attraction of external grants into account (European Commission, Erawatch, 2014w). A number of 'bottom-up' or ''free funding' programmes are supported either directly by government, or by three research councils. Of particular relevance are the support towards basic research by the Swedish Research Council (VR) to the tune of €283 million; and the support towards sustainable development by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) to the tune of €59 million. Research programmes are the most common mechanism for the distribution of these funds (European Commission, Erawatch, 2014n). In addition there are a number of semi-public research foundations who support R&D through various programmes including: the Swedish Foundation for Strategic Research (SSF; supporting research in natural science, engineering and medicine), the Knowledge Foundation (KKS; supporting research at new universities and university colleges), the Foundation for Strategic Environmental Research (MISTRA; supporting research of strategic importance for a good living environment); the Swedish Foundation for Health Care Sciences and Allergy Research (Vårdal Foundation; supporting research in health care science and allergy); and the Swedish Foundation for International Cooperation in Research and Higher Education (STINT; supporting international contacts in all academic fields and disciplines) (European Commission, Erawatch, 2014n).

A large intake of entrants into doctoral studies is incorporated within these research endeavours. Figures show that 3,718 new PhD students were admitted in 2012, bringing the overall total to 18,934 active doctoral students in Sweden, which shows an increase in numbers since 2009 (European Commission, Erawatch, 2014x). Nevertheless, universities are still somewhat restricted in their activities through State control, which restricts the amount of profit making activities universities can partake in. However, recent suggestions for governmental reform through a bill on greater autonomy for HEIs 'Academia for this day and age' (Govt. Bill 2009/10:149) (effective as of 2011) aims to transform these institutions and strengthen the independence of universities and HEIs. As a result, HEIs are still considered as state agencies, however, faculty boards are no longer a requirement, and regulation occurs through the Higher Education Ordinance. In addition, two amendments were made to the government bill 'A Reformed Constitution' (Govt. Bill 2009/10:80). As a result, freedom of HEIs has been increased, specifically relating to the

freedom of research which is protected under statuary provisions, enabling researchers to have continued freedom to design their own research agendas and choose how to publish their results.

A unique aspect of intellectual property rights in Sweden relates to the 'Professor's Privilege' (Färnstrand Damsgaard and Thursby, 2012) which means the legal rights of any invention, discovery, or scientific results belongs to the inventor or researcher, regardless of whether this work was carried out during regular work as an employee. This is obviously particularly attractive for entrepreneurial academic researchers. Nevertheless, this particular right has also created problems towards the utilisation and commercialisation of research results, given some researchers lack interest in pursuing commercial activities alongside their academic activities. The government has stepped in to address this issue, and aims to accompany the existing legal framework with an obligation for academic staff whereby employers must be notified should the new discovery have any commercialisation potential (European Commission, Erawatch, 2014y). A programme on public procurement for innovation is also underway at Vinnova in order to increase commercialisation activities (European Commission, Erawatch, 2014y).

4.2.3 Knowledge Triangulation Policies

It is clear that public and private R&D systems are institutionally separate, meaning finance within each sector, stays within each sector, with very little interaction between them. Both the 2012 governmental research bill and the 2012 governmental national innovation strategy also notes this anomaly, highlighting that a serious structural problem exists within the Swedish innovation system (European Commission, Erawatch, 2014z). This particular situation is attributed to the weak, or perhaps inexistent links between academia and industry (European Commission, Erawatch, 2014z).

A number of initiatives are underway which have been designed to stimulate knowledge transfer and the subsequent commercialisation of research results. This includes a number of sectoral policies which have been designed to create new international competitive research environments, whereby HEIs, industry, public authorities, and research institutes are encouraged to collaborate (European Commission, Erawatch, 2014s). As part of the 2008 research and innovation bill (A Boost to Research and Innovation), seven universities were identified by government (including the KTH Royal Institute of Technology and the Karolinska Institute), to have the opportunity to set-up innovation offices, in order to increase the utilisation of research results for the benefit of the economy and society (European Commission, Erawatch, 2014aa). A total of €8 million provided on an annual basis was made available to realise the project. The objective of the programme was to create offices that could support academics with the commercialisation, patenting and licensing, knowledge transfer, and development of research contracts with industry (European Commission, Erawatch, 2014aa). In addition, the offices are also required to stimulate researchers to innovate and subsequently pursue the commercial aspects of their research, through providing information on the process. The following 2012 research and innovation bill increased the annual contribution to this project by €2 million on an annual basis, which has enabled more universities to create such offices (European Commission, Erawatch, 2014aa). The increase of available venture capital funds is another issue which has been identified within these last two research and innovation bills as an area requiring attention. As such, Innovationbron (an innovation bridging company set up in 2005 by the Teknikbrostiftelserna, Industrifonden and the State with support from Vinnova) has been identified as the platform upon which to increase such venture capital, given it currently provides development and seed financing in combination with active ownership of industry related business developers, and also helps with the development of business incubators (European Commission, Erawatch, 2014aa). There is a realisation that further support is required to support the already existing mechanisms supporting spin-off development. As a result, and to increase efficient and effective support, Innovationsbron AB and Almi Företagspartner AB (a regionally based venture capital company) merged into one organisation in 2013 (European Commission, Erawatch, 2014aa).

Another mechanism towards the circulation of knowledge between academia and industry has been designed through inter-sectoral mobility. Vinnova, and some other agencies, have initiated a number of programmes to achieve this aim. Specifically, three activities have been identified as possibilities to increase interaction and collaboration between academia and industry: creating industry PhDs; hiring professors in industry; and the establishment of graduate schools which include elements of industrial collaboration and innovation activities (European Commission, Erawatch,

2014ab). It has been noted that researcher mobility is more common at the beginning of people's careers, as opposed to those who have reached senior professor or senior researcher level (European Commission, Erawatch, 2014ab). This is very likely linked with tenure progression within academia. Nevertheless, Vinnova has established several instruments for the support of senior researchers to take part in inter-sectoral mobility (European Commission, Erawatch, 2014ab).

Another increasingly important issue relates to the access to infrastructure, which has been identified by many research fields, and is also crucial towards participation within international collaborations. The Swedish Research Council's guide to Infrastructure (updated in 2007) and the research bill (2010/2011) highlighted the infrastructure need in Sweden (European Commission, Erawatch, 2014ac). As such, over the period 2009-2012, VR spent in the region of €13.4 million on research infrastructure, and government subsequently pledged a further €5 million to research infrastructure (European Commission, Erawatch, 2014ac). Examples of some of the projects being funded after identification within the ESFRI Roadmap for Research Infrastructures report include: ELIXIR (European Life Sciences Infrastructure for Biological Information); Infrafrontier (Infrastructure for phenotyping and archiving of model mammalian genomes); LifeWatch (e-science and technology infrastructure for biodiversity data and observations) and XFEL (X-ray Free Electron Laser) (European Commission, Erawatch, 2014ac). A number of other projects relating to the life science sector have also been given support. Interestingly, investments in infrastructure have increased since 2005, however, the Swedish Research Council actually invested more money in international infrastructure than in national infrastructure, investing €45 million in international infrastructure and €37 million in national infrastructure (European Commission, Erawatch, 2014ac).

Importantly, the creation of public-private partnerships is supported through a range of measures including: academically based competence centres which incorporate considerable industry involvement; research-institute based competence centres, again incorporating considerable industry involvement; and other programmes which support mission-oriented, pre-competitive R&D collaboration between academia and industry, including the new Challenges-Driven Innovation programme which aims to establish a consortia of businesses, academia, and public actors for the purpose of addressing societal challenges (European Commission, Erawatch, 2014n). In addition, entrepreneurship and innovative start-ups are supported through the Innovation Bridge, VINNOVA, the Industrial Fund, the University holding companies, the Swedish Agency for Economic and Regional Growth and ALMI Business Partner (Trendchart, 2008; European Commission, Erawatch, 2014k).

4.2.4 Life Sciences and the Stockholm Region

Although regional policy has changed over the decades from being centralised at State level towards the implementation of local policies, the innovation system is still very much influenced by national level, and regional policies are used to complement and provide linkages with overarching policies, sectors and regions. This was originally introduced through the government bill 'A Policy for Growth and Viability Throughout Sweden' (2001/2002:4) (European Commission, Erawatch 2014ad). The main focus of this bill was upon the regions' capacities for the purposes of economic growth and renewal. Strategic action plans are also implemented to create economic growth whilst also taking into consideration the ecological and social sustainability of each region. As such Regional Growth Programmes have been designed to meet this aim (European Commission, Erawatch 2014ad). In May 2013, government stipulated that for the coming programming period (2014-2020), 70% of funds assigned to regional and national authorities for the development of these regional development programmes, should service the three main goals; strengthening research and innovation in the country; increasing SME competitiveness; and increasing the quality and access to ICT (European Commission, Erawatch 2014ad). Nevertheless, the regions in Sweden are not particularly coherent in their promotion of the innovation system. Most regions in Sweden each operate their own national innovation agencies. In some cases, trade unions wield great influence on innovation policy and governance; in other regions, public-private partnership organisations play significant roles; and in the case of universities, their innovation offices tend to be regionally oriented (European Commission, Erawatch 2014ad).

The life sciences sector, including biotechnology, is an important thematic sector within the Stockholm region, and indeed Sweden. In fact, the Stockholm region forms part of the Stockholm-Uppsala life science region, which is one of

the largest clusters in Europe (Centre for Research on Innovation and Industrial Dynamics, 2012). This is illustrated by the fact that in Stockholm, the medical disciplinary area alone consumed 31.4% of the total research budget of the academic sector in Sweden (European Commission, Erawatch, 2014k). As highlighted by the 2012 research bill, much of the additional funding appropriations have been directed towards enhancing this particular sector. Although, the decentralisation of the R&D system means that much of the influence in direction of priority setting rests with universities, as opposed to the ministries. Other particularly relevant policy areas include the identification of strategic research areas pertaining to climate, the environment, and agriculture (European Commission, Erawatch, 2014y). Based on 2010 figures, the Stockholm-Uppsala region is home to 633 companies operating within the life science sector, which includes pharmaceuticals, medical technology, biotech tools and supply, contract research and other services, diagnostics, and biotechnology (Centre for Research on Innovation and Industrial Dynamics, 2012). In addition, their combined turnover totals around €20 billion (Centre for Research on Innovation and Industrial Dynamics, 2012). Nevertheless, global trends show a reduction in employment within this sector; as such, the restructuring of one of the major employers (Astra Zeneca), has impacted the region somewhat. However, new plans are in operation to invest in the region of €7 billion in public-private partnerships specifically for the purposes of research funding and research and physical infrastructure, in a bid to support existing and stimulate new generation companies. Examples of specific initiatives have been introduced in predeceasing sections. The Science for Life Laboratory (established in 2013), was highlighted as one of the four major focus areas within the 2012 research bill, is a tool to strengthen the life science sector in Sweden, through integrating academic and private R&D activities to span the boundaries of industry and academia (European Commission, Erawatch, 2014k).

4.2.5 Results from the Independent Expert Consultant (Commenting on Government and Funding Agency Perspectives)

4.2.5.1 Actors

Vinnova is the agency dealing with innovation and providing a huge range of programmes, which universities can participate in. In addition there is quite a large research foundation operating with the same aim, as well as many other research funding organisations, which are influential.

4.2.5.2 Mechanisms

Overall there is no difference between the Stockholm region and the rest of the country in respect to the innovation system per se, given the same legislation and opportunities exist for everybody regardless of where in the country a university is located. Universities are encouraged to engage in activities through financial incentives provided through a variety of grants and funding programmes. Vinnova spend several billion Swedish Kroners of the federal budget which is a lot for a small country. Often there are strings attached to these programmes including industrial cooperation for example. They also operate pilot projects whereby around 10,000 Euros is available to develop an idea or a proposal. Overall, some programmes are repeated, and some are closed down after only one period. However, there is an interest in both short and long term projects.

Governments have established holding companies at the major Swedish universities. In addition, governmental research funding has been reorganised into more of a performance based funding system incorporating performance indicators such as external cooperation. Adopting a historical perspective, university contribution has increased over the last 30 years, but in recent years it has perhaps not increased as much. Nevertheless, it is easy for universities to participate, however there are sometimes complaints about the lengthy applications formed that must be completed within the process. There is some support available through information seminars organised by Vinnova regarding collaboration within the European Framework programmes. However, all universities have something like an external relations office which can support academics in these administrative processes. Platforms are organised by actors themselves, and funding organisations do not play an active role in this. Therefore they have a bottom-up approach. In addition, there are networks which are driven through bottom-up individual initiatives, meaning researchers can find one another and support one another.

4.2.5.3 Organisational Barriers and Enablers

In Sweden there is more of a culture for entrepreneurship and innovation which is embedded within the system rather than being driven by government. The governmental structure in Sweden is very different from other European countries in that there are very small ministries, and underneath there are very large national agencies or national authorities, such as Vinnova and the Swedish Research council. Therefore the government and the ministries do very little, except fund Swedish welfare and the public state. Anything that is more operative is left to the quite large agencies. The National Innovation Strategy is written by the government (ministry of research and ministry of enterprise), who produce a White Paper outlining the main direction of the innovation policy. This is then handed down to the agencies who then try to design it for implementation.

4.2.6 Results from the Bridging Organisation Representative

4.2.6.1 Actors

The respondent felt that *"all pieces in the puzzle contribute in their own way".* The technology-transfer offices within the university are a crucial component, bridging organisations such as the Stockholm Science City Foundation facilitate all kinds of Life Science activities in the Stockholm region; and the innovation office at Stockholm City Council is important for facilitating innovation between Medical technology companies and the healthcare system. Close collaboration is essential, and as such collaboration happens almost on a daily basis. There is a network, meaning no matter who you speak to, you will be guided to the right person. The bridging organisation is a bridge, linking researchers to entrepreneurs, venture capitalists and other components in the ecosystem, and vice versa.

4.2.6.2 Mechanisms

There are niches within the Life Sciences area in Stockholm, and these are the main focus for trying to stimulate collaboration. The innovation system is structured in such a way as to promote and help researcher develop, and encourage researchers to commercialise, rather than to demand it.

Each university has their own innovations system, meaning they are independent but also collaborate to a certain extent. This, however, is structured differently at each university. Nevertheless, each technology-transfer office aims to reach out to the researchers through marketing their services to them. The respondent indicated that generally within the Stockholm region, they are very good at building companies, and some venture capital is available through university development offices, for example, Karolinska Development. Universities are very open to this, and happily accept help. In fact, this particular bridging organisation is funded by all four universities in Stockholm, so universities have a vested interest.

The bridging organisation tries to bring different actors together through monthly seminars focused on various issues including IP issues, partnerships, and so on. They invite an expert and a company case where they present on the topic, and invite other companies and researchers, which forms a platform for entrepreneurs, companies and researchers to meet. In addition, the bridging organisation invites foreign companies to the region and sets up meetings with local researchers through custom made days. So overall, they help by taking the first step in forming collaborations.

The bridging organisation doesn't have any money themselves, which the respondent felt was problematic, however funding is available through the European Horizon 2020 Framework Programme. Therefore, they advertise calls arising from this funding scheme, and help actors to form consortia.

There is a mix of short and long term goals within the system, but the respondent feels that short term goals are easier to grasp and communicate. The respondent felt that although universities have long term goals, it tends to be the short term strategies that really pay off.

4.2.6.3 Organisational Barriers and Enablers

The Professor's Privilege, which is unique in Sweden, means that researchers own all the IP. As such, universities cannot force a scientist to develop and commercialise their discoveries, it is totally up to the scientist. Therefore, the trick is how to encourage the scientist to develop the IP, because it takes more than a patent to commercialise, you must find someone to licence it out.

Timeframes are another problem. Researchers have a completely different agenda to a company when it comes to innovation and discovery, and also have a different timeframe, as companies usually work on shorter timeframes. Communication issues also arise, given researchers and industry talk different languages. Platforms where people exchange knowledge, makes the process easier.

Funding is another barrier, *"if there is no money, it's hard to do anything"*. On a national level there are no tax incentives for companies and investors which reflects the funding opportunities. However, it comes down to the classic *"valley of death"*. The respondent argued, *"when you commercialise academic finding its usually fairly easy to get funding for the very early stages because that falls within the academic research and also you can get some seed money to start the product development cycle, the problem in science is that the product development cycle is quite long, and usually the start-ups run out of money before they have a product they can sell, so they can't reach the same stage where the company can really start taking off and they can't get any more funding because they exhausted all the seed money sources, so there is a gap between the final product and being on the market, that's the big barrier in Sweden."*

The respondent feels there is a need to sustain the national innovation system with a bit more of a long-term view with regard to funding. The respondent indicated that the current system could be complimented with national support incorporating a long terms strategy to incubate and fund start-ups springing from universities until they reach the market stage, given there is a shortage of intermediary support between the initial inception of basic research and the commercialisation. There is some increased financial support for incubators, and discussions are taking place at national level to set up a patent trading website to form a common market place open to the global community, in a bid to boost commercialisation. In Stockholm there are around 20 organisations similar to the respondent's organisation, which focus on the Life Science sector. They are enablers in the process as they improve coordination and communication between actors and make sure actors are coming together, and also ensure communication between them, both formally and informally.

The respondent feels that universities are much more open now compared to 15 or 20 years ago, which has also evolved given the pressure to give returns for the amount of public money invested. New structures in the form of technology-transfer offices and innovation offices, as well as departments set up for strategic collaborations with large companies, have been beneficial for university contribution to the innovation system. However, individual academic entrepreneurs still play a strong role, as *"the best contact and best results will always come from individuals who are really driven"*. Nevertheless, these new structures are *"invaluable in-roads to the universities"*.

