Research Sans Frontières?

The Effects of Funding Schemes on International Research Collaboration

A thesis submitted for the degree of Doctor of Philosophy of The Australian National University, School of Sociology, Research School of Social Sciences

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I declare that this thesis is my own original work and is in accordance with The Australian National University thesis guidelines for higher degree research.

[Signature]
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“Aishwaryam”
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Abstract

Collaborating with international researchers is particularly important for small and middle-range countries, such as Australia, that cannot source all of their science and technology needs domestically. However, a major influence on international research collaboration—national research funding councils—has largely been ignored within the literature. Past research has either taken a social constructivist approach to influences on knowledge and downplayed influences such as research councils, or examined research councils’ role in the research system, but has given little attention to their effects at the level of the researcher. Bibliometric studies dominate investigations on international research collaboration, but these cannot reveal insights into the internal dynamics of research collaborations. Consequently, little is empirically known about how funding schemes affect international research collaboration. This study bridges the gap between analysis of the sociology of science and science policy studies by contributing to a middle-range theory about the effects of institutions on international research collaboration.

Using comparative case studies, this thesis identifies the social mechanisms through which funding schemes affect international research collaboration. Researchers supported through the Australian National Health and Medical Research Council’s (NHMRC’s) major funding schemes of Program and Project grants were compared with those supported through three of this Council’s schemes specifically aimed at supporting international research collaboration; the Human Frontier Science Program grants, the International Collaborative Research Grants scheme and the NHMRC’s European (EU) Framework Programme Partnership Scheme.

Despite international research collaboration being a normal way of working, few of the conditions for the four types of international research collaboration identified in this study are supported by the NHMRC’s two major funding schemes. Health researchers in Australia are highly dependent on external funds—particularly those from the NHMRC, as this is the only major national source of external funds.

This thesis argues that because of this dependency and because of the lack of support for the necessary conditions for international research collaborations, researchers engaging in international research collaborations have to employ a number of strategies. These strategies affect the conduct and content of research. Working with international researchers enables Australian researchers to access the world’s best knowledge. However, most Australian researchers have to conduct international research collaborations through the NHMRC’s Program and Project Grants Schemes, and, as a result, limit with whom they work and how they work with international collaborators.

This thesis contributes to a middle-range theory by identifying the range of types of international research collaboration, the conditions associated with each of these types, the response of researchers according to the level of support of these conditions, and the subsequent effects on research. By providing the conditions for international research collaboration, researchers can fully engage in state-of-the-art knowledge, wherever it is in the world. This access is critical to a country’s success in the global knowledge economy.
Introduction

From an early age, I developed an admiration for and an appreciation of how health and medical research changes lives. During my sociology honours year, in 1995, my father had heart bypass surgery that saved his life. I remember seeing him in hospital just after the surgery, but before he had regained consciousness. Touching his hand, he was as cold as ice and his beautiful Indian skin was a blue-grey colour. His chest was going up and down in very definitive movements and the sound of the machine that was breathing for him was ever present. It was a scary scene, but I remember feeling intense relief that he had made it through the operation.

Having children of my own now, I can better appreciate how hard this time would have been for my mother. It would have been particularly difficult because she had lost her father when she was seven, and her mother and sister had both passed away years earlier, both due to heart attacks (prior to the availability of bypass surgery).

My father’s surgeon in Australia stood on the shoulders of his international colleagues in the United States (US), Argentina and Russia, who had pioneered this technique through many years of research. My father had three major heart attacks prior to his heart bypass surgery, all of which I remember vividly. The first occurred when I was 13. Together with my younger brother, who was 10 at the time, we were taken to the hospital to say goodbye to our father, as he was not expected to live.

I was aware that my father’s heart condition was hereditary. My paternal grandmother had died at 35 from a heart attack when my father was nine, and my paternal grandfather also died from a heart attack. This left my father without both parents before he was 30. My mother lost both of her parents before she was 34. As a consequence of this, my brother and I were never to know our grandparents.

As a result of advances in health and medical research, my father, at the age of 70, continues to enjoy a very good quality of life. He has now seen both his children grow up and have children of their own. Without health and medical research, my
mother would have lost her husband and had to raise her children on her own, as her mother had done. In addition, my brother and I, like my father and mother, would have suffered the loss of a parent at a very early age, and my children and their cousins would never have known their Pa.