The respondent suggested that lessons can be learned from the UK, whereby there are huge tax discounts available to develop technologies that remain within the UK. In addition, the respondent mentioned that the VIB, a high profile Flemish Institute in Belgium, have a really interesting model whereby researchers are evaluated for further funding based on the number of patents you file, meaning the kick back rewards are realised in the following budget year, rather than having to wait 10 years for commercialisation to generate profits. The respondent feels the region could learn from this quick feedback system.

4.2.7 Results from the Bridging Organisation / Platform Representative

This particular bridging organisation / online platform includes Sweden and Austria, as well as many other countries, and is based in Heidelberg, Germany. Therefore, general discussion took place mainly discussing the enablers and barriers witnessed, particularly in the German case. Nevertheless, the results have been included given they shed interesting perspectives on dilemmas found in the other case studies.

4.2.7.2 Actors

The respondent believes that innovation starts at universities and research institutes. This online platform provides a virtual network within the Life Sciences disciplinary area, and therefore aims to bring all actors within the life sciences together. This includes industry, technology-transfer offices, venture capital firms, and everyone that is somehow connected to the field. Most other platforms immediately segregate academia and industry, whereas the main goal is to have everyone together in one platform in order to map the infrastructure within the field, and enable people to find each other easily. Therefore, the platform does not concentrate on one geographic region (although you can limit search criteria this way of you wish), it allows the users to virtually map the real situation across the nodes.

4.2.7.3 Mechanisms

Marketing strategies are an important tool in order to reach potential participants.

4.2.7.4 Organisational Barriers and Enablers

An important barrier is the need for follow up investors, given initial seed money usually runs out after 2 years, and unfortunately the project is still too early for venture capital. In addition, within the case of Heidelberg, there are no incubators as investments were not made in infrastructure. The respondent feels that this stems from the traditional attitudes and culture present within the universities and innovation system there. Even TTO's are fighting to explain the need for their existence. In the US there is a culture to engage in riskier projects, whereas in Europe, there is an incapability to sell ideas to potential investors in the right way. In addition, politics plays a role. The US are investing money when opportunities are spotted, whereas in Europe, they discuss policies, and as such their eventual decisions are 10 years behind where they should be, causing Europeans to be years behind their American competitors: *"In Europe everything seems to be like driving with a handbrake you know, you want to go faster but someone is pulling you back"*. In addition, people tend to focus on short term goals, and short term performance. They recognise potential risks, *"so instead of doing the right thing, we choose to observe the status quo because we know that way we are safe, we've been working this way for 30 years and we know nothing will happen to us".*

Another barrier is the level of commitment required for people to invest time into participating in the project, meaning people's mind-sets are a problem given the need to accept new tools and engage in the process. In addition, no external funds are available to develop the platform, meaning limitations in staff numbers.

The importance of connections is both an enabler and a barrier. If professors have good connections, or those behind a project are very influential, projects get funded. However, the decisions to pursue projects doesn't have much to do with logic, it's more connections. Therefore, if you do not have a well-established network, you will struggle. In addition, many projects being developed, *"I would never really invest money in, the results are not there*". Therefore, in some cases the problem is not with the funding environment, as in some cases good people are involved. The problem is that the people behind the project have a poor understanding of the basic science before making decisions to start a business. Therefore, *"sometimes projects that do not deserve to go forward, do go forward"*, or alternatively, *"sometimes they wait to develop the business, waiting for a certain opportunity that never comes"*.

Regarding enablers, a good technology-transfer office offers wide ranging support, and can give you many contacts, but finance is the main problem given the need for a lot of money to develop Biotechnology, and results of projects take a long time to show up. Sometimes it can be difficult to find the right people to get in touch with, and the biggest barrier is that the information needed to launch something is too scattered, and too hard to find. Events, although good, sometimes do not function as intended (i.e. enabling different actors to meet). Often you find that researchers are in one group, and investors are in another, and these groups rarely overlap at events because investors simply aren't there.

In addition, there are problems concerning knowledge exchange within universities themselves; researchers sitting meters apart, not knowing what each other is doing. There is a need for a centralised seminar management system, and a mechanism for more efficient research, knowledge sharing, and the personalisation of knowledge sharing, much in the way social media tools work in order to organise information in an efficient way.

4.2.8 Results from KTH Royal Institute of Technology

KTH was founded in 1827, and is the largest, oldest and most international technical university in Sweden. One third of Sweden's technical research and engineering education capacity at university level is provided by this university (KTH, 2014a). KTH has a relatively broad disciplinary focus within the technical disciplines, encompassing the natural sciences, all branches of engineering, and also caters for industrial management, urban planning and architecture subject areas. The university has strong links with industry, with subjects incorporating a strong professional element to meet the needs of prospective employers, thus a strong applied approach is emphasised in the educational output of the university, rather than its scientific foundations (KTH, 2014b). In the early days, the clash between academic and industrial perspectives relating to the paradigm between basic and applied research was apparent, given the different expectations of the university and society. Nevertheless, cross-fertilisation of basic research and practical engineering often took place, and with developments over time, engineering has been held in high regard from both personal and social perspectives considering its developmental potential, and thus remains strong today (KTH, 2014b). A range of Bachelor, Master and PhD programmes are available for a student body totalling more than 12,500 undergraduate students, and more than 1,800 postgraduate students (KTH, 2014a). KTH employs over 4,800 employees, who are involved in a wide range of teaching, research and third mission activities, who continue to build upon the entrepreneurial orientation of the institution and its activities. Operational leadership of the university resides with the University Board, which consists of a mixture of internal and external representatives including three students; the President's Group, formed by the leading managers in the university, and dealing with strategic educational, research and quality issues, as well as other more general matters; the Management Group, which deals with matters concerning all KTH schools; and the Faculty Council, responsible for the quality of KTH's education and research (KTH, 2014k). In addition, there are a number of administrative offices and services dealing with various authoritative tasks, faculty administration, and infrastructure tasks (KTH, 2014l).

The university is organised into 10 schools, which are responsible for the research and educational activities at the university (KTH, 2014c), namely Architecture and the Built Environment; Biotechnology; Chemical Science and Engineering; Computer Science and Communication; Education and Communication in Engineering Science; Electrical Engineering; Engineering Sciences; Industrial Engineering and Management; Information and Communication Technology; and Technology and Health. In addition, a number of competence centres exist within each school that deal with new subjects and joint projects with industry and a range of societal bodies (KTH, 2014d). However, these centres encompass variations in management, with some managed by the department, and some being autonomous units directly subordinate to the KTH president. Most centres maintain close links with industry, and some act as liaison offices between the university and other universities. In addition, a number of other centres exist where KTH plays an important role, but are, however, run by other bodies (KTH, 2014d). Interestingly, KTH has followed its cross-fertilisation of technical and science areas through the development of the Biotechnology department. Research focus within this school rests upon Gene Technology; Glycoscience; Industrial Biotechnology; Protein Technology; Nanobiotechnology; Proteomics; Theoretical Chemistry and Biology; and it participates in a number of cutting-edge international industry research projects within the field (KTH, 2014e; KTH, 2014f). The university also encompasses a range of administrative and service units alongside its university management.

International cooperation is another important element within the universities orientation. Whether through student exchanges, delivering Master's programmes in English, involvement in international projects and networks, or through international research cooperation, KTH aims to establish new collaborations within its educational and research endeavours (KTH, 2014g). In addition, business liaison is another important element in order to maintain and create collaborations with external stakeholders, and is perceived as an area of great importance for KTH's future competitiveness (KTH, 2014h). As such, KTH Innovation offers commercialisation support for both students and researchers free of charge, in order to turn viable research projects into tangible products and spin-off businesses (KTH, 2014i). KTH is also very aware of the environment and sustainable development, and encompasses these elements within their education and research endeavours. Aside from increasing student numbers and encouraging more women into the technical disciplinary areas, KTH also aims to develop its research and innovation endeavours in order to continue the trend of creating cross and multidisciplinary research platforms and centres, whilst also aiming to

increase its success in gaining EU and third party funding sources, and increasing its number of collaborations with a multitude of stakeholders (KTH, 2014j; KTH, 2014k).

Four representatives were interviewed at KTH.

4.2.8.1 Actors

There are a lot of government actors in Sweden including different ministries and agencies such as Vinnova. There are also some private actors, including industry, but Respondent 1 (R1) feels that government are the main drivers. R1 also feels that KTH Innovation is also very active within the university to promote commercialisation activities, through interaction within the various university media channels including the website, emails, and delivering seminars to academic departments. Researchers and students are also pivotal given they see business opportunities and pursue these. In addition, if there is a *"champion"* within the process, then the collaboration really worked well according to Respondent 2 (R2). Close relationships with KTH Innovation and KTH Holding also enhances processes. Respondent 4 (R4) feels that interaction with industry and other public actors makes the university more entrepreneurial and creates an innovation focussed mind-set. R2 also noted that industry are *"really major stakeholders"* in the university, given they can influence the direction education and research moves, as they are *"really part of the university system"*. In addition, there is a greater awareness of the role of the university within the innovation system, and as such, R4 feels that various actors have made efforts to engage the university, which is driven by both public and private interests of the associated parties.

4.2.8.2 Mechanisms

National funds and European funds are important sources for collaboration. National programmes have a strong focus on the national agenda, whereas European programmes have more of an international focus. Respondent 3 (R3) believes Horizon 2020 and other framework programmes will become more important in future.

R2 believes that innovation does not come due to contacts with industry, but feels it's more to do with the tradition of the schools of the university, and how they work. R3 states that KTH has worked with industry for a long time, with some big companies such as Eriksson and ABB locating their head offices close to the campus. Involvement in Knowledge and Innovation Communities (KICs) are also important for collaboration. The "professor's privilege" is unique in Sweden given professors own all the IP. However the university has its own IP policies, wan important requirement, given they sign a lot of collaboration agreements with industry. R2 reckons around 10-20% of income arises from industry collaboration, however academics are left to find external funds themselves, the university is not so much a part of this.

Government has given support through creating infrastructure around innovation in order to provide student incubators, support with patents, and starting holding companies that could give loans to start-ups. Nevertheless, government generally directs funding to strategic thematic areas. The SciLifeLab has also been established to create greater collaboration between academia and industry.

4.2.8.3 Organisational Barriers and Enablers

As mentioned, the "professor's privilege" means that the researcher owns the IP, whereas in the US there is a different model whereby by the university owns the IP, but if they do not pursue the patent then it goes back to the researcher, so there is the possibility to make a deal, or gain some part of the revenues generated in any case. However, in the Swedish case, it is really exceptional for individual researchers to be able to gain funding from governmental sources in order to develop such IP, meaning you must approach business angels and venture capitalists, as there is a lack of seed finance available. R2 believes that this is not a good way to finance projects as too much control rests with such private financiers, meaning *"you have the rifle, the gun, in your back, so sometimes it could be good to take it a little slower".* Nevertheless, R2 feels that the early stages of commercialisation are the most difficult, but felt that the process is now much smoother, as help can be sought from KTH Innovation free of charge, and the system itself works really smoothly. Overall, R4 feels it is important to keep the Professor's Privilege.

R3 and R4 also agreed that there are challenges in funding commercialisation activities given there is a lack of seed funding to bridge the gap between development and commercialisation. However they noted that the legal framework also plays an inhibiting role, given KTH are not allowed to use governmental money given to the university to pay for patenting costs or commercial developments. R3 finds it contradictory because, *"they (the government) have given us a task, and funded that task, but we're not really allowed to do, within the framework, what has to be done, so that's a big challenge"*. R4 noted that, *"one difficulty in Sweden is that Swedish universities are a government agency, and have to follow a very specific regular system, for example you're not allowed to have shares or economic interests and so on. So in one way we are prevented from acting in a more free sense as for example the UK or US universities, which means in principle, let's say, we cannot create an innovation office that attempts to make money in the long term to invest in start-ups and then get the feedback. We are not allowed to own anything, so these are kind of restrictions for universities in Sweden which somewhat hamper the innovation system"*. Therefore R2 states that the university is pretty autonomous, but not when it comes to economic actions, *"and this of course means there is a limitation in our freedom to really support an innovation ecosystem"*. R4 notes that it is a challenge to get funding for what you want to do, and not what the funding source wants you to do.

R2 noted that structural change have been top-down, but that they are probably stimulated from environments where it has been bottom-up. As such, governments look at how successful environments have been created, given the need to make it easier for more people to create environments where innovation can take off. R2 also felt that it has become easier to find information through different sources, given there has been *"a change in the machinery… and it's actually part of the machinery in a much clearer way"*. Nevertheless, R3 pointed out that one problem is that researchers in different departments across the schools usually don't meet each other, despite carrying out research within the same application areas. Therefore the development of platforms has enabled these connections to be made. Yet R4 feels that due to the size of the university, it can sometimes be difficult to bridge the breadth of the different groups together and focus on one central theme. R1 felt that academic culture is a major inhibitor, given *"one of the problems is that academic culture is so geared towards academic peer reviewed journals- publish or perish"*.

R2 highlighted that 10 year Centres of Excellence funded by Vinnova are, *"a fantastic way to get things moving"*, given they get companies and academia together and stimulate research in an area. Yet, they also enable enough flexibility for companies to protect their key strengths and IPR so that they can move away from the centre and create bilateral partnerships with certain research groups. Therefore, it stimulates the next generation of research groups which fit well with companies. However, R3 highlighted that often there are different expectations from different players, so there is a need for a common overall goal. As such a clear IP policy is needed, as even within centres there are very different expectations on what the centre should do and the results it should produce. Therefore creating a simple structure has been successful as it has *"created a good environment for collaborations"* (R3).

4.2.8.4 Strengthened Steering Core

R3 believes that government initiatives, EU initiatives and industry have been influential on structural change, given these actors are stressing for more collaborations that will result in more innovations. Therefore, there is an expectation, and a need for the university to change, and R3 thinks this awareness has become more and more obvious over the past couple of years. A major reorganisation took place in 2005 which transformed the university into a strict line organisation, splitting 30 departments into 9 schools. All respondents felt that such structural changes were in response to both government policy and the needs of industry, and also to both improve interaction and service changing funding environments. Each school has clear instruction to maintain the core teaching and research activities of the university, but also to engage in third mission activities such as engagement with society, creating innovations, starting companies, and collaborating with industry. As such, internal performance is measured in each of these core tasks in order to distribute finance among the schools. Therefore, such third mission activities are clearly in their day to day functions, which is a big change from what it was even 15 years ago. University leadership took the decision that KTH would engage actively and mobilise lots of the universities strength, however, it is still very much based on the researchers. Therefore there is a combination of top-down and bottom-up approaches. R1 felt that the tradition of the university had a strong bearing on the level of interaction. In addition, given problems associated with ownership of IP, R3 noted that development of an IP policy at the university has been important for KTH to be able to extend the

research carried out by its researchers. A person within the executive level of university management has also been appointed to deal specifically with the setting up of strategic long-term (around 10 years) partnerships with industry.

R4 noted that there are different forms of evaluation of the system at the university. An annual evaluation takes place, as well as periodic Research Assessment Exercises which also assess impact on society. They also ask individual research groups to show how they impact society, which has led to a learning process for the university. KTH also takes part in an Administrative Assessment Exercise (AAE), which is a type of peer review process that includes a self-evaluation. Findings of previous AAE's showed that many of the goals of commercialisation and interaction are not as well connected with the overall goal and mission of the university, meaning there is a gap, which according to R3 is, *"bigger than it should be"*.

R1 highlighted that lately, politicians in Sweden have been very eager to promote entrepreneurial thinking, but also to start determining in detail what universities should be doing. This has met with a lot of criticism from academics. Academics feel that decisions should not only be free from politicians, but also free from commercial interest, given academics have a tendency to perceive such interference as corrupt, whilst academia stands for something more pure and unbiased. R3 also stated the need for greater autonomy.

R1 noted that KTH is very decentralised, so much so, that, *"it doesn't matter so much what the president says because the separate schools and departments have such autonomy, and they do pretty much whatever they want- that's one of the consequences of having such a strong collegiate. Professors make a lot of the decisions themselves"*. R1 also noted the differences between managerial processes within academia and industry, stating that management control systems are very much enforced in industry, but it's much more intuitive in academia, with professors deciding on implementation of strategies themselves. The president outlines what is possible, and given academic culture, researchers prefer to have autonomy to decide what should be researched.

R1 felt that change makers are important in the system. R1 noted that there are still senior researchers who are very entrepreneurial, and they tend to be serial entrepreneurs. Importantly, R1 noted that those change makers with huge political impact, can get backed up by universities and the government meaning many initiatives are driven by one or two strong individuals in academia.

4.2.8.5 Expanded Development Periphery

R4 highlighted that the strategy of the university is clearly to engage with society, both corporate and public. As such, new structures were specifically built to address this. A vice president is in charge of innovation and cooperation with society, and there are offices dedicated to supporting commercialisation, including a special business liaison office. Therefore, support structures exist at the leadership level and at administrative level, which act horizontally (not at the department or school level). There are three departments which are centrally managed: the innovation department which works primarily with research results; the business liaison department which works at the strategic level to find new business partnerships; and the research office which focuses on EU funding and applications. Each department works together to ease collaboration processes. KTH Innovation offers its services and support for free. Nevertheless, R1 feels that there is still not enough mechanisms for interaction and would like to see better links, given R1 does not know of anywhere where you can get this sort of interaction naturally. However, R1 noted that KTH Innovation can give some small seed funds to the level of 10-50,000 Swedish Kroner, but the limitation is that they don't have any bigger funds to help form a company. KTH Holding, although managed by the same person as KTH Innovation, is a slightly different business model (a private company), so they fund projects, take shares in these new companies, and get researchers to sign off all IP, and therefore have a different policy in comparison.