My career over the last 17 years has involved working in a range of research, program and policy health-related positions. These have included positions in Australia (at The National Centre for Epidemiology and Population Health, The Federal Department of Health and The Australian Institute of Health and Welfare) and in the United Kingdom (UK) (at The Royal Pharmaceutical Society of Great Britain, The Medical Research Council and The Wellcome Trust). I also represented Australia on the Board of the International Human Frontier Science Program (HFSP) for five years. It was not a conscious decision, but looking back, my thankfulness that Dad was alive and had been able to see me grow up probably influenced my decision to enter the health area. From 2000 to 2009, I worked at the Australian National Health and Medical Research Council (NHMRC). It was through working at the NHMRC that I was inspired to undertake the study that is the subject of this PhD.

After spending some time managing and developing policy for most of the NHMRC research funding schemes, I became more and more concerned that although Australia had a strong international science reputation, the NHMRC—the major government and external funder of health and medical research in Australia—provided little explicit support for Australian researchers to engage in international research collaborations. Although supporting international collaboration had been mentioned in the NHMRC strategic plans for years, there were few programs available to explicitly support this work, and only a fraction of the NHMRC budget was allocated to this area. My concern was based on the view that international research collaboration should be enabled when researchers believe it is necessary and or could significantly enhance their research.

Unlike other international counterparts, such as the Canadian Institutes of Health Research and the Medical Research Council in the UK, the NHMRC had no international engagement strategy and no funds specifically allocated for this activity.
This was surprising given that the NHMRC proudly stated that about two thirds of its researchers engaged in international collaboration, thus reflecting this as a normal approach when undertaking research.

It is widely accepted that international collaboration and worldwide engagement in science and research, though not necessarily superior to national collaboration, are increasingly important for all countries. International research collaboration is not a new notion—many argue that scientific endeavour has always been an international enterprise. However, the crucial role of agencies, such as national research councils, in the science system has increased over recent years. The importance of research councils in the research system has increased with the dramatic reduction in recurrent funding in many Western countries. Researchers are increasingly dependent on external funding to conduct not just new lines of research—as in previous years—but all research. More than ever before, governments are placing strong emphasis on research funds being awarded through competitive processes of research funding councils such as agencies.

Australian science has a strong international reputation, which is reflected, for example, in the many Australian Nobel Laureates in medical science. However, a question that became pertinent to this study related to how the NHMRC ensures Australian researchers are able to work with the best researchers, using the best methods and objects, on the most exciting problems. This related not just to research in Australia, but to anywhere in the world, given that scientific endeavour is now, more than ever, an international enterprise. Specifically, I asked myself: What is known about what is needed for researchers to engage with international collaborators, and how can the NHMRC best support them in doing this?

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1 For example, the European Union, through its Framework Programmes, has promoted international collaboration but this has not resulted in European science or industry becoming beacons of global competitiveness. While the Framework Programmes are contested by some European researchers who maintain they have contributed to Europe taking an inward focus, the Framework Programmes still provide important opportunities for Australian researchers to work with international collaborators.
An examination of the literature revealed that although there had been a great deal written about the benefits of research collaboration, the internal dynamics of research collaborations, let alone international research collaborations, had been surprisingly unexplored. Bibliometric studies dominated the research collaboration literature, particularly the international research collaboration literature. These studies demonstrated that there had been a dramatic increase in joint publishing by researchers from different countries, but they could provide few insights into the research actions of collaborators. In addition, there was virtually no empirical research on the effects that funding schemes had on the conduct or content of international research collaboration at the level of the researcher.

Constructivist sociology of science had downplayed the influences of structures, such as research councils, on knowledge, while science policy studies had given little attention to how science policy affected knowledge at the level of the researcher. Indeed, I was surprised that the NHMRC had not commissioned such research, itself. Instead, studies commissioned by the NHMRC had focused on bibliometric analyses or strategic reviews of its funding schemes—none of which examined the effects of funding schemes at the level of the researcher, or gave specific attention to international research collaboration.

Therefore, I was inspired to undertake this study to investigate what activities were undertaken between Australian researchers and their international research collaborators, what researchers actually required in order to undertake successful international research collaboration, and what effects the NHMRC funding schemes have on international research collaboration conduct and content. In summary, I sought to identify the social mechanisms that linked variations in NHMRC funding schemes to changes in international research collaboration conduct and content. I believed a sociological examination of these issues could provide valuable insights into these questions.