R2 noted that there are more calls towards supporting multi-disciplinary research, so this is more at a governmental level, rather than structural change within the university to create such organisationally visible multi-disciplinary environments. R1 pointed out that the development of cross-disciplinary departments is the way forward if they want to have more applied science, and want to have a more entrepreneurial university, and felt that there is not enough of these. Nevertheless, platforms have been created to cover KTH's 5 strength areas, which came as a result of the Research Assessment Exercise carried out in 2008, finding that too little cooperation occurred between the different

schools in the university. It is a bid to *"catch all interdisciplinary ideas"* (R2). These platforms *"act like a portal*" (R2) and *"are not a physical space"* (R3), but they are used to gather research in the strength areas and proactively search for interesting partnerships. It provides a structure that enables researchers from all the different disciplines to connect, cooperate, and subsequently collaborate on larger projects with industry. R2 noted that very little money was invested in the project, but R4 feels that larger funding has been focused towards the initiatives resulting from the platforms.

KTH are involved in the SciLifeLab development for cluster activity with other universities in Stockholm and industry. They are also involved in tri-lateral networks, however R1 feels that there are too many of these. Within the Stockholm region alone, R1 thought there may be around 12 of these for the Life Science sector, which *"all do pretty much the same thing"*. R1 felt that this promoted regional competition between organisations, rather than collaborating to enable competition in the international arena. Open Lab is another initiative to create a collaboration arena which crosses disciplines and universities in the Stockholm area, however this is still in the early stages of development.

With regard to collaborations with external partners, R1 feels that personal relations are important, and that collaborations develop organically, particularly if based on friendship, rather than being steered from above, given the latter type of collaborative formation does not tend to work. R2's response also agrees with this reasoning, given R2 stated that, *"I know personally every CEO and every head of research for every company in the Life Science field in Sweden"*, showing that academic's personal relations are extremely important for expanding the development periphery.

4.2.8.6 Diversified Funding Base

R1 has witnessed increasing autonomy, and increasing funds coming from industry. R1 notes that some schools have very good industry collaborations, whereas others do not, and as such are more government funded. This is highly dependent upon the scientific subject in which schools are involved, and how each school functions, given their level of autonomy means they function in different ways. Nevertheless, R1 feels that researchers prefer government funding because it provides a feeling of security as it tends to be more long term. However, researchers often do not like the terms of funding arising from government programmes, meaning they have to adjust their research applications to fit, but also have to take time away from research to fill out such applications. R1 believes that researchers tend to apply for government funding just to get the money. Most grants are geared towards applied scientific research, but R1 noted that it doesn't mean researchers are actually doing applied research. R1 highlighted that, *"it doesn't matter how many rules you have, it's the interpretation of the rules that matters"*. Professors need peer reviewed articles, which means they need basic science because this is where they find something new. Nevertheless, R4 highlighted that part of the funding has specific rules attached which requires collaboration with different actors, which therefore stimulates such collaborative activity. R4 noted that entering strategic dialogue with industry and subsequently signing Memorandum of Understanding is a good way to develop long term relations with industry. This has been a good way to increase funding from industry and other public sources. Nevertheless, R3 highlighted that complexities in IP policy is a big challenge given the number of agreements required to actually be able to collaborate and commercialise, and this takes a lot of time, administration, and can be somewhat restrictive.

R2 feels that the most important funding source has been private funding, as it has really stimulated innovation in recent years. Philanthropic funding sources are starting to emerge in Sweden, which has funded projects involved in fundamental research. R4 states that government have also increased funds towards fundamental research in selected areas since 2009 / 2010. R4 pointed out that, overall, one can be quite satisfied with funding in Sweden, but that more funding is always helpful. Importantly R4 feels that a good balance between directing finance towards basic and applied research is required because, *"a danger is when you build a successful innovation system, you think you can just look at innovation and not at basic research because if you don't invest in the knowledge base at the same time, you endanger the long-term contribution of innovation, so I think you really have to look at the entire value chain".*

4.2.8.7 Stimulated Academic Heartland

R1 and R2 feel that the older generation of academics are more resistant than the younger researchers. R1 feels there is a transformation going on whereby it is becoming more positive to be entrepreneurial as a researcher. R4 feels that most staff welcome change, although R4 indicated that there has been some reluctance at the dean or school level to see the benefit of the new platforms, given it is perceived as a competing structure. Internal incentives are not used to promote structural change. R2 felt that change is embedded within the system. Academics do not get higher salaries if they create a lot of inventions, but they are clearly visualised though press releases instead. R3 highlighted that they have less problems as a technical university in this regard, compared to traditional universities. Nevertheless, R3 still feels that engagement in technology-transfer and commercialisation is not prioritised enough due to the lack of time to do everything expected of academics, and the fact that *"it's not really a natural part of what they do as a researcher, (however) that's kind of our goal, this has to be something that is part of being a researcher, it's not something to do when you have extra time"*. R3 feels there is a need to put time into innovation and creating impact, but limitations on time mean the normal tasks of research and education are prioritised. R3 feels that the head of the university and the rector need to stress the importance of this, and that a system is needed to avoid leaning on researchers too much. Therefore, a project called "Search for Talents" has been initiated to try to recruit people at the early stage of research projects to help reduce the burden on researchers when working towards commercialisation. Despite this lack of prioritisation, R3 feels that there is much more interest in entrepreneurial aspects at the university, with academics partaking in different projects including the Entrepreneurial Faculty Project, whereby the Innovation Office took a large proportion of the faculty to other universities to learn of their experiences in technology transfer. In fact, since the 1990's KTH has worked closely with Stanford University, looking at projects to link society with education through open ended projects based on problems posed by the public or private sector. R4 claims that this has been very positive for some of the schools, as it has opened up interest from both researchers and students. In addition, a similar multidisciplinary system was run to solve problems in hospitals, which created an ecosystem allowing interaction across borders.

R4 noted that whenever you introduce something new, there's differing responses from the academics. Utilising the example of the platforms, R4 noted that some particularly strong research groups didn't see the necessity of the platforms because they managed do well on their own. In addition, the challenge of adopting these horizontal platforms is that groups work very differently. Nevertheless R4 notes that this is also natural because the platform will not serve everyone. R4 feels that showing that platforms benefit the university and the research groups, and by building structures and enabling these platforms in such a way for them to operate successfully, also acts as a way to convince people of the benefits. R4 noted that if this is not done, and it is not backed by the entire leadership and others at the university, then you will inevitably meet problems. R2 noted that, in recent times, there hasn't been many problems when change is implemented. R2 believes there is trust in the management of KTH. R2 attributed this to the fact that there had been a very strong rationale behind a quite dramatic and revolutionary change that totally changed the organisation. When everyone saw that it worked well, and they could see the vision of management clearly, it was well accepted. In addition, the change had been planned well, incorporating a clear agenda, and clear instruction, regarding how change should be implemented. R2 also praised the SciLifeLab given the organisation of this new facility means researchers work together in the same space, regardless of their home university. R2 feels that the younger generation are what has helped to make this a success. The representation of differing prevailing university cultures 10 or 20 years ago would not have enabled this to work, given *"the collaborative atmosphere wasn't there"*.

4.2.8.8 Integrated Entrepreneurial Culture

R4 believes there is an entrepreneurial spirit within the minds of many people. This agrees with R2, who felt that attitude changes over the years has been *"absolutely clear"*. In addition, R4 feels that there is a spirit to engage with industry and society. As such, industry sees that the university engages with actors, which has increased industry interaction; and researchers interact more with each other as a result. Therefore, R4 believes this creates, *"a positive spiral"*. Importantly, R4 believes that one advantage is that Swedish society is pretty flat, and rather open minded. Therefore R4 believes it is easy to form multi or transversal interactions. R4 notes that many individuals have engaged in third mission activities, showing there is an interest in public issues. In comparing the Swedish situation to that of

more hierarchical universities and societies, R4 thinks these other situations experience more difficulties in engagement and crossing barriers compared to Sweden, and indeed they would require much more effort in order to overcome such problems. Nevertheless, R4 also points out that there are barriers in Sweden, despite the flat structure, given different disciplinary areas always feel they know best in comparison to others, but overall, feels that Swedish society is open minded.

R4 feels that there is awareness among the university leadership, which is very supportive to entrepreneurial activities. However R4 also noted that there has to be research groups who want to engage in such activities, and without this, and the necessary funding, it won't work. R3 feels that entrepreneurial academics have been a strong driving force for developments, but that they see more and more that the administrative part of the university is becoming increasingly involved. Nevertheless, R3 feels it is still driven more by entrepreneurial academics than by the administration. However, R1 feels that KTH Innovation's approach to helping people, no matter who they are, is *"a good way of spreading entrepreneurial culture"* because their service also helps to bridge the gap between academic and business cultures. R1 noted that KTH Innovation has adopted a business culture for the last 3 or 4 years, and as such, often recommend that if there is a lack of human resources or knowledge in the research teams, to go outside of KTH to find it. R1 thinks that this is a very good approach.

4.2.9 Results from Karolinska Institutet

Established in 1810, Karolinska Institutet is one of the world's leading medical universities, and conducts around 40% of the medical academic research in Sweden (Karolinska Institutet, 2014a). It also offers the broadest range of education within medicine and health sciences in the country. Its core mission is to contribute to the improvement of human health through research and education (Karolinska Institutet, 2014b). Research and education at the university are conducted within 22 departments, providing a comprehensive offering of human medical disciplines as well as dental medicine, to around 6,000 full-time students, by around 4,300 staff (Karolinska Institutet, 2014b; Karolinska Institutet, 2014c). Research at the university encompasses the entire medical field, ranging from basic experimental research to patient-oriented and nursing research (Karolinska Institutet, 2014b). Research areas include Cancer and Haematology; Cell, Molecular and Structural Biology; Circulation and Respiration; Development Biology, Stem Cells, Reproductive, Regenerative and Reparative Medicine; Endocrinology and Metabolism; Epidemiology and Public Health Sciences; Health Care Sciences; Immunology, Infection, Inflammation and Microbiology; and Neuroscience (Karolinska Institutet, 2014b).

The close proximity of the university to the teaching hospitals enables translational research to take place, with new experimental results implemented quickly for the benefit of hospital patients, whilst clinical observations provide a foundation for new and innovative research ideas (Karolinska Institutet, 2014b). In addition, a comparative medicine department was established in 2010, which deals with all aspects of activities concerned with experimental animals in research (Karolinska Institutet, 2014d). As such, the department has a veterinary unit that provides veterinary services and an educational unit which offers courses in laboratory animal science, and other facilities for experimental animal based activities (Karolinska Institutet, 2014d). In addition to these departments, the university also has around 45 centres, each focused on specific research or educational areas. These centres are flexible in organisation and aim to create dynamic collaborations (Karolinska Institutet, 2014e). Centres may be established by the president or the board of the university, or by the board of research, or the board of education (Karolinska Institutet, 2014e). Importantly, one commonality amongst the centres is that researchers tend to share equipment and premises, creating efficiencies, and also creating a platform for innovation.

Karolinska Institutet is hierarchical in structure. It has a board comprising of a range of internal and external representatives, which is regulated in Government Regulation, the Higher Education Act, and the Higher Education Ordinance (Karolinska Institutet, 2014f). This board deals with issues relating to the universities organisation, auditing, the distribution of internal resources, and the compilation of annual reports, to name but a few. From an internal management perspective, the operational leadership of Karolinska Institutet consists of the Vice-Chancellor, the Pro-Vice-Chancellor and the University Director (Karolinska Institutet, 2014g). The university has three internal boards, the Boards of Higher Education, the Board of Doctoral Education, and the Board of Research (Karolinska Institutet, 2014h). A variety of boards, councils and committees also exist (Karolinska Institutet, 2014i). External collaboration is

particularly important for Karolinska Institutet, who has collaborative agreements in research and education with a number of universities, companies, and individual countries all over the world (Karolinska Institutet, 2014b). The university considers its internationalisation strategy as a priority and aims to integrate an international perspective throughout the university; develop further strategic alliances; attract top talent; and strengthen its brand internationally (Karolinska Institutet, 2014j). Importantly, the university aims to strengthen its leadership and improve conditions for core activities through efficient operations and administrative support. The university also aims to improve the integration between health care, research and education, and shorten the period between research results and practical application (Karolinska Institutet, 2014k).

Taking steps towards this objective, Karolinska Institutet has developed its own innovation system as a means to identify ideas and support the commercialisation and exploitation of innovations in order to maximise the use of research findings (Karolinska Institutet, 2014b). The innovation office provides free consultation and support for individuals and collaborative projects between academia and industry. This system also provides education and coaching in entrepreneurship, as well as how to develop new innovations from the formation of start-ups to making licensing deals through their Unit for Bioentrepreneurship, and through the Karolinska Institutet Innovations AB (formed in 1996) (Karolinska Institutet, 2014b; (Karolinska Institutet, 2014l). The Karolinska Institutet Science Park AB provides the support and infrastructure for a range of companies including small start-ups and mature Life Science companies, and the Karolinska innovation system also aids the process of corporate collaboration, and linkage with industry (Karolinska Institutet, 2014b). In addition, Karolinska Development AB (formed in 1995) is a stock-market listed investment company, which also selects, develops and commercialises innovations from the life sciences at the university (Karolinska Institutet, 2014l; Karolinska Institutet, 2014b).

Two representatives were interviewed at Karolinska Institutet.

4.2.9.1 Actors

Industry is an important actor for collaboration with the university, given this is where the *"need"* arises from. However, if they are not interested, it is difficult. In addition, collaboration on EU funded research projects, and projects through Vinnova, are also important. Government aren't perceived to be as influential. They can be characterised as having a top-down influence through funding programmes. However, researchers have a bottom-up approach to creating research agendas within the university, and sourcing finance.

4.2.9.2 Mechanisms

Any type of funding source is seen as potential for collaboration. Researchers will sometimes skew their proposed research projects in order to get funding, but they remain autonomous to decline potential collaborations also. In addition, various infrastructure has been set up at the university including Karolinska Development, Karolinska Innovation, and the technology-transfer office which aim to enhance collaborations, given the higher complexity in funding sources, and challenging EU application processes. The structure has changed to become more professionalised.

4.2.9.3 Organisational Barriers and Enablers

Respondent 1 (R1) argues that the biggest barrier is suspicion of industry, because industry is based on profit, and conflict of interest could ensue. However, R1 feels this barrier is being softened given the university now takes more responsibility to interact with the private sector, rather than researchers doing it themselves. R2 also notes the problems associated with interaction with various actors. In addition, R2 points out that the merit systems in most universities, *"does not, in any sense, support complicated, delayed, trans-disciplinary interaction… it usually somehow benefits those who stick to one research line and produce a lot of publications"*. Therefore, R2 believes that, *"it is counterproductive from the perspective of the scientist when investing time in finding money. So at the other end of the story when scientists, young scientists, not least, look 5 or 15 years ahead, they think about, 'what will I be assessed on?' and still, they're not assessed enough on trans-disciplinarity of, let's say, being useful to society"*.

However, R2 believes that the main barrier is the perception among scientists that the innovation system may not be able to help them. With the Professor's Privilege, they have found that 90% of IP bypass the technology transfer system and go directly into industry. Therefore, the barriers in the Swedish system could be quite different given they, *"go out into the world and face other barriers"* (R2). R2 also noted that there is a need for more funding for the early stages of development, as well as concrete consultation with experts in IP and market analysis.

4.2.9.4 Strengthened Steering Core

R2 feels that changes within the funding and policy environment influence the university's path, although it takes some time. Therefore departments try to attract money, and management is quite responsive. However, as a medical university with 650 units operating, it takes time, as many buttons must be pressed. R2 also feels that industry collaboration has been very influential upon structural change. On the other hand, R1 feels that government has been important in creating infrastructure and providing laws and regulations about how to deal with conflict of interest, potential profits, and how to deal with issues relating to IPR. In addition, R1 feels there are visionary people in leadership positions at the university who think it is important to interact in the innovation system and to address demands from society, considering public funds are limited. R1 also considers this as an indirect pressure from government, given their requirement for universities to engage with different actors in order to meet societal needs, and thus return something to society for the money invested by tax payers. Nevertheless, R1 recognises that the university leadership has created infrastructure to enable researchers to function in such environments. However, R2 feels that, on paper, the mission and strategy of the university is to become more entrepreneurial. However, in reality this situation is *"so-so"*, but R2 feels it is going in the right direction. To date, the university has not put entrepreneurship to the top of its strategy, with existing documentation covering this topic in *"slightly vague wording"*.

4.2.9.5 Expanded Development Periphery

The technology transfer office is fully owned by the university, although it is not centrally managed, as it was formally an independent organisation. Legally it is a corporation, but it is, *"close to the chest"* (R2) of Karolinska Institutet. The people that carry out the scouting and who stay in touch with researchers, *"are maybe not as knowledgeable about the university research groups and people as they should be"* (R2). Nevertheless, R2 feels it is much better now than even just 5 years ago, so things are moving in the right direction. R2 also noted that most universities place an administrator in charge of the TTO or Innovation Office, but then realise 5 to 10 years later that, *"hmmm, maybe we should have more industry people, and then things sober up without delay"*. As a result, the university system is now heavily populated with industry people, which has, *"made a big difference to professionalise it"* (R2). R2 believes the TTO provides the interface between the researcher and industry, and also helps with the economic aspects of interactions where researchers do not have the required competencies.

With regard to inter- and multi-disciplinary departments, R1 feels this is an area that is currently under-exploited. R1 points out that, *"doctors must now work with engineers, lawyers, cell researchers… it is interdisciplinary work"*. However, the infrastructure for interdisciplinary work is not available within the university as such, but R1 points out that such interdisciplinary work is happening. Nevertheless, R1 thinks the present structure and organisation of the university is very old and detrimental to discovery. In addition, it is a very hierarchical organisation which limits the potential of the people. People within departments are confined to the research being carried out within that department, and R1 feels there is a need for more freedom and individuality in future so that people can collaborate and interact with other people. At present, *"money is the evil, it comes to a department and the department wants to keep that money, they don't want to share that money with other people"* (R1). R2 feels that this limitation relates to people being overly cautious about being over trans-disciplinary, given they tend to shape their efforts towards what reviewers will want instead.