The independent variable in this study was NHMRC funding schemes, which were defined as institutions. Institutions were viewed as systems of formal and informal rules (North, 1990; Scharpf, 1997). NHMRC funding schemes that supported
international research collaboration were viewed as institutions in this study, as the policy for these schemes provided the formal rules by which research was supported. When looking for a theoretical framework to guide this study, it became clear that there existed no theory of research collaboration (Shrum et al., 2007:7) or of how funding institutions affect research.

However, there was an analytical approach that could support investigating the effects of institutions on changes in international research collaboration conduct and content. This approach was actor-centred institutionalism (Mayntz & Scharpf, 1995; Scharpf, 1997). This was adopted for this study because actor-centred institutionalism is an analytical approach that supports the specific theoretical interest in institutions, making them the central independent variable whose effects are to be investigated. This originates, and has been mostly used, within political science. However, this approach has also been used effectively by the few sociologists of science who have investigated the effects of other institutions, such as research evaluation systems, on knowledge production (Gläser & Laudel, 2007:127–151).

Actor-centred institutionalism does not reduce explanations of actions to institutional influences, but treats the latter as a factor that can be enforced or counteracted by other influences. As a result, if actor-centred institutionalism is applied, the effects of institutions have to take into account other intervening influences. These other influences include economic, epistemic, social and cultural. This approach therefore supported the following central research question: How do research council funding schemes affect international research collaboration conduct and content? This research question reflects the central position of NHMRC funding schemes as the independent variable, but notes that these funding schemes are mediated by other intervening variables.

In order to investigate social mechanisms, a comparative case study approach was adopted to examine differences in causes and effects. There were two levels of cases. First-level cases were five NHMRC funding schemes. Two schemes of Project and Program grants were chosen because they were the main vehicles by which NHMRC provided support to teams. These were termed in this study as ‘general schemes’. A
further three schemes were termed ‘targeted schemes’ in this study because they aimed to specifically support international research collaboration. These were chosen to compare with the general schemes. Second-level cases were ‘projects of investigation’, which were projects supported through one of these five NHMRC schemes, in which Australian researchers were working with international collaborators. Comparisons were made based on the NHMRC schemes, as well as the projects of investigation supported through the different NHMRC funding schemes.

To answer the research question, it was necessary to gain an in-depth understanding of the world of the researcher. To achieve this, qualitative interviews were used as the main empirical base for the cases. Interviews were conducted with Australian researchers and their international collaborators, as well as with NHMRC managers. Evidence from scientific narratives from researchers and interviews with NHMRC managers were triangulated with other sources. ‘Research trails’ were developed for interviewed researchers, based on bibliometric coupling, to examine any changes in their research area. Related research papers and reports were also examined. In addition, a detailed policy analysis of each of the NHMRC funding schemes was undertaken.

This investigation has elements of an ‘action-based’ approach, in which an aim of the research is to instigate positive change (White, 2006). The lack of research in this area and the recognition that, ‘The major issue currently being faced in regard to international science and technology in Australia, and indeed across the world, is how such activities can best be supported and managed’ (Allen Consulting Group, 2003:96) called for a direct link between this research and policy-makers. One reason I was motivated to undertake this study was that I believed my position at the NHMRC could provide an opportunity to translate empirical findings into policy. Therefore, the central aim of this study was to contribute to a middle-range theory linking variations in funding schemes to effects on international research collaboration. However, this study also had a practical element. This practical application was realised in 2009, when the NHMRC made changes to its Project Grants scheme to improve support for international research collaboration based on the findings of this study.

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This study found that there are different types of international research collaboration, based on their levels of intensity. Different types of international research collaboration were reported in this study to have different suites of necessary conditions. These conditions are different to those required for national collaboration. Conditions also differ depending on the collaborating country and size of collaboration. These conditions are poorly supported through the NHMRC’s two major schemes of Project and Program grants which are the schemes through which most researchers have to conduct international research collaborations. As a result, researchers have to adjust who they work with internationally, and how they work with them. Researchers were found to change their research problems, methods and objects in response to the NHMRC general schemes.

Researchers funded through the NHMRC general schemes were limited in their ability to work with the best researchers, objects and methods in the world, as well as to work on the most exciting problems. This was in stark contrast to their colleagues who were funded under the NHMRC targeted schemes (aimed at supporting international research collaboration), which support more of the necessary conditions for international research collaboration. These targeted scheme researchers were found to work with a broad range of international collaborators and engage in high-intensity collaborations, as well as low and mid types of collaboration. As a result, these researchers broadened their fields of research, provided and accessed unique methods and objects, and increased the scale of their work. This resulted in an increased quality of research. To my knowledge, this thesis is the first investigation that empirically identifies what is required for international research, as well as what facilitates and hinders different types of international research collaborations. It is also the first study that identifies the social mechanisms that link variations in institutions to effects on international research collaboration conduct and content.