Cluster activity takes place, and the SciLifeLab has been created which provides the opportunity to work with companies. Networks and platforms are also available, and professors have their own personal collaborations. In addition, the Innovation Office interacts with the hospital systems and local SMEs, as well as big industrial companies. There are also additional units including the Unit for Bioentrepreneurship, the fund raising or development office, and the grants office which help with interactions and the process in general. However R2 notes that although there are

multiple mechanisms for interaction, as soon as projects become bilateral, trilateral or even quadrilateral, the complication and complexity increases, as does the inertia. This causes people to collaborate for a while before deciding to move away from the project. In addition, R2 notes that confusion also increases if there is no clear format, or clear leadership structure. R2 believes simplification is important in order to become less bureaucratic, and therefore thinks a flexible systems is needed in comparison the present EU standard used for setting up projects.

4.2.9.6 Diversified Funding Base

There is a tendency to go for the standard sources of funding, i.e. competitive grant funding from the governmental agencies, or the foundations. One challenge for the scientists is to integrate with other scientists or other types of actors when making applications, given it requires, *"so much more planning, administration, complexity and misunderstanding"* (R2). Nevertheless, there has been an increase in financing from philanthropic sources over the last 7 to 8 years. This includes large collaborations with philanthropic foundations, and philanthropic funding from other countries.

R1 feels that government has a responsibility to create more resources, given high quality industries in Sweden rely on research products, and at present, there is a limited availability of finance. In addition, R1 feels there is a need for more freedom regarding the funds received. R2 feels that there is a need for both government support and further autonomy, given operations of the university, *"must be funded to a large degree by the public source"*, but R2 believes that this does not mean it needs to then be steered by government. R2 notes that 30 years ago, 75% of funding automatically came to the university, and now almost 75% is competitive, meaning only 25-20% of government funding automatically comes from government. R2 feels that government has too much influence, and therefore universities need both increases in public funding and autonomy. R2 feels this increase in money would be useful if directed towards research, infrastructure, and also strategic requirements to attract people to work at the university.

4.2.9.7 Stimulated Academic Heartland

To date, there are no specific incentives for academics to commercialise. However, patenting is one thing that the university gives merit on, therefore academics can gain fame from their successes. In addition, these types of activities have been headlined in the merit portfolio, so within the CV templates, academics have to say something about their entrepreneurial activities. R1 feels the mission and strategy of the university is important, but notes that researchers are not very interested in this, and that there has always been researchers who are proactive, but that these interactions have now become the rule rather than the exception.

R1 points out that they are not bound to any particular kinds of research, but have the freedom to follow research themes as long as they can find funding. Their salaries remain the same regardless.

4.2.9.8 Integrated Entrepreneurial Culture

Both R1 and R2 agreed that there is still some resistance to engagement in technology-transfer activities. R1 argued that some people just want to do their own research, whereas others realise that something has to be given back to society. R2 feels that some academics feel that perhaps these activities take money out of the research purse. However, compared to 15 or 20 years ago when there was structural resistance, R2 thinks today it is moving in the right direction, with more and more people becoming concurrently more interested and able. The culture in the old days was very different, given collaboration with industry had different kinds of connotations. In addition, very few people at the top had any experience of entrepreneurialism. It was definitely not even part of the general thinking or culture.

Nevertheless, R1 believes certain individuals drive such interactions, however the university has created infrastructure making it more of a university undertaking now. R2 believes that entrepreneurialism is not embedded throughout the university, but that is it highly variable throughout the 650 units within the university. Overall, R2 believes that the university has become more entrepreneurial over the last 10 years, but this process could, *"move even further and faster"*.

CHAPTER 5: DISCUSSION

University contribution to regional and national systems of innovation has been discussed to great length (e.g. Etzkowitz and Ledesdorff, 2000; Etzkowitz, 2003a; Gunasekara, 2006; Bercovitz and Feldman, 2006; Bramwell and Wolfe, 2008; Marxt and Brunner, 2013). The continual internal transformation of case universities as they strive to become more entrepreneurial is another important area of study within the literature (e.g. Birnbaum, 1988; Clark, 1998; Etzkowitz, Webster, Gebhardt, Cantisano and Branca, 2000; Davies, 2001; Martinelli, Meyer and Von Tunzelmann, 2008; Davey, Baaken, Muros and Meerman, 2011; Koryakina, Tiexeira and Sarrico, 2012). Nevertheless, the cross-over between these two bodies of literature, on university transformation in response to prevailing political, funding and legislative environments within broader national innovation systems, was somewhat lacking. Therefore, the aim of the study was to determine how prevailing National and Regional Innovation Systems affect university contribution and transformation towards becoming more entrepreneurial. As such, interviews were conducted with a variety of universities and external innovation system actors in order to consider which actors, mechanisms, organisational barriers, and indeed organisational enablers, affected this anomaly. It is now apt to analyse and discuss the results pertaining to each sub research question, in order to establish the lessons learned through this comparative study.

In general, both external innovation actors and university actors were consistent within their responses. In particular, very few tensions were noted within each university case study, highlighting that representatives' opinions generally agreed with one another in each case. Nevertheless, triangulation of the primary and secondary data collected from the field highlight interesting revelations, particularly regarding organisational barriers and organisational enablers within the system. The following discussion has been subdivided accordingly to answer the research questions posed in Chapter 1.

5.1 Sub Research Question 1

How and which actors of the innovation system have influenced universities to become more entrepreneurial?

In the Austrian context, the general consensus rested upon the fact that numerous actors are influential within the innovation system. This ranged from political actors to funding agencies, industry, and the universities themselves. Interestingly, all interviewees discussed influential actors in conjunction with the mechanisms present within the system, given some actors were pivotal for providing important mechanisms to bring the various nodes of the innovation system together; and the actual collaboration of various actors was noted to be conducive towards greater technology-transfer (reflecting Etzkowitz and Dzisah, 2008; Leydesdorff, 2012; Ranga and Etzkowitz, 2013; Farinha and Ferreira, 2013). Importantly, the Austrian Bridging Organisation representative specifically noted that organisations such as funding agencies and bridging organisations have encouraged universities to become more entrepreneurial through a mix of structural, organisation and cultural changes through consultancy support and financial assistance. Nevertheless, the view from the universities suggested that industry actors and governmental funding programmes are the most influential, which suggests that university interaction concentrates on generating more funding to stem the shortfall of core funding. On the other hand, external innovation actors seem to recognise the importance of university interaction with the innovation system. However, they obviously need further mechanisms to overcome the primary issues limitations in university funding places upon the academic sector, given funding shortages tend to steer universities towards the types and levels of interaction they participate in. This suggests that the misalignment generated by shortages in funding creates a barrier in this sense, given the untapped potential for both basic and applied research as a result of greater interactions. Secondary data suggests that there is a disconnection between ministries in Austria, with no formal mechanisms of coordination, meaning the overall system is quite fragmented. This is problematic given the Ministry of Finance holds the power which impacts the research policy system, thus indicating that flaws within the design of the institutional framework in Austria are potentially inhibiting progress. In addition, the overall culture within the country must also be taken into consideration in this respect, given a more bureaucratic culture is present, which is not so entrepreneurial in nature. Nevertheless, it is recognised that transformation within the system is required, and structural change has been taking place over the years, and is outlined within future plans to enhance the potential of the system (European Commission, Erawatch, 2014b). However, it seems that further work is needed to create opportunities for innovation actors, including universities, to

discuss future policy strategies with government in order to overcome the bureaucratic hurdles currently hindering the system; especially given universities are considered the backbone of research within the country, and are increasingly expected to partake in third mission activities and cooperation with industry (European Commission, Erawatch, 2014b).

In the Swedish context, there were four distinct responses regarding influential actors, which directly reflected the origin of the interviewee. The external representative felt that the funding agencies and organisations were most pivotal given the programmes they organised to bring actors together; the bridging organisation representative felt that all actors were important within "the puzzle", and therefore felt that bridging organisations were pivotal to bridge the connection between all actors; the representative from the online bridging platform felt that innovation starts within universities and research institutes; and the universities reflected the Austrian university response, highlighting that industry, and government (who provide the funding for programmes), were most pivotal, as well as the universities and researchers themselves. This was an interesting response, given its fragmented nature reflected the perceived fragmented nature of the innovation system itself (European Commission, Erawatch, 2014u), highlighting that perhaps more connection is needed, which reflects findings that policies for the knowledge triangle are insufficiently joined up (FarHorizon, 2010). Nevertheless, this particular response highlighted which elements are perceived as important from the differing perspectives of the actors involved. Therefore, the triangulation of these opinions may generate discussion processes on how to successfully propagate the system in place at present, in order to create more conducive alignments.

From a comparative perspective, it appears that innovation actors in both countries recognise the importance of what actors can bring to the table in order to stimulate interaction (whether through funding programmes or other mechanisms) and how these influence universities to thus become more entrepreneurial in the process. This dominantly stems from the funding incentives various actors provide. Nevertheless, it seems that both countries aim to create interactions of differing actors, but the prevailing institutional framework and culture perhaps differs in its influence on how well these endeavours take place. From the information gathered, it suggests that the aforementioned proposition potentially holds true, given that higher interactions of actors, representing different nodes of the Triple Helix does increase the likelihood that universities will contribute to the innovation system. This can be attributed to governmental funding programmes, industrial collaborations, and the work of bridging organisations in particular, who have provided mechanisms and assistance to universities (which will be discussed next) to not only encourage universities to participate, but also encourage universities to professionalise in order to make such collaborations easier. This is of great significance considering university-industry linkages are important for growth (Conti and Gaulé, 2009a). This finding also reflects Kapetaniou and Lee (2013) and Serrao (2013) who highlighted the important role of government in small countries, given it acts as a catalyst and facilitator through providing institutional support systems and policy interventions for the improvement of institutional structures and processes of innovation; and in a regional context, helps create the overlapping of triple helix interactions through a combination of top-down and bottom-up approaches. Therefore, if government and its associated agencies have such influence, it is pertinent that dialogue is increased within both country innovation systems in order to find practical solutions for current bottlenecks, which will also be discussed shortly.

5.2 Sub Research Question 2

What mechanisms (funding, platforms, programs, regulation etc.) exist in the NIS / RIS to harness university contribution to innovation and economic development?

In the Austrian context, various initiatives have been developed within the innovation system to encourage university interaction, whether directly or indirectly. These include a number of government funded programmes directed at both basic and applied research, with some specifically targeting collaboration of actors through university-industry cooperation. Importantly, various other actors in the system provide funding initiatives which are ultimately supported through regional and national finance initiatives. All university representatives noted the importance of these programmes as a means to secure much needed finance, but also noted the restrictive and bureaucratic nature of such mechanisms, which created implications for the direction of research, and the time available to carry out such research. The competitive nature of such programmes of funding was also highlighted as an issue considering the low

success rates that can be achieved when competing nationally and internationally. Interestingly, another point raised by R2 of the Medical University pertained to the need for the increased basic funding of universities, given this ensures universities can retain power within collaborative activities with industry, and cover the core missions of the university. In addition, such basic funding is tied to 3-year performance contracts which reduces the level of autonomy somewhat, and also takes time to administer (R1, BOKU). As a result, it seems tensions exist within the system, as government appear to be trying to regain some power over universities despite reducing funds being directed to the sector. This has implications on how universities respond to this ever-changing financial environment, from both an organisational perspective, but importantly from a cultural perspective. The uni:invent programme was a pivotal development which has impacted the innovative performance of universities within the innovation system. Nevertheless, its demise in 2009 has been felt within universities given the costs required to operate technology-transfer offices, suggesting further mechanisms are needed to bolster and further develop the great work of this initiative. This is particularly relevant given technology-transfer is a current priority area targeted for expansion (Federal Ministry of Science and Research, 2013). Nevertheless, one problem could pertain to the disconnection within the knowledge triangle, given education policy has not been fully integrated to date (European Commission, Erawatch, 2014i). This suggests that improved alignment between education policy, research policy, and other economic areas would benefit universities in their quest to improve their efficiency of third mission activities, especially given the orientation of activities require emphasis from the commercial aspect of technology-transfer, which is possibly not so well established within current education policies. In addition, the availability of finance for patent applications and pre-seed funds are pivotal, yet limited in their availability, which is bound to limit the amount of commercialisation which can take place.

It appears the development of Competence Centres have been an important addition to the system, given their design enables a space for industry and academics to meet and conduct research in new areas. Not only have these centres been praised by interviewees, but the long-term design of this initiative has been particularly welcome, as it enables time for trust-building between actors (reflecting findings by ESMU,2012). The University Act 2002 has also played a crucial role in the entrepreneurial development and professionalisation of Austrian universities. All respondents made reference to this legislative development as an important step towards easing interaction processes of universities within the innovation system. There appear to be a number of platforms, both formal and informal, whereby actors meet, yet emphasis seems to rest on academic entrepreneurs to drive such interactions. In addition, the industry representative perceived it as advantageous if ex-university staff were working elsewhere within the innovation system, given their knowledge and contacts helped ease the formation of collaborations, within which seems to be a very complex environment due to the varying structures and processes present at each university. This highlighted the importance of processes within this people-oriented sector, given evolving dynamics seem more people-centric rather than set in structures. However, professional structures were also highlighted as an important factor within collaboration, which will be discussed shortly. Internally within universities, the commitment of the rectorate and supportive nature of the TTOs was also a crucial component given 'buy-in' at this level is required if such interactions are to take place. Indirectly, the Tax Allowance Scheme also plays an important role, providing industry with incentives to participate in R&D activities. This shows just how relevant it is to triangulate policies and mechanisms within education, research and the industrial sectors, given the resulting positive spiral that can take place as a consequence of such actions in the other spheres. In addition, closer alignment also brings efficiencies and should create opportunities to create greater synergies between the research products universities produces, and what industry, and indeed regions, need. This reflects findings within the Triple Helix literature (e.g. Etzkowitz, 2002; Farinha and Ferreira, 2013; Ranga and Etzkowitz, 2013).

In the Swedish context, the government have committed a large investment to the R&D sector, amounting to 8 billion Euros over a period of 8 years (European Commission, Erawatch, 2014o), with a view to enhance Sweden's long-term competitiveness, of which, universities have an important role to play. Importantly, it was felt that the innovation system in Sweden is designed to promote rather than demand innovation and commercialisation (Bridging Organisation Representative, Sweden). Although the Swedish system does not have a culture for venture capital, some is available through university development offices, and there have been recent examples of philanthropic donations towards basic research, which have stimulated both the basic and applied research environment, and opened new streams of finance. Like Austria, universities are also encouraged to engage through various financial incentives, particularly governmental funding programmes. Nevertheless, strings are attached to such programmes,

and basic funding of universities is also based upon performance-based contracts. Similar to the Austrian case, this has implications for how universities interact. However, as opposed to Austria, university respondents' felt that funding in general was adequate, which perhaps contributes to the positive entrepreneurial attitude of academics. Nevertheless, the current lack of autonomy within the university sector has been highlighted as being restrictive towards interaction within the innovation system (R2, Karolinska Institutet). As such, legislative restrictions actually inhibit universities from fully engaging in technology-transfer activities, requiring some reconfiguration of the institutional framework within the prevailing innovation system. Nevertheless, universities do have freedom to follow their own research agendas, and decide how to publish their results, but availability of funding is the main restriction to this freedom, especially given basic funding rules prevent the utilisation of such monies for commercialisation processes.

Similarly to Austria, the Swedish government also invested money to create holding companies and innovation offices within selected Swedish universities. As a result, universities have been aiming to professionalise operations through the creation of appropriate infrastructure, such as TTOs, and structuring activities in such a way to enable collaboration, reflecting findings by Clark (1998). However, R1 (KTH) felt that the tradition of the schools played an important part in how universities interacted, showing that aside from the structural aspects, softer aspects such as culture and disciplinary orientation influence the extent to which such mechanisms within the innovation system actually harness universities. The Life Sciences sector has a more natural disciplinary orientation towards such interaction, yet it is worth considering the principle of this finding, given it could potentially contribute to greater efficiencies and synergies in future. The Professor's Privilege is a unique mechanism within the Swedish system which enables IPR to reside with the inventor, regardless of whether the research is funded through the public purse. This creates a unique anomaly for universities, given they cannot force inventors to commercialise. However, it does function as an incentive for academics, therefore TTOs and university managers are designing IP policies to deal with this issue. Elements of this particular mechanism have the potential to enhance innovative activities, provided the appropriate seed bed is present (i.e. an entrepreneurial innovation ecosystem), which is designed to not only be conducive to such developments, but also encourage them. This will be discussed further shortly.

A weakness within the Swedish system pertains to the small amount of interaction that takes place, as highlighted by the finding that funding transferred between sectors is low (European Commission, Erawatch, 2014m). This could potentially be due to the fact that the majority of R&D expenditure is allocated to the HE sector (70.6%) (European Commission, Erawatch, 2014n), and thus requires further investigation to understand how technology-transfer occurs between universities and SMEs. This is important, given collaboration with industry can provide additional funding for universities. Nevertheless, findings in the literature point towards the difficulties SMEs have to form collaborations with universities (Filip, 2013). Therefore, it is apt to explore why transfer of funds is so low between sectors, and whether structural issues within universities are inhibiting SMEs to successfully interact with universities. This is particularly important from a regional perspective to increase growth and build industrial competences for enhanced competitiveness, through knowledge transfer with universities. Inter-sectoral mobility could hold an important key towards stimulating interaction between universities and industry, and increasing the level of knowledge transfer between sectors, however, the current structure of tenure progression in academia perhaps requires rethinking in order to add another mechanism to bring university interactions with the innovation system closer. Nevertheless, developments such as SciLifeLab are providing platforms whereby academia and industry meet. This particular development was perceived as being culture and time dependent, given that this type of collaboration would not likely have succeeded in the past, due to prevailing cultures and innovation landscapes at the time. This suggests that the evolving innovation ecosystem through a combination of institutional framework developments, funding pressures, and policy measures have created the impetus for such collaborations, through the course of evolutionary behaviour within the national system, and as a result of impacts from international developments (i.e. European funding instruments).

From a comparative perspective, both Austria and Sweden rely on international sources of public and private funding, the extent of which seems to be increasing as national budgets tighten, resulting from current financial pressures. Therefore, at present, national governments need to take action within national institutional frameworks (particularly legislative and bureaucratic hurdles) in order to ease collaboration processes, given niche disciplinary areas of research transcend national borders. This is somewhat inhibited, given disconnections and lack of coordination within

the governance structure and policy instruments, and underutilisation of the interaction potential of each actor within both the Austrian and Swedish systems (Austrian Council, 2009; Conti and Gaulé, 2009; Farhorizon, 2010; European Commission, Erawatch, 2014u). These barriers will be discussed shortly. Strategy planning and financial availability appear to differ in each case, with Sweden adopting a longer-term commitment towards R&D development, and Austria adopting a more conservative commitment. As such, Austria could learn more lessons from Sweden in this regard given enhanced dialogue between actors in the development of strategy planning can ease bottlenecks, and service the requirements of those partaking in such activities. This is particularly important, given increased targeted funding of universities could potentially ease interaction and collaboration processes through appropriate structural processes and infrastructural developments. This has been highlighted by those innovation actors actively taking part in such collaborative activities with universities, and will be further discussed in the next section. In addition, both countries do not harbour a philanthropic culture, and as such need further sources of private venture capital. This follows Mazzucato's (2013) finding that government can play a crucial role in financing high risk knowledge intensive activities. This approach would be useful, at least until institutional frameworks and mechanisms evolve to encourage heightened venture capital activities from private sources. Therefore, stimulation of private sources of funding could potentially build a self-reliant funding source (Mora, Detmer, and Vieira, 2010), however, this is heavily dependent on mechanisms, culture, and the legal frameworks in place.

Leydesdorff (2012) highlights that government can provide stabilisation within a system, thus reducing the possibility of chaotic behaviour when two or more helices are in operation. Nevertheless, to avoid domination of government, it is suggested that a two-way flow of dialogue between all actors takes place when designing strategies in order to symbiotically develop mechanisms and processes that promote innovative inclusive development, which reflects issues raised by the various nodes within the Triple Helix. Interestingly, the study highlighted that although formal and informal mechanisms exist between actors, there was still heavy reliance on less formal mechanisms, and the existing networks of academics, reflecting findings by Hughes (2003), as well as Martinelli, Meyer, and von Tunzelmann (2008) who also highlighted that schools and faculty differ in their approaches to collaboration. This loosely structured interaction process must be taken into consideration, especially when considering organisational change and process transformation in universities, in order to maintain flexibility, and avoid breaking interactions through strict organisational regimes and funding allocations. These administrative mechanisms can indeed inhibit cross-pollination of research activities internally, as was found in the case of Karolinska University. This is particularly important given Doloreux (2002) found that mechanisms which promote knowledge and interactive learning enhance the advantage of proximity and social embeddedness.

In this regard, it is difficult to adopt or dismiss the proposition posed in Chapter 1, given university representatives generally stated that they do participate in various funding programmes in order to achieve funding allocations, which are needed to bolster the shortage of public finances being directed to the sector. Yet, it was less clear whether universities transform organisationally in order to take advantage of funding opportunities, thus becoming more entrepreneurial in their structure and functionality. This is largely due to the differing opinions of the interviewees, and how they analysed their current situation. For example, in the Swedish case, interviewees recognised the on-going professionalisation of their universities as a result of innovation system interactions, such as competing for funding, or indeed as a result of the changing governmental policy landscape. However, in the Austrian case, representatives did not feel that transformation had occurred as a result of changing funding landscapes, but felt it was more than that. Their reasoning pertained to the need for functionality, adaptability, and flexibility of their interactions with the outside world, and indeed how they were seen by the outside world. Considering the transformations that took place as a result of the University Act 2002, a policy designed to give more autonomy and professionalise the system, it is suggested that perhaps the interviewees in this context considered their current adaptions, rather than the obvious transformation which took place in 2004 as a result of this Act. Therefore, it seems that there are more factors at play besides funding, which have encouraged universities to transform and become more entrepreneurial, including policy, interactions with industry over time, and the expectations of the public, which were perceived as important drivers in both country cases.

5.3 Sub Research Question 3

What are the organisational barriers and enablers for university engagement to become more entrepreneurial?

Interestingly, the Swedish external innovation actors highlighted that there is a culture for innovation embedded within the Swedish Innovation system. This was at odds with the respondents from Austria who felt that there was still some way to go regarding entrepreneurial culture, and that the system was too bureaucratic, and not innovation friendly enough. Another interesting point was the differing governance structures of the innovation system within the two case countries, with agencies tending to have more power than the ministries in the case of Sweden. It would be interesting to investigate further how such power distribution could function in Austria, given a Federal system is present. Nevertheless, it seems that a clearer strategy is needed first, given the perception currently is that differing strategies and goals are present in the innovation system (Industry Representative, Austria). Therefore, more collaboration is required between actors in the system in order to improve policy design, and reduce bureaucratic hurdles. Such administrative hurdles appear to be a common problem throughout Europe, with Koryakina, Teixeira, and Sarrico (2012) noting particular issues regarding rules, bureaucracy and project payment systems. In both cases, better alignment with the healthcare system was noted, especially given the close proximity of university hospitals to the functioning of the university. Yet again, problems within the structure and organisation of the institutional framework came to the fore, especially in the Austrian case, which again has impacted the flow of innovations within the Life Sciences sector. This particular anomaly is out-with the scope of the project, but requires further investigation, particularly in comparison with the German healthcare system, which was noted to be much more open and flexible (Industry Representative, Austria).

In the Austrian case, the government representative felt that long-term approaches pay off in a better way, however, comparing this with the opinions of other innovation actors suggests that there is a lack of clear strategy in the system, highlighting contradictions, especially given funding mechanisms tend to be primarily designed for the short to mid-term, with Competence Centres one of the few examples of longer-term initiatives. Nevertheless, Competence Centres have been highlighted as a success story. They have encouraged universities to become more entrepreneurial, and have also reduced the gap between the research endeavours of universities, and the needs of industry, which has gone some way to creating better alignment. One of the main success factors highlighted within this particular initiative is that the longer-term orientation of these Centres enables trust building between actors from different nodes. This is fundamental within both short-term and long-term partnerships (Mora, Detmer, and Vieira, 2010). In addition, it creates an innovation environment, which acts like a melting pot. Considering modern research increasingly requires the cross-pollination of disciplines, this type of structure provides the seed-bed for such pollination to take place.

Comparatively, both country cases exhibited similar issues, with Sweden being more satisfied in general with the level of public funding in comparison to Austria, who felt there was a massive need for further funding initiatives. One interviewee stated that a 50% increase in funds is required in order to support the variety of missions universities are expected to undertake (R2, Medical University, Vienna). University respondents also felt it was important to have this increase in funds to maintain independence when designing collaborations, given too much venture capital, or finance by industry, can have detrimental impacts on research endeavours. This was due to the potential for dominant steering by the collaborator which could narrow the scope of development, thus reducing innovative capacity, or pressurising universities to produce results which are needed rather than particularly accurate. Interesting insights gleaned from both external innovation actors and university actors have highlighted issues from each side concerning collaboration processes, and what is needed to help ease collaboration processes. These issues lie at the intersection between bottlenecks in the innovation system, the transformation processes of universities, and also what further collective transformation is required in order to address these challenges. Governments should take heed of the issues raised given these are some of the core bottlenecks currently impacting how universities interact and contribute to the innovation system. Therefore, recognition of the following challenges could potentially help create efficiencies and increase output in the innovation system.

In the Austrian context, external innovation actors agreed that the variety of existing university structures make collaboration difficult. This was due to the differing organisational structures and processes at each university, as well

as the vast number of people external actors needed to know in order to find the right people to collaborate with. In addition, differing cultures between nodes also had an important role to play, creating difficulties within collaborations between actors. Therefore, although universities are unique in their traditional orientation and disciplinary focus, it is clear that tensions exist between maintaining their own individuality and having a professionalised business model, which is accessible at the interface between university and other actors in the innovation system. Similar issues were also highlighted as barriers by ESMU (2012), during their study to explore ways to assist the building of collaborative partnerships. Results from interviewees in both country cases highlighted that the presence of a TTO made collaboration somewhat easier, showing that such professionalisation, although perhaps not profit generating, was an important structural development for university interaction. Nevertheless, it has been noted that the embeddedness of such infrastructure in relation to the core activities of the university relates to its success (Mora, Detmer, and Vieira, 2010). Findings from the GOODUEP project (Mora, Detmer, and Vieira, 2010) also noted that universities are not earning profit through commercialisation activities, and have been heavily subsidised by public and private sources (Mora, Detmer and Viera, 2010). This shows that further subsidisation is needed to support commercialisation processes.

These particular issues couple closely with communication problems, both internally within universities, whereby knowledge transfer mechanisms between schools and departments have been identified as requiring attention; and externally, whereby knowledge transfer between universities and the outside world has been identified as an inhibitory factor, given the level of effort required to actually find information. Therefore there is a need to overcome information silos. Simple knowledge management mechanisms could alleviate many of these issues, particularly if designed in conjunction with social media tools for the benefit of giving easier access to research findings for both internal and external actors (Bridging Platform Respondent, Sweden). Yet culture plays a huge role in the potential success of this type of development, requiring appropriate design and leadership inside universities to set strategies (Etzkowitz, 2008), and the creation of appropriate platforms in the innovation system to guide this process. It will be interesting to watch how Sweden's new approach to trade patents globally over the internet will stimulate university-industry interaction, and indeed, how this transfer of knowledge will shape how universities structure themselves organisationally to partake in further research endeavours globally. In this case, it is assumed that issues regarding infrastructure will require further attention.

A lack of funding was the main barrier, particularly in the Austrian case, reflecting Koryakina, Teixeira and Sarrico's (2012) finding that the deficit in public funding is placing pressure on universities to diversify their income base. However both countries reported a lack in the availability of private capital, given the culture of risk money is, in general, extremely low in Europe compared with the US. Importantly, the "Valley of Death" was perceived as a crucial barrier to the growth of usable innovations emerging as a result of university research. The funding gap created between initial basic research and commercialisation was noted in both country cases as a major problem, given the capital investment required to bridge this financial gap. Universities in both case countries, but particularly in Austria, noted that there is a lack of funds for technology transfer, and given IP development is a costly undertaking, some projects are killed off due to the high administrative costs of maintaining IPR. Although only a small proportion of IP generates revenues in the long-run, it still accentuates the fact that some innovations are not even making it far enough along the value chain to even reach commercialisation, which not only impacts the economic potential in the innovation system, but also costs society unrealised benefits of such innovations. Considering findings that not enough research is being translated into usable products in Europe, the so called European Paradox (European Commission, 2007; The North Sea Region Programme Secretariat, 2013), it seems apparent that targeted funding and policies in this particular area could have positive effects. Therefore, more seed funding is required to bridge this anomaly, given the majority of innovations borne in universities are too early for industry to commercialise. As a result government must take a longer-term view, especially considering the fruits of such investments in the technology-transfer scene only become apparent after 5 to 10 years. Therefore, by increasing capital investment towards this funding gap, government would in essence be creating efficiencies, given much capital investment is lost from the innovation system due to projects having to be killed off. Sweden plans to provide more finance for incubators, so it will be interesting to note the success rates of this venture, and also to explore how and where incubators are structured in relation to universities (i.e. within universities, within science parks, or independently elsewhere in the innovation system). Nevertheless, it was highlighted that implementation of a quick feedback system, regarding finance (as in the

case of Belgium, (Bridging Organisation Respondent)), could provide a very efficient model upon which to generate more finance earlier in the process, rather than waiting 5 to 10 years for royalties. This particular model could be beneficial in both country cases, as a means to alleviate current funding restraints, but needs further analysis with respect to prevailing innovation systems and institutional frameworks.

Also, as universities have a cost to cooperate with industry, universities noted the difficulties in being able to match fund projects, and particularly noted the limitations existing infrastructure had on the extent of activities they could feasibly participate in. Plans to create a new university financing law which takes account of research, teaching and infrastructure demands is set to come into action in 2019 (European Commission, Erawatch, 2014f). It will be interesting to gauge its success, and witness how this impacts funding distribution in future, particularly given current funding for infrastructure has been decreasing to date (Wiener Wissenschafts-, Forschungs- und Technologiefonds, 2014). Aside from infrastructure, the need for increased specially qualified human resources was also evident within the TTOs, however universities noted that restricted budgets meant it was not possible to hire the support needed. This obviously impacts the volume of collaborations that can take place, and has time implications, given longer periods of time are needed to set up collaborations. This is particularly problematic for industry, and therefore targeted funding towards infrastructure and human capital would help reduce these current structural problems in universities. Nevertheless, culture in this respect must also be factored into the equation, given the timeframes of researchers and industry are often different. Therefore, it seems that a complex mix of structural and cultural issues must align in order to overcome current barriers and enable collaboration in this sense.

In addition, the demands placed on academics means there is limited time and manpower of researchers, with academics having a tendency to service the core missions of university teaching and research, and only partake in commercialisation if there is extra time available. This reflects Allinson's finding that universities face a lot of challenges given the numerous missions they have to carry out, thus requiring complex decisions to meet all demands placed upon them (University Industry Innovation Network,2013). Interviewees noted that it was important to generally increase the awareness of entrepreneurial activities among staff, but also highlighted the importance of academic entrepreneurs (Slaughter and Leslie, 1997). This suggests that despite new structures such as TTOs helping to educate and encourage staff to partake in such activities, individual efforts are still very much to the fore in driving entrepreneurialism. However these activities are perhaps pursued out of particular individual interest, considering the time pressures facing academics. In addition, there is a need to create more time and entrepreneurial culture in order to encourage academics to partake in the commercialisation process, given their specific knowledge is pivotal to ensure the process of commercialisation is successful. However, given the tenure system in universities is based upon publications rather than commercialisation, it was felt that this system itself was a major driver pertaining to the actions of academics. Therefore, in addition to such systems, legal systems also create limitations, as was found in the case of Sweden whereby universities could not use public funds to support commercialisation ventures. These problem areas impact the university on two levels, the functionality of human resources, and the functionality of management and output of the university. Therefore, these external 'systems' must be redesigned to be more supportive of these new emerging needs placed upon the sector, which not only stems from the historical institutional framework in place, but also the academic culture of what the sector has traditionally been based upon.

Another notable change was within the measurement of technology-transfer activities at universities, given administratively, TTOs require all commercialisation activities to go through the TTO in the case of Austria. This method enables greater visualisation of the process and its overall functionality. However, in the Swedish case, this was not so easy, given the Professor's Privilege still enables academics to by-pass the university to take part in commercialisation. However, new university IP policies have been designed to stem this particular issue. As a consequence, there were mixed feelings amongst the Swedish respondents as to whether the Professor's Privilege was indeed a barrier or an enabler. However, from a structural perspective, it seems that the development of specific IP policies was pivotal to improve the management of IPR, and make the process more transparent and legally accountable, particularly for ensuring transparent collaborative activity with industry. Therefore, the Professor's Privilege provides a good incentive, as long as it marries well with university commercialisation processes. University managers could take these principles into account when designing such incentive mechanisms alongside their own particular IP policies.

Platforms have been highlighted as a means to improve coordination and communication, with noticeable changes in university interaction as a result. Nevertheless, academics' own connections seem to still hold precedence, both for finding collaborations and also securing funds. This can be considered an enabler and a barrier in some respects given an already established network has had time to build trust and expertise, and thus build upon previous successes. However, young academics with a lack of connections find it difficult to forge such collaborations, and therefore require more structured approaches, which platforms can provide, at least initially. Therefore, the results suggest that appropriate creation and adoption of platforms within the innovation system, and indeed within universities, has the power to make connections between actors, which has proven to be quite successful at KTH Royal Institute of Technology. Nevertheless, KTH noted that structure and size of the university can make it difficult to bridge the breadth of different groups together, and focus on one central theme. Therefore the creation of these flexible platforms, which have not been physically introduced into the actual structure of the university, has provided connections between research groups.

One respondent particularly noted the importance of having some sort of platform, but utilising the example of various events, highlighted that these types of platforms do not always work as intended, particularly if actors representing different nodes and functions (e.g. venture capitalists) do not attend (Bridging Platform Representative, Sweden). Therefore, more structure with appropriate financing may create incentives upon which next generation platforms can emerge. The example of LifeScience.Net is an excellent example of a modern, online portal, connecting nodes and actors across international borders, which is incredibly important given modern research endeavours transcend regional and indeed national borders. Overall, this highlights that a 'one size fits all' approach will not work, and must be designed conducively to the host university or system. It also needs a level of commitment from people to drive the process and change in general. Without this commitment, no types of policy will make a fundamental impact on the ground.

Considering the various barriers and enablers within the system, it is apt to accept the proposition formulated in Chapter 1, as it appears barriers such as ear marked funding, legislation, disjointed policy design, and non-entrepreneurial internal structure and orientation may inhibit university interaction and contribution with the innovation system. Therefore, prevailing innovation systems and institutional frameworks impact heavily upon how universities respond to their given environment, highlighting how sensitive universities are to drivers and interactions within the innovation system, and how inhibiting certain barriers out-with universities' control are to their contribution within the innovation system. Therefore, overcoming these bottlenecks, and noting successes within such interactions, can provide learning for future policy design in innovation systems and within universities.

5.4 Sub Research Question 4

How do actors and mechanisms of the innovation system ease contribution processes by universities?