The validity of these findings rests on this study’s ability to draw conclusions about change and its causes from interviewees’ statements about their research content. Therefore, it was necessary to ensure that the findings reflected these causes and effects, rather than just the researchers’ opinions. Similar to Laudel and Gläser
(2012), this study focused on the structural properties of interviewees’ research, and how these properties linked to interviewees’ previous research, to the research of their community and to their decisions regarding international collaborators (who they worked with and how they worked with them).

Most of the categories in this study’s analysis were not directly discussed during the interviews. By soliciting scientific narratives about the epistemic properties of the research—such as time characteristics, approaches, equipment, uncertainty and international collaborators—it was possible to limit the opportunities for interviewees to produce ad hoc rationalisations, or to respond in ways they might assume were expected by the NHMRC. The findings were corroborated from additional sources where possible. This is why I am confident that in the cases investigated, this study’s findings reflect the effects of NHMRC funding schemes on international research collaboration conduct and content.

**Theoretical Frameworks: Contributing to a Middle-Range Theory Based on Identifying Social Mechanisms**

A brief discussion now follows on the rationale behind the theoretical approach taken in this study. There is no theory of international research collaboration and few in regard to policy implementation (Braun & Guston, 2003; Shove, 2003; Shrum et al., 2007). However, in regard to researching policy making, Braun and Guston (2003) contend that it is possible to identify five theoretical currents. These are classical economics (Polanyi, 1962; Tullock, 1966), Marxist economics (Bourdieu, 1975), system theory, constructivism (Latour & Woolgar, 1979; Knorr Cetina, 1981; Latour, 1987), institutionalism (Merton, 1970 [1938]), and discussion on the ‘finalisation of science’ (Weingart, 1997).

Noting these currents, Braun and Guston (2003:302) argued that these approaches ‘are either too abstract [system theory], lacking in parsimony or theoretical rigor [constructivism, institutionalism, finalisation] or if they are parsimonious [like classical economics], they abstract too greatly from the “requisite variety” of real
life'. Two theoretical frameworks that have been used recently in relation to science policy are multi-level systems analysis and principal-agent theory. For example, these were both used by Morris (2004) in assessing how UK scientists respond to science policy.

In science policy studies, the concept of multi-level analysis of systems has been developed to provide a theoretical framework for understanding the functioning of national research systems. Rip and van der Meulen (1996) conceptualised national research systems as multi-level systems held together by mutual interdependencies. Multi-level analysis 'recognises the existence within any complex system of the different levels or layers of activity and operations, ranging through macro, meso and micro levels' (Morris, 2004:11). Each level has its own features, but its development is influenced by, and influences, the development of the others. Through a 'nesting effect what goes on in one level can constrain or enable what goes on in another. The mutual dependency of each level on the workings of the others binds them into a system' (Morris, 2004:11).

Within this multi-level framework, Morris (2004) used principal-agent theory to investigate relationships across levels, and the strategies employed by the various actors. Principal-agent theory 'deals with the contractual relation between a principal, who buys a particular good or service, and an agent, who delivers the good or service' (van der Most, 2009:16). Principal-agent theory is derived from the new economics of organisation (Moe, 1984). As stated by Kassim and Mennon (2003:122):

Agency relationships are created when one party, the principal, enters into a contractual agreement with a second party, the agent, and delegates to the latter responsibility for carrying out a function or set of tasks on the principal’s behalf. In the classic representation, the principal is the shareholder of a company that contracts an executive to manage the business on a day-to-day basis. However, the principal can be any individual or organization that delegates responsibility to another in order to economize on transactions costs, pursue goals that would otherwise be too costly, or secure expertise.

Principal-agent theory has been used by a number of science policy studies to analyse the relationships between the state and academic research, and between research and its funders in a broader sense (Braun, 1993; Guston, 1996; Caswill, 1998; van der
Meulen, 1998; Morris, 2004). However, this study argues that principal-agent theory has two deficits, and, as a result, was not used in this study. Firstly, this theory focuses on the interests of the principal as being the state or the research agency, rather than the research performer. This thesis aims to identify