In the Austrian context, it is clear that university development and transformation is influenced by developments within the wider innovation system, particularly national and EU strategies and policies. The University Act 2002 has had a major impact on university transformation, given the increase in autonomy has encouraged universities to professionalise their organisation, structure and functionality. Nevertheless, this is somewhat restricted by performance contracts, which have, in essence, reduced autonomy and limited time available for carrying out the range of tasks academics are expected to fulfil. As a consequence, they have become vertical steering structures within the system (Glaser, 2012). Therefore, the professionalisation undertaken by universities to expand their development periphery by addition of TTOs funded through the uni:invent programme, has created a bridge to interact with the innovation system. This particular government funding programme has had a positive effect on developing infrastructure to increase contribution by universities. Nevertheless, a lack of time and funds has effectively capped the level of performance such TTOs can reach, given academics are under pressure to fulfil the core missions of teaching and basic research. Therefore, a lack of funding for both human resources and research activities limits the level of output which can be achieved. This is illustrated in the case of the Medical University, given strategic decisions have been made to not follow up all potential IP due to the lack of available funds. As such, strategic decisions have been made to concentrate resources towards key strengths of university research groups in the area of nice markets. As such, internal clustering has been a strategic and deliberate choice (R2, Medical University Vienna). This reflects

actions taken by KTH to create specific platforms relating to their key strengths, implemented as a result of their RAE. The reality within all case universities is that TTOs create a relatively balanced situation financially, however profit is not generated. Yet, all reported a need for more staff in order to increase potential contribution to the innovation system.

Interestingly, in the case of both Austrian and Swedish universities, it was found that the Medical Universities were more rigid in their structures, which, particularly in the Swedish case, was found to be particularly restrictive and detrimental to innovation. In the cases of BOKU and KTH Royal Institute of Technology, both universities have transformed to create larger schools, incorporating a flexible structure to enable cross-disciplinary working, and enable easy responses to project funding calls. Flexibility in management and governance structures was noted as a critical factor within several case studies analysed by Mora, Detmer, and Vieira (2010), thus highlighting its necessity when designing transformational change. In addition, Clark (1998) also argued that entrepreneurial universities exhibiting a strong steering core are capable to respond flexibly and strategically to opportunities within the innovation system. R1 from BOKU felt it was really necessary to change the structure of university departments and organisational functions to make it easier to compete for funding. However, R2 from BOKU noted that these transformations were not actioned directly to do this, but to form departments with enough flexibility and focus, and to give a clear structure to outside world. KTH has had a slightly different approach through creating autonomy and internal performance measurement for the distribution of funds to each school; and the creation of platforms in order to respond to the increasing needs for cross-disciplinary research. This latter has been designed as a means to overcome the difficulties in bridging the variety of research groups operating at the university. Importantly, third mission activities are clearly understood as day-to-day functions at KTH, with an executive position created specifically for increasing collaboration with external actors. In addition, specific IP policies have been implemented to overcome the Professor's Privilege. This highlights examples of strategic structural approaches taken to embed tech-transfer activities within the university, showing that university contribution to the innovation system, and society in general, is an important strategy for the university. As such, university transformation has taken place in order to ease collaboration processes. This echoes Spanier (2010) who found that the easiest way for universities to be strategic and adaptable is through transformation of the hierarchy and organisational structure in place. Nevertheless, Martinelli, Meyer and von Tunzelmann (2008) also warn about loss of identity in the creation of larger schools, requiring sensitivity in such structural reorganisation.

Although universities reported their successes in applying for funding through various governmental funding programmes, Austrian universities felt that adequate funding was the crucial element missing in increasing what they can feasibly contribute to the innovation system. The difficulty at present is finding external partners, considering industry have reduced funding available given the current economic situation. However, universities desperately need to find third party sources of funding, as public funds are not adequate to cover the various capital requirements of today's entrepreneurial university This includes, increasing staff in order to secure further funding; match funding projects with industry; and increasing basic infrastructure, which in its current state limits the amount of diversified funds the university can acquire. Importantly in both country cases, universities reported the importance of public funding to maintain power within collaborative relationships in order to steer developments. However, due to restrictions in funding, private funding is critical to fund research teaching in the case of the Medical University in Austria. Therefore government are still a very important actor in easing contribution processes, whether by designing more favourable legal policies, or through directing finance to projects pivotal for long-term development of universities within the system. Nevertheless, resource diversification is an indispensable supplement to the government budget, which is badly needed to help universities fulfil their core missions, reflecting findings of Koryakina, Teixeira, and Sarrico, (2012) in the case of Portuguese universities.

Nevertheless, aside from these institutional changes both internally within universities and externally within the innovation system, recognition must also be given to the various cultures present within these respective spheres. Culture has a major role to play in the level of entrepreneurial performance academics engage in. As such, transformation processes, particularly in Sweden paid particular attention to this element. KTH noted that the way in which university management implemented change was accepted because of excellent leadership and trust within the system. TTOs have been pivotal in all cases in trying to embed an entrepreneurial culture and change attitudes, which appear to have been particularly successful in the case of BOKU and KTH, given their universities have a tradition of

entrepreneurial activities. This suggests that careful organisational design and phased implementation of change and transformation is pivotal in conjunction with the prevailing university culture and traditional orientation. In addition, bridging academic and industrial cultures also emerged as an important factor in the success of university contribution. R2 from Karolinska Institutet suggests that staffing TTOs with more people coming from industry may be a way to bridge this gap. Again, a 'one size fits all' approach cannot be applied to all universities. However, the principles learned here can be applied sensitively to a given scenario.

In general, younger academics tend to be more enthusiastic about participating in tech-transfer activities. However, respondents noted that tech-transfer activities are not prioritised given the lack of time and staff availability for such endeavours. This seems slightly counterproductive to the freedom provided to academics to follow their own research themes. In one respect this acts as an incentive, but lack of time and funding means this can rarely be achieved, at least not in its original state. Therefore, academics have to change research projects to reflect funded themes, thus reducing the incentive somewhat. Nevertheless, it seems that collaborative activities are increasingly accepted nowadays in comparison to 10 to 15 years ago, perhaps highlighting a trajectory that is more favourable to the development of such entrepreneurial processes in universities. This was exemplified by respondents from Karolinska Institutet who noted that there is a different attitude today towards commercialisation. In addition, they noticed that the university has become more entrepreneurial over the last 10 years, with management having slightly more experience regarding entrepreneurialism compared to the past. Nevertheless, in this particular case, it was noted that entrepreneurialism is not embedded at the university, highlighting its highly variable nature, with hotspots of particular entrepreneurial academics or research groups dotted throughout the university. This is likely due to the fact that such entrepreneurial activities are not embedded within the mission and strategy of the university, and therefore, are possibly mainly driven out of interest, rather than as a collective endeavour by the whole university.

Therefore, acceptance and academic interest in participation is a major element towards success, but external innovation actors must create innovation environments which cater for the specific needs and requirements of universities, given their unique orientation to serve both public and private demands. It seems that prevailing cultures present within national systems have a major influence on the success of these dynamics. Swedish respondents noted that an entrepreneurial spirit is present in Sweden, perhaps enhanced by the open-minded, flat society that is present. Whereas, Austrian respondents felt that entrepreneurial culture was not present to a high enough degree within the Austrian system. Therefore, indicating a major barrier which is perhaps inhibiting how actors and mechanisms function, and in turn encouraging what level of university contribution is achieved. Nevertheless, as exemplified in the Swedish case, this is dependent on having change makers within the system, who can impact governmental levels so that change can actually permeate throughout the system. However, for this to happen, these champions must be identified and provided with support (Gibb and Hannon, 2006). Apart from one or two examples, it seems support is directed towards programmes, rather than those who can actually drive change.

In the Swedish context, the funding and policy environment is also very influential on the transformation of universities, as well as industrial collaboration. Nevertheless, the traditional orientation of the university had a strong bearing on the time taken to implement change, with KTH reporting much faster transformation compared to the Kaorlinska Institutet. Nevertheless, visionary university leadership, and a government initiative to create Innovation Offices within selected universities had a positive influence on the professionalisation of universities. Nevertheless, universities still suffer restricted autonomy, highlighting that the legal system is a major inhibitor towards increased university contribution at present. Despite this, universities are overcoming this particular restriction through participation in platforms such as SciLifeLab, which has been reported as an extremely positive development for engaging universities within the innovation system. Nevertheless, all Swedish university respondents noted the need for more multi- or cross-disciplinary departments, in order to become more entrepreneurial and create new innovations which will subsequently feed into applied research endeavours. The need for further basic research support was evident in the opinions of respondents from both country cases, showing the need to understand its crucial relationship to subsequent applied research. A major factor inhibiting this process is the lack of infrastructure for inter-disciplinary working, yet it seems such inter-disciplinarity is still happening to a certain extent. However, it appeared that the structure and organisation of the university had an impact on how research activities took place. In the case of Karolinska Institutet, it was deemed that the hierarchical university structure was detrimental to discovery, given it limited what people could do.

Therefore, increased freedom and individuality of academics (as opposed to being strictly assigned to a certain area of research or department) was perceived as a way to encourage interaction and collaboration.

Regarding collaboration with various actors in the innovation system, an important issue that came to light in all cases was the realisation that cooperation needs time and money. In addition, requires a longer-term investment, particularly given the time-lag in the outcome of TTOs, and the time needed for trust building between actors. Therefore, Competence Centres have emerged as an excellent tool praised by each side of the innovation system, proving that such platforms create an excellent innovation environment. However, it appears that academics personal network and relationships with external actors is pivotal for making collaborations, which highlights that academic entrepreneurs are still incredibly important within both country cases. These long-term connections seem to provide a relatively informal mechanism whereby trust and expertise has been built over time, thus impacting university contribution positively. Nevertheless, (Leydesdorff and Van den Besselaar, 1994) noted that chaotic behaviour takes place when two or more spheres of the Triple Helix interact. This was exemplified by R2 (Karolinska Institutet) who noted that during such interactions within the innovation system, inertia increases in such complex collaborations, and therefore found that people do not stick to collaborations. Therefore, to increase its success, the respondent noted that there is a need for clearer collaborative formats and appropriate leadership structures. It seems simplification and flexibility are key, particularly with regard to current complex application processes. This is particularly relevant in the case of European funded projects where collaborators tend to transcend national borders, thus increasing complexity due to time and space.

Across all case universities, a tendency was noted to go for standard sources of funding, mainly through government funded mechanisms, or direct collaboration with industry. Despite this, all respondents noted that there was a need to increase philanthropic sources within the system, which has been exemplified in the Swedish case. In this case, major basic research projects are underway, and subsequently stimulating further applied research around the periphery of the universities in Stockholm. Nevertheless, R1 (KTH) felt that too much competition existed in the region, and that there was a need for more collaboration. This reflects the Austrian system to a certain extent, given each region or Federal State is competing with each other. This suggests that government can take active measures to create efficiencies and bring together actors to avoid duplication in the system, and thus increase regional engagement. Therefore, it is important to enhance the linkages between regional and national systems in order to reduce conflict between strategies, goals, and ultimate competitiveness (ESMU, 2012). In addition, universities noted that aside from their need for an increase in basic funding, that it should be accompanied with further support, autonomy and freedom for universities to decide themselves how to utilise funds, with similar findings made at Portuguese universities (Koryakina, Teixeira, and Sarrico, 2012). Therefore, it seems striking an appropriate balance is paramount to improve relations between the governance and academic nodes, and hinges greatly on the level of trust between these nodes.

From a comparative perspective, the traditional orientation and level of entrepreneurial activity that took place at universities had a huge bearing on contribution processes. In addition, the flexibility of having a mixture of top-down and bottom-up approaches appears to also stimulate more interaction and contribution. Nevertheless, prevailing policies and institutional frameworks impact the potential for university contribution. However, it is clear that reductions in basic funding are steering universities towards achieving funds through various mechanisms, and through collaborations with a variety of actors. Therefore, professionalisation through organisational, structural, and procedural developments has been pivotal to ease the contribution processes of all universities. As such, transformations are not only designed to accommodate and improve interaction, but it seems universities are aiming to maximise their capacity for innovation, but are restricted by available funding and infrastructure to do so. Interestingly, Austrian universities don't see the pressing need for structural reform for the sake of responding to changing funding streams. This analysis could be overshadowed by the fact that the 2002 University Act forced change in organisational structure and professionalisation of the sector for the last 10 years. In comparison, Swedish Universities see the fundamental importance of creating such structural changes. However, the lack of autonomy granted to universities is perceived as an inhibitor to further technology-transfer. Analysing this against the observations of external innovation actors reveals that they see a need for universities to have appropriate professional structures in place, given each university has different methods and ways of doing things, and numerous different types of contact persons, which adds great complexity for creating potential collaborations. In addition, the importance of knowledge transfer was also highlighted

as a pivotal factor for the progression and creation of partnerships. However it was noted that there is a need for internal structures and processes so that internal university staff know the research endeavours being undertaken, and for external actors to be able to find research outputs easily, and know what areas of research are taking place and planned for the future, as at present, this particular linkage is difficult to make, and has fundamental knock-on effects on innovation system interactions. It also appears that evolving cultures have had a positive impact on contribution processes, although to differing degrees between country cases, which is likely due to prevailing national cultures, and traditional orientations of given universities. Therefore, there is evidence for the proposition formulated in Chapter 1, as it seems greater synergies between actors and the designing of mechanisms does ease the interaction and contribution processes of universities within the innovation system. Nevertheless, university transformation, although influenced by external actors and mechanisms, is a key process in order to also ease contribution processes, thus suggesting symbiotic action is needed in this case. However, further investigation is required to explore the impact differing institutional framework models could potentially have on these processes, in order to find a contextual fit for future development within national and regional innovation systems.

CHAPTER 6: CONCLUSIONS

6.1 Main Research Question

How do prevailing National and Regional Innovation Systems affect university contribution, and transformation towards building an Entrepreneurial University?

After investigation, it appears that prevailing innovation systems and their overarching institutional frameworks affect the level of university contribution. This echoes and extends Hoareau, Ritzen and Marconi's (2012) finding that political systems may influence performance of their public policies. Interestingly, the regional dimension of innovation did not have as much impact as the overarching national dimension. This is due to the fact that many mechanisms and policies are rolled out at national level. Nevertheless, it was clear that the regional dimension came into effect concerning actors and small proportions of regional funding which are targeted towards the Life Sciences sector. This reflects findings by Davey et al. (2009) who found that regional strategies play to key strengths of a region. Yet in the Swedish case, it was clear that the national system prevailed, with only regional competition being highlighted as a detrimental factor to development. However in the Austrian case, it seemed that regional dynamics played a stronger role, as Federal States seem autonomous in their activities, and very much disconnected. This disconnection also echoed in the governance of the innovation system, with knowledge triangulation policies still quite disconnected in their orientation (European Commission, Erawatch, 2014i). The structure of the system definitely echoes the principles of the National System of Innovation (Lundvall, 1992). Nevertheless, the system seems quite hierarchical and disconnected, and could potentially learn from Sweden in this case, given Lundvall et al. (2011) pointed out that intra-organisational interaction is necessary, as hierarchical modes of organising can create barriers. As such, the Triple Helix approach prevails in Sweden, which is possibly aided by the flat structure present in the country, as well as the types of funding programmes and various mechanisms in place to stimulate collaboration between different nodes. This reflects Lundvall's (2005) finding that historical and local contexts affect the extent to which innovation will take place. Therefore, focusing on the system dimension, rather than solely on STI policy creates greater connections which are contextually relevant to the case country's economic, political, and cultural traditions (Lundvall, 2005; Ramstad, 2009). However, much work still has to be done given closer inspection revealed that transfer of funding between sectors does not take place to a large extent (European Commission, Erawatch, 2014m). This particular anomaly requires further analysis to determine why.

In both country cases, government (or its associated agencies in Swedish case), appear to have a fundamental impact on how universities are transforming. This can be attributed to policy changes (in the Austrian case) whereby further autonomy has been granted to universities as a means to enable them to professionalise and secure diversified sources of funding from elsewhere in the innovation system. It can also be attributed to various short-, mid-, and long-term funding projects (in both country cases), whereby universities are being steered towards priority thematic areas, and to also collaborate with other actors in the innovation system, given the rules and regulations of acquiring such funding. Nevertheless, the disciplinary focus and traditional orientation of each university case reflected its level of entrepreneurial activities and transformation. Both BOKU and KTH Royal Institute of Technology have had close links with industry for several decades, and this reflected in the structural and organisational transformation that has taken place over time, and the generally positive attitudes of academics towards contributing to the innovation system. Therefore, although bridging organisations are vital to connect actors, and industry are incredibly important in collaborating with universities, it seems government plays a pivotal role in creating the appropriate entrepreneurial innovation environment whereby universities have enough autonomy and resources to contribute efficiently, whilst also maintaining their core missions.

In particular, the University Act 2002 and uni:invent programme have played pivotal roles in the Austrian system for the entrepreneurial transformation of universities. Although Swedish universities feel restricted in their autonomy, they have also benefited from targeted funding for the development of Innovation Offices. This particular infrastructural development has been a positive development to bridge university commercialisation in the innovation system. Competence Centres have also been highlighted in both cases as being pivotal, considering the unique innovation environment and platform it provides. Its long-term orientation also enables trust building, which has been noted as a fundamental element in university collaboration processes. In addition, government funding programmes in both

country cases has been noted as being particularly important in order to increase funding allocations to universities. Nevertheless, government need to provide more risk capital to bridge the gap created by the low number of venture capitalists, given current institutional frameworks and prevailing cultures are still in their infancy in this regard in both country cases. From the university perspective, having support from university management, and inclusion of entrepreneurial activities within strategy documents and development plans of a university, seems to promote successful transformation, given entrepreneurialism permeates throughout the system as a result. Other important mechanisms such as IP policies and the Professor's Privilege have also highlighted that elements from these mechanisms could potentially be adopted into systems to ensure transparent collaboration, and also incentivise academics to collaborate.

Nevertheless, a number of barriers were highlighted which were common to both innovation systems under analysis. A lack of funding was the main barrier, highlighting that targeted funding could reduce current bottlenecks in the system. Areas requiring attention include the need for higher levels of basic university funding from government, in order for universities to be able to match fund industry projects and maintain their independence in such collaborations. Higher allocations of risk capital is also missing within the system, requiring government to bridge the current 'Valley of Death'. In addition, further funding is required to improve and increase infrastructure within universities, and enable the recruitment of further human resources for TTOs, given the current situation is limiting its collaboration volume potential, thus capping its income potential. This reflects Koryakina, Teixeira, and Sarrico (2012) who noted that there is a need for appropriate infrastructure to support emerging third mission activities. From a structural and organisational perspective, external innovation actors noted difficulties relating to the variety of university structures present, thus requiring varying individual approaches. Further, the vast number of people external innovation actors need to know within universities also increases the time taken to form collaborations, which adds complexity to creating collaborations. In addition, bottlenecks exist regarding knowledge transfer internally within universities and what is made available externally to innovation actors. This requires the design and utilisation of knowledge management systems in order to avoid duplication of research, enable greater transparency of projects, and create efficiencies in the distribution and development of knowledge for commercialisation. However, it seems tensions exist within universities between operating a professional business model and performing the core traditional functions of the university, which stems from limitations in time, funding, and in some cases, academic cultures present within universities, and their subsequent resulting engagement in commercialisation activities. Care must be taken to overcome this hurdle, given conflict between academics and administrators within universities can inhibit transformation and development (Martinelli, Meyer and von Tunzelmann (2008). Culture plays an incredibly important role within such processes, both within universities and in the broader innovation system, and it was found that differing cultures between nodes also created tensions during collaboration. Therefore, this requires a balanced approach, taking into account structural, organisational, and cultural bottlenecks simultaneously.

It is also important to align these barriers identified at the micro level, with those highlighted at the macro level. In the Austrian case, the prevailing bureaucratic structure, and perceived lack of a clear strategy and goals, and indeed varying goals and strategies between actors, was considered a major inhibitor for development within the system. In the case of the Life Sciences sector, the complicated situation regarding the healthcare system was also identified as an inhibitor. Despite its proximity to universities, its governance structure currently creates a major barrier for the uptake of innovations flowing from universities and the innovation system. However, this particular issue goes beyond the scope of the project. In the Swedish case, it was clear that a differing governance system was in place, with much more control afforded to the associated agencies. However, the legal system was perceived as a barrier given rules and regulations associated with basic university funding. Despite this, the Swedish respondents felt happier with the level of basic funding received. Nevertheless, both country case representatives noted that the academic emphasis on producing publications rather than number of commercialisations has great impact on output, reflecting similar tensions found by Martinelli, Meyer, and von Tunzelmann (2008). This can be attributed to the traditional tenure system in place, which also impacts the mobility of researchers between industry and academia, particularly later in their careers. Therefore, this requires attention at system level, in order to create balance and overcome issues between public and private knowledge. Returning to the issues of culture, it appears that a culture for innovation and entrepreneurialism prevails in Sweden, which could indicate why, despite their identified bottlenecks, they are still

categorised as an Innovation Leader. It would be interesting to delve further into their differing governance structure, to understand how applicable this system may be in other country cases such as Austria.

A number of enablers were also identified in both country cases, with Competence Centres identified as an excellent long-term initiative, providing a much needed platform where trust building could take place. In addition, expanding the development periphery of universities through the addition of TTOs has also been hailed as a successful development for easing the collaboration and contribution processes of universities within the innovation system. This is likely due to the professionalisation of the system, and the increased visibility of this interface, whereby external actors can interact and collaborate more easily. However, it should be noted that presence of the TTO alone is not enough, and requires a commitment from leadership, and appropriate processes, functions, and IP policies in order for it to be successful. Elements of the Professor's Privilege, a highly debated issue within the study, could potentially yield good results if adopted carefully within a university system. Pressures on academics and their general orientation towards the core missions of teaching and research, tends to reduce the efforts directed towards commercialisation. Nevertheless, balance is required when considering to incentivise commercialisation, given its potential detrimental impact on these aforementioned core functions. As such, additional human resources could potentially alleviate such burdens, and thus requires complex strategic solutions to overcome this issue.

It appears that all actors play a role in easing university contribution to the innovation system, however government plays an elevated role due to developments in national and EU strategy documents, their allocation of funding through various mechanisms, and changes made to legislation (e.g. University Act 2002 in Austria). Targeted funding towards the development of TTOs in both cases has enabled universities to professionalise their organisation and functions in response to the innovation system. The most successful transformation cases included those where entrepreneurial activities were embedded within the mission and the strategy of the university, and considered as day-to-day activities. Therefore, this incorporates the same importance placed on the other core missions of the university, echoing the University of Waterloo's approach towards promoting entrepreneurialism throughout its vision and mission statements, as a means to serve as an institutional enabler of entrepreneurial culture within their institution (Bramwell and Wolfe, 2008). Nevertheless, the traditional orientation of the university plays a strong bearing on how well it can interact and contribute to the innovation system, with the Life Sciences area considered a strength in this respect. It was also noted that the formation of broader schools within universities went some way towards creating conducive environments for collaborative activity. Nevertheless, the creation of unstructured platforms through internal clustering seemed to be a successful addition in the aim towards creating cross-disciplinary environments- an area many respondents felt was underdeveloped and underutilised. However, due to the lack of funding available within the system, universities have to take strategic decisions regarding which IP is pursued, and as such identification of niche markets has been a pivotal strategy to deal with lack of funding, but place focus on key strengths of universities. Therefore, it is apparent that it is not only actors and mechanisms in the system that eases university contribution, but also universities themselves through transformation and professionalisation. However, successful transformation needs incremental change over a considerable period of time (Clark, 1998), which appears evident, particularly in the case of BOKU and KTH Institute of Technology. In addition, a mixture of structured and unstructured transformations appears to be conducive to the entrepreneurial development of universities, and subsequently, their contribution potential. This could be due to the fact that structured transformation provides a visual organised and professional model which is clearly understood by external actors, and can be managed in terms of day-to-day functions, and financial health. Whereas the unstructured approach to platforms and academic networks utilises the flexibility, freedom, and individual characteristics of research disciplines and the people carrying out the work. Therefore, this highlights the symbiotic nature of solutions required between universities and external actors to increase growth of the innovation system, through creation of a dual structure. Nevertheless, given the high complexity present, simplification is imperative to ease collaboration processes through reducing bureaucracy, and attempting to control chaotic behaviour that can take place when two or more nodes collaborate. This could be further eased through reducing competition in the system and increasing collaboration to create efficiencies.

From a comparative perspective, the life sciences are a very important sector economically in both the Stockholm and Vienna regions. Governmental strategies in both regions pay attention to this area, with funding programmes specifically designed to target continued growth in this area. As such, it is evident that bridging organisations have

emerged to try to ease and enhance collaborations within this sector in both regions. However, coordination of players is still currently a problem, particularly in the Austrian system. In addition, the differing organisational structures present at universities is impacting the speed at which collaborations can take place, given the complex nature of interactions between differing business models of universities and industry. Within the Vienna region, available funding is directed towards specific programmes, with the grand challenges at European level having some impact in steering how research funding is allocated. Similar findings were made in the Swedish case whereby European and international funding was of great importance. The level of available funding in Austria seems conservative in comparison to Sweden's approach, given Austria tends to direct funds towards specific areas for limited periods of time; whereas in the Swedish case, massive investment has been directed towards the sector for its long term development and growth (given the demise of Astrazeneca, an important industry player). This is evident in the fact that infrastructure is being developed for sector revitalisation, and the stimulation of new generation companies. Nevertheless, Austria is not far behind in this respect, considering current and up-coming efforts include programmes designed to develop infrastructure, as well as the development of cluster management (European Commission, Erawatch, 2014k: European Commission, Erawatch, 2014f). In addition, within both cases, the development of excellence centres has helped to provide a platform to bridge academia and industry, with initiatives including the Christian Doppler Laboratories in Austria, and SciLifeLab in Sweden. Sources of funding revealed the greatest difference between cases, given the perception that funding was relatively good in Sweden, with the presence of philanthropic sources of funding for basic research, which appears to be a relatively new phenomenon in the country. However, the Austrian case revealed that funding was inadequate, given industry currently do not have much spare capital to invest in collaborations. The "Valley of Death" is the main problem facing both Austria and Sweden, highlighting that work is required to ease this current inhibiting bottleneck within each system. Comparatively, each regional sector is unique in its contextual approaches and challenges, however, it seems that Sweden is slightly ahead of Austria with regard to strategizing and realising efforts from political level down to local level. Therefore, Austria must consider how best to ease bottlenecks and target funds for the long-term development of the sector, in order to create stronger competitive advantage at an international level.

The comparative analysis of the case universities highlights that all universities are becoming increasingly professionalised and entrepreneurial, although this is taking place at differing levels and time scales. The medical universities appear to be more traditional in culture and structure, particularly in the Swedish case. However, this is changing, as pockets of academic entrepreneurs are increasingly participating in collaborations and technology-transfer activities. Nevertheless, it was highly noticeable that both KTH Royal Institute of Technology and BOKU are much more entrepreneurial, and also have a longer history of development in this respect. Additionally, a culture for entrepreneurial activities was strong in both institutions. This may be attributed to the fact that entrepreneurialism was given greater emphasis within the mission and strategy of these universities in comparison to the medical universities, with buy-in from top management clearly evident in the long-term planning for collaborations, particularly in the case of KTH Royal Institute of Technology. The analysis suggests that the creation of flexible structures such as platforms that allow for cross-pollination of research areas, knowledge transfer within universities, and more flexible responses to the external environment, have greater success when collaborating within the innovation system. In addition, a mix of top-down and bottom-up approaches appear to have been successful at KTH Royal Institute of Technology, with structural change most successful in this case. This could be attributed to the fact that decentralisation has taken place to certain extent, with the implementation of professional groups functioning well to communicate issues between academics and management. However, transformation must be well designed and prove to academics that the given change is good, and will be successful, in order to stimulate much needed buy-in from academics (who then create the change within the institution).

A commonality of all university cases was the increasingly diversified funding base and enlargement of the development periphery as a response to the changing funding landscape in which universities operate. As such, each university interacts with various government mechanisms, whether through research funding, or other programmes to stimulate collaboration with industry. The implementation of technology-transfer offices have been a welcome addition in all cases, despite not being a profitable entity. There is a realisation that there is a need for the right structures and processes for collaboration, and it appears universities are tackling IP policy issues internally in order to ease collaboration with industry and make activities more transparent for academics. This has been crucial within the

Swedish system given the Professor's Privilege creates complexities regarding ownership and commercialisation of innovations. Overall, it appears similar barriers exist for universities in both regions, which suggests that these are national system level anomalies. Therefore, there is a need for structural easing, particularly regarding autonomy in the Swedish system. Additional funds are also required, particularly in the Austrian system, in order to give universities more flexibility and power, and also bridge current funding gaps. Importantly, there is a need to move away from traditional publication based recognition in universities in order to further enhance cross-disciplinary working, and enable easier movement of academics to industry. It is clear that entrepreneurial change is catalysed by academic entrepreneurs, particularly champions who start the ball rolling and drive activities to stimulate institutional and systemic change. It also appears that change is heavily dependent on context, time and space, given reports within the Swedish case that institutional culture is better now, and less resistance exists with regard to collaborations. This is evident in the success of Centres of Excellence. Despite this, even the most entrepreneurial universities reported that commercialisation is not a natural part of what researchers do, and therefore, university managers must consider this within the remit of their strategizing and implementation of programmes in order to create a stimulus and environment in which academics can embrace third mission activities in their entirety. It must become part of day-to-day activities if entrepreneurialism is to become embedded.

Comparing national and regional innovation systems, the national system predominates in both country cases; however, some regional differences occur, particularly in Austria, where federal regions appear quite autonomous in their strategies and approaches. In this case, Austria has afforded more autonomy to its university system in comparison to Sweden, which has enabled universities to take more decisions, and professionalise accordingly. This particular move would be beneficial in the Swedish system to increase the scale at which universities can make decisions regarding infrastructure and the financing of technology-transfer activities. It is apparent that the institutional and cultural landscape is quite different between the country cases. Importantly, approaches towards funding, and sources of funding are more attractive in the Swedish case, given sizable long-term governmental investments and the presence of philanthropic funding possibilities. In addition, a culture of innovation and entrepreneurialism seems stronger within the Swedish case. Interestingly, the governance structure in Sweden is quite different to that in Austria, with governmental agencies having greater power and autonomy to interpret strategies and distribute funding. Despite disconnections, fragmentation and disjointed structural problems in each case country, the clarity and focus of innovation strategies appears stronger in Sweden. Nevertheless, both regions, and indeed countries, face similar issues, including the gap in funding known as the "Valley of Death", which is ultimately causing a gap in innovations within the system. Weak links also exist between academia and industry generally, despite some universities having elevated success in this area. It will be interesting to track the progress of the current large targeted financial investment in Sweden, especially given governments there have identified the importance of investing in infrastructure and research in a centralised way in order to get more out of capital expenditure in research and development. As such, timing of investments and targeting towards pivotal areas seems to have been what has led to greater success in the Swedish case, given investment in the life sciences, for example, has been identified as an area for building long-term competitiveness. The development of incubators clusters and bridging organisations seems strong in Sweden, although Austria is also making good progress in this respect, with various Centres of Excellence and bridging organisations such as LISA Vienna easing collaboration processes.

Following Triple Helix theory, it seems governments are aware of the importance of connecting the nodes between academia, industry and government; however existing National Innovation Systems and their prevailing institutional frameworks dictate the complexities of enabling these connections to be made. This highlights the need to consider how prevailing governing structures and legislative frameworks are impacting innovation system dynamics. This is particularly evident in the Austrian case where the Ministry of Finance controls allocation of finances, despite being disconnected to the Ministries formulating policies within the realm of R&D and university reform ((European Commission, Erawatch, 2014c). This is further exacerbated by the fact that education policy is not fully integrated in knowledge triangle within Austria at present (European Commission, Erawatch, 2014i), thus creating the need for more joined up thinking. Fragmentation also exists within the Swedish case, given public and private R&D systems are separate in Sweden, with universities carrying out most public R&D (European Commission, Erawatch, 2014n: European Commission, Erawatch, 2014t). Nevertheless, governmental programmes aim to encourage public private partnerships, and greater efforts are being made in the Swedish innovation system to involve universities. However, at

present, it seems too much competition exists between regions, which create an environment that restricts collaborative activities. Each country case has individual elements which are outperforming the other, yet Sweden appears to be slightly ahead of Austria, due to governments being more supportive of R&D in Sweden in comparison. Both countries are actively designing programmes and projects to stimulate collaboration; however one main lesson arising from this comparative study is the need for more funding and infrastructure for strategizing for long-term competitiveness and growth. Importantly, there is a need for more governmental support for universities and technology-transfer, and an increasing need to invest in basic research in order to maintain a successful innovation system. Therefore, increasing university autonomy, and creating opportunities for structural easing within prevailing institutional structures at system level should provide a framework upon which innovation can flourish from a practical system perspective. However, it appears that culture plays an incredibly important role, considering people are the main drivers towards change. Therefore, the presence of flat societies and hierarchies appears to foster the development of an entrepreneurial culture that becomes embedded within innovation systems, which is in stark contrast to more traditional hierarchical systems. As such, finding a balance between structural easing and cultural hierarchical structure at university level, regional level, and national level, could help to create changes that enable Austria to transition from being an Innovation Follower towards becoming an Innovation Leader, as Sweden successfully demonstrates.

Overall, comparing systems, it is clear that convergence in approaches are taking place, however it seems a leap is required in order to embrace new ideas and nodes of thinking, thus requiring further flexibility and openness within the system. Nevertheless, availability of funding is the core problem to overcome in this mission. In addition, the culture and ideology to adopt new ways of doing things is necessary. Interestingly, within the Austrian system adopting mechanisms such as tax incentives and further autonomy are elements that the Swedish system recognises it requires. Nevertheless, the structure and governance of such systems are starkly different, which may begin to shed light on why perhaps Sweden is an Innovation Leader. However, this seems strongly connected to prevailing cultures which tie closely with the institutional framework in place. Nevertheless, it is clear both systems are not without their challenges. Of most significance was the finding that structure of university systems is perhaps not as important at first glance as actual processes and cultures present. However, upon closer inspection, it seems structure has an important role to play in providing the physical infrastructure to complement an institutional framework upon which such processes can take place. Drilling down into the problem areas highlighted, it is clear that the overarching NIS and institutional framework influences how innovation will take place. In turn, this has influenced how universities respond, perhaps more reactively in the case of Austria. As such, prevailing culture has a major role to play both inside universities, and within the broader innovation system.

This study has gone some way to bring observations regarding university contribution and transformation from both sides of the innovation system, thus extending current literature by bringing the observations of various nodes together in one place. This has important implications for policy, given the findings not only highlight bottlenecks within the system, but highlight perceived issues from each actor collaborating with universities, and vice-versa. Therefore, it is anticipated that this study has pinpointed areas where future policy design can have significant impact for the growth of the innovation system, and the efficient development and contribution of universities. Therefore it is suggested that more inclusively designed studies are carried out in future to capture the collective thoughts of various actors for cross-analysis. Various issues have been raised within this study, requiring deeper analysis at individual topic level. Therefore, these two approaches towards research analysis have potential to provide practical insights for future development.

6.2 Policy Implications

Like a rubrics cube or complex drainage system, it can be difficult to find a blockage or create conducive alignment. This study goes some way towards exploring this phenomenon, and it is clear that universities have the potential to contribute significantly to the innovation system. This study has exposed a number of barriers and enablers at the junction of collaboration. Therefore, the following conclusions and implications may be interesting for policy makers and university managers in both Austria and Sweden. Generic conclusions applicable to both country contexts will be

discussed first, then unique country specific implications for Austria and Sweden will be highlighted, before drawing lessons for policy design at university and governmental level.

In both country cases, funding has been highlighted as a key bottleneck for transformation and contribution of universities to the innovation system. Availability of infrastructure is restricting the amount of collaboration that can feasibly take place, thus limiting the amount of diversified funds universities can realistically acquire. Therefore, government need to understand that targeting funding to this aim would create a positive investment for the future, enabling universities to source funds elsewhere in the system, thus potentially reducing their level of dependency on public funds. The "Valley of Death" has been pinpointed as a major inhibitor towards commercialisation of research. Therefore, targeted government funding is required to provide risk capital that is currently extremely sparse within both country cases. This should help to transform more research into products and services for the market, which is noted as lacking at present (The North Sea Region Programme Secretariat, 2013. p.5). It should also increase the returns on public investment, given too many projects have to be killed off because of lack of funding to continue their development. At present, there is also too much competition within the system, requiring strategic measures to promote collaboration. Therefore, greater alignment between regions and federal states will not only create efficiencies, but ensure knowledge transfer permeates throughout the system, thus raising innovation potential nationally, rather than within specific hotspots. In addition, the need to target more funds towards basic research was also highlighted by actors, given a lack in basic research will ultimately restrict the amount of applied research that can be carried out, thus stunting the research system. This reflects Allinson's (University Industry Innovation Network, 2013) finding that funding mechanisms has reduced time and funds for the pursuit of new knowledge. Therefore, this appears to be a common problem beyond the case countries under analysis.

Another commonality to both country cases is that the traditional orientation and structure of universities varies greatly, which slows the process of collaboration due to bureaucracy, difficulties in identifying the right people to contact, and a lack of visibility regarding how business negotiations should take place with universities. Funding through various mechanisms has seen the implementation of TTOs which has enhanced the interface between universities and the innovation system. However, more needs to be done to enhance the business models of universities in order to further professionalise university operations, particularly with regard to management of collaborations, so that universities are able to operate more entrepreneurially, and thus enhance and extend the third mission activities in which they are involved. This includes the need for further infrastructure and human resources, which has the potential to increase commercialisation activities. Various issues were also exposed regarding the successful implementation of university transformation. Embedding entrepreneurialism within the mission and strategy of the university is imperative. In addition, strong leadership, and development of trust within the system is needed to get academics on board. Pressures to service the core missions of the university, as well as third mission activities, is facing major limitations due to available time and funding. Therefore, university managers must design solutions which are contextually sensitive to the prevailing organisational, structural and cultural environment present. The case studies analysed within this study go some way to illustrate successful methods and challenges which could be useful for benchmarking purposes.

Platforms such as the Competence Centres have been highlighted as a positive addition to both country cases' innovation systems, given their long-term orientation and capacity to enable trust building between actors. Davey et al. (2009) also maintain that sustainable high-level commitment is required, not only with respect to funding models (found in Koryakina, Teixeira, and Sarrico's (2012) study), but also softer aspects such as communication, motivation and time horizons of stakeholders in order to promote collaboration between actors. It is suggested that further funding is directed to support longer-term endeavours in conjunction with mechanisms designed to deliver results in the short to mid-term. Providing greater synergies and connections between policy areas could potentially enable the fruitful design of complementary mechanisms which will not only provide efficiencies, but deliver intended results. Nevertheless, knowledge transfer systems are needed within universities, and externally to communicate research endeavours with other innovation actors. Such a system could speed up the development of research by reducing duplication in the system and aligning interested industry partners with appropriate research groups for collaboration.

Significantly, two particularly unique country specific implications were also highlighted during the study. In the Austrian case it is clear that disconnection exists within knowledge triangle policies (European Commission, Erawatch, 2014i), which echoes findings by FarHorizon (2010) and the Austrian Council (2009), as even after 5 years, work still needs to be done. Therefore greater alignment in policies could potentially enhance output of the system. However, culture plays a pivotal role, and mechanisms must take account of current prevailing cultures, and strategically design systems which will promote entrepreneurial activity. In the Swedish case, further autonomy should be afforded to universities in order to overcome legal barriers pertaining to the funding of commercialisation. By providing an appropriate regulatory environment, universities will increase their performance if they are empowered to do so (Hoareau, Ritzen and Marconi, 2012).

Overall, adoption of the aforementioned suggestions should aid the design of a more flexible system incorporating synergies and mechanisms to encourage collaboration and knowledge transfer, which should ultimately lead to economic growth, and may help to overcome the European Paradox (European Commission, 2007). However, ignoring these structural issues, particularly regarding targeted funding and development of infrastructure, will ultimately stall developments within each given system. This could potentially have lasting consequences on innovation and national competitiveness as a result, if private funding does not increase to meet the shortfall (Hoareau, Ritzen and Marconi, 2012). Therefore, funding endeavours must be regarded as a long-term investment to the system, in order to reap the benefits of economic growth, and create efficiencies within the system. This study has highlighted the importance of including all actors and being sensitive to their needs, as well as having a well-functioning and stimulating enabling environment, which has been proven to be heavily influenced by the prevailing institutional framework and innovation system. Therefore, improving interactions and providing a conducive environment increases the chances of innovative activity and potential economic development, which is imperative to try to improve return on public investment. However, it is also important to balance competing objectives within the system and within universities, given the varying missions universities are expected to carry out. Therefore, this study has enabled a snapshot of how this has impacted university transformation towards becoming more entrepreneurial, and where actors collectively see bottlenecks, which, if addressed, would ultimately increase university interaction and contribution to their respective innovation systems.

These lessons can be utilised in both country contexts to redesign policies and initiatives to be conducive to universities and the wider system, in order to create greater returns, and protect and maintain the core mission of universities. Understanding the role of proximity at regional, national and international level, both geographically and culturally may be useful in order to further develop technopoles (Doloreux, 2002) such as Competence Centres, to encourage interactions and cross-pollination of knowledge between actors, and further enhance activity in both country contexts. In addition, universities can benchmark and find solutions to meet the range of demands placed upon them. Importantly, governments need to provide funding and policies that provide a supportive mechanism promoting university interaction and contribution (through technology-transfer), rather than a restraint or bolt on requirement. Taking account of the lessons learned in this study may go some way to help Austria in its endeavour to become an Innovation Leader, and help Sweden to further elevate its activity. In a globalised and competitive world, now is the time to address these challenges in order to remain competitive and ensure these innovation systems and universities continue to develop, considering university technology-transfer is underutilised in many countries within Europe (IKTIMED, 2013).

6.3 Limitations

Recruiting participants for the study was difficult, and impacted severely upon the timeline of the project. As such, the low number of respondents (17 in total) reduces the generalizability of the results. The study would have benefited greatly if more representatives from university management had been available for interview. However, it was difficult to recruit such busy individuals. A future study would also benefit from recruiting university managers dealing not only with research, but also finance, strategy, and general management, given this level has the most power to instigate transformation processes and negotiate with external stakeholders. Nevertheless, candidates representing university deans, professors, researchers, and technology-transfer managers gave a unique insight into the impact of external innovation system influences on university transformation, and their daily experiences working in such an environment.

Interestingly, university culture was a recurring theme, despite the focus of the study centring upon transformational change particularly relating to organisational and structural change. This highlights the importance of employing soft approaches when implementing organisational change, given staff are the people who implement changes on the ground within this people-oriented organisation that is a university. Therefore, should this particular study be carried out again in a new geographical context, it would greatly benefit from the recruitment of a higher number of participants, from identified roles within the system. Despite this, the fact that respondents provided similar observations increases the impact of the results gathered. Nevertheless, in hindsight, it would have been useful to concentrate on less elements, given the sheer volume of information gathered during the process. However, the orientation of the project made this particular endeavour difficult, requiring an understanding of actors, mechanisms, and organisational barriers and enablers, in order to better understand university transformation and contribution. Perhaps in future, a carefully designed online survey would enable a larger sample to be targeted, although interviewing key people within the system is advised, given the value of this data capture method.

6.4 Areas for Future Research

During the course of the study, several areas were identified requiring further research. It would be useful to carry out this study in more depth, including more participants, across other European countries. Considering the EU wish to solve the European Paradox, further insights at the interface between universities and other innovation actors may highlight whether similar bottlenecks exist in other country cases. This would enable better targeting of EU funds in order to service the aims and objectives of Innovation Union, in order to aid competitiveness and functionality of the system. It would also be beneficial to carry out a targeted study specifically on the bottlenecks highlighted within this study in order to look for possible solutions that could be implemented within each case country. In addition, investigating why transfer of funding between sectors is low in Sweden would be useful to determine how to improve Triple Helix interactions. The complex structure and organisation of the health system in conjunction with university hospitals requires further analysis in order to simplify the complex landscape and ease bottlenecks for innovation within the system. Also, further insights into differing governance structures are imperative to identify how influential this locus of control is. Considering Sweden places a lot of power to government agencies, and Austria has a more bureaucratic system with relatively autonomous Federal States, it would be interesting to investigate how differing institutional framework models affect output, and thus identify their adaptability and application in other systems for the benefit of innovation. This type of study would also benefit through recognition of prevailing cultures, given this has been highlighted as a key component dictating the success of mechanisms within a system, whether at micro or macro level.

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8. APPENDIX A Interview Guide - Universities

As part of the process I need to obtain your consent for participating in the study, obviously participation is voluntary and you will not be compensated for your participation. Are you happy to have your opinions included within my research project?

Are you happy to be quoted anonymously as part of the project?
Are you happy to be contacted via email should any follow-up questions arise?
All recordings will be kept confidential and destroyed after the study is complete.

Thank you very much for agreeing to participate in this project. This interview is part of my Master's thesis exploring how prevailing national and regional innovation systems affect university contribution, and transformation towards building an Entrepreneurial University. The study aims to fill the current knowledge gap which exists at the interface between universities and their prevailing innovation system. A comparative approach has been adopted, utilising the Life Sciences disciplinary area within the regions of Stockholm and Vienna. As such, actors representing universities, government, funding agencies, industry, and bridging organisations have been targeted to capture a holistic view of the situation.

Has university participation in commercial projects increased as a result of increased interaction with industry, government, and other innovation actors? Which actor is most influential? How?
Does your university actively pursue external funding opportunities?
Do you pursue these funding opportunities out of interest in the project? Or, to primarily attract funding?
Have you had to change the structure of university departments and organisational functions in order to make it easier to compete for funding?
What barriers have you found inhibit university interaction and contribution to the innovation system? (e.g. ear marked funding, legislation, disjointed policy design, and non-entrepreneurial internal structure and orientation)

Have **new structures** been constructed to maximise capacity / potential for innovation, or as a result of government policy / responding to industry?
Have **structural changes** taken place to accommodate / improve interaction? Or have these changes taken place to primarily service changing funding environments? Are approaches bottom-up or top-down?

- How does this relate to the **mission and strategy** of the university?
- Are internal incentives used to promote the success of structural change and entrepreneurial activities?
- How is the paradigm between applied contractual research and research as discovery handled?

How have developments emerged over the years towards building an **entrepreneurial university**? How do changes in the policy/funding environment influence your path?

Have new inter/**multi-disciplinary departments** been set up in response to government or industry funding? What is the reason behind this structural change?
Are you aware of **cluster** activities in the region?

- Are you involved?
- How?

Are you aware of any **trilateral networks** in operation? How does the university interact with these? Are efforts made by external bodies to involve universities in these?

- How do universities respond to such involvements? Are particular actors the driving force? Who manages the interactions? (solo efforts, departments, or embedded throughout university)

Do you have a mechanism for finding commercial opportunities within the university structure in order to link research to external markets?

- Is **technology-transfer** centrally managed? How does this work?

Has there been an organisational shift to create more **multi-disciplinary environments**?

Which changes has been more influential on structural change - government funding and programmes or industry cooperation?
What are the successes and constraints regarding management of income diversification activities?

- Do you need more autonomy?
- Do you need more government (funding) support? Where? How?

Are incentives for academics used to promote structural change?
How do academics perceive transformations towards entrepreneurial activities? Is it welcomed, or is there resistance?

8. APPENDIX B Interview Guide - Government and Funding Agencies

As part of the process I need to obtain your consent for participating in the study, obviously participation is voluntary and you will not be compensated for your participation. Are you happy to have your opinions included within my research project?

Are you happy to be quoted anonymously as part of the project?
Are you happy to be contacted via email should any follow-up questions arise?
All recordings will be kept confidential and destroyed after the study is complete.

Thank you very much for agreeing to participate in this project. This interview is part of my Master's thesis exploring how structural changes in national and regional innovation systems affect university contribution, and transformation towards building an Entrepreneurial University. The study aims to fill the current knowledge gap which exists at the interface between universities and their prevailing innovation system. A comparative approach has been adopted, utilising the Life Sciences disciplinary area within the regions of Stockholm and Vienna. As such, actors representing universities, government, funding agencies, industry, and bridging organisations have been targeted to capture a holistic view of the situation.

Are there specific initiatives designed to bring together different **actors** in the innovation system? (e.g. academia, industry, government, etc.)
How are universities encouraged to engage with actors within the innovation system (e.g. industry, government, etc.)?
Do you have initiatives / plans to support informal networks between academics and other actors e.g. industry etc.?
Are there initiatives to identify and support change agents (i.e. those who drive change) to lead sustainable change over the long term?
Do you notice increased university contribution as a result of increased interaction with industry, government and other innovation actors (e.g. trilateral networks)?

What **mechanisms** (funding, platforms, programs, regulation etc.) exist in the NIS to harness university contribution to innovation and economic development?
What legal instruments / fiscal incentives have been designed specifically to ease university interaction and contribution within innovation systems?
How is the system evaluated?

How open is the system? For example:

- Is it easy for universities to be able to take part in initiatives?
- Are there support mechanisms (such as administrative assistance, or other services / initiatives) to reduce time consuming processes associated with bureaucracy and reaching agreements for collaboration?

What kind of strategies / initiatives are designed to help universities attract funding from third party sources?
Are platforms available whereby actors (industry, academia, and government) have the opportunity to meet?
What measures are available to overcome barriers to collaboration?

- Are networks available?
- How do you stimulate social interaction and communication between potential partners?
- What are the hard and soft approaches undertaken to achieve this? For example:
  - Do you concentrate on designing concrete programmes and funding frameworks as opposed to creating initiatives between actors that will encourage trust building and leadership?
  - Are special platforms supported to enable the building of relationships between actors?
  - What support is given to universities?

What percentage of programmes are "one-off" (i.e. are not repeated in future), and what percentage are long-term (i.e. either run for a number of years, or are continued after a set period of time)?
Which is more important in the eyes of your organisation: long-term goals or short-term goals?

8. APPENDIX C Interview Guide - Industry Representatives

As part of the process I need to obtain your consent for participating in the study, obviously participation is voluntary and you will not be compensated for your participation. Are you happy to have your opinions included within my research project?

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Does anyone within your organisation specifically maintain communication with universities? Who?
Who do you maintain contact with in universities? (e.g. Individual academics? TTOs? Department Head?)
Are there any other actors who try to maintain communication and support initiatives between universities and industry?

Are there specific initiatives in place to encourage SME's and universities to collaborate?
Are there specific regulations which make collaboration difficult or easy?
Are there specific platforms in place to provide informal or formal modes of communication between universities and industry?

Have you noticed a difference in university interaction and collaboration with industry over the years?
What do you foresee as barriers towards university-industry interaction? (e.g. structural, organisational, cultural barriers)
Can you give any examples of barriers which have inhibited interaction?
What do you foresee as the enablers towards university-industry interaction? (e.g. structural, organisational, cultural enablers)
Can you give an example of enablers that have eased interaction?

Do you believe there are specific actors who are pivotal to university-industry interaction within this system? Who?
Do you believe there are specific mechanisms which are pivotal to university-industry interaction within this system? Which?
How does the current prevailing innovation system promote or inhibit interaction?
Can you suggest factors within the national and regional innovation system which could ease interaction?
Do you have an example of beneficial lessons from other regional or national contexts whereby you feel this region would benefit?

8. APPENDIX D Interview Guide - Bridging Organisations

As part of the process I need to obtain your consent for participating in the study, obviously participation is voluntary and you will not be compensated for your participation. Are you happy to have your opinions included within my research project?

Are you happy to be quoted anonymously as part of the project?
Are you happy to be contacted via email should any follow-up questions arise?
All recordings will be kept confidential and destroyed after the study is complete.

Thank you very much for agreeing to participate in this project. This interview is part of my Master's thesis exploring how structural changes in national and regional innovation systems affect university contribution, and transformation towards building an Entrepreneurial University. The study aims to fill the current knowledge gap which exists at the interface between universities and their prevailing innovation system. A comparative approach has been adopted, utilising the Life Sciences disciplinary area within the regions of Stockholm and Vienna. As such, actors representing universities, government, funding agencies, industry, and bridging organisations have been targeted to capture a holistic view of the situation.

Do you have specific initiatives to bring together different actors within the innovation system?
How do you do this?
Do you believe there are important change agents within the innovation system? Who?
Do you believe these actors have encouraged universities to become more entrepreneurial?

What mechanisms do you have to stimulate university interaction?
Do you have specific funding available for this purpose?
How does it work?

Have you identified any barriers towards interaction between universities, industry and government?
Have you identified any enablers towards interaction between universities, industry and government?
What steps are taken to improve coordination and communication between actors?
Do you provide a platform or opportunities for working groups?
Are these formal or informal?
Have you noticed a change in university interaction over the years?
What measures have universities taken in order to increase interaction and collaboration?

Do you believe there are specific actors who are pivotal to university interaction within this system? Who?
Do you believe there are specific mechanisms which are pivotal to university interaction within this system? Which?
Can you suggest areas within the national and regional innovation system which could ease university interaction?
Do you have an example of beneficial lessons from other regional or national contexts whereby you feel this region would benefit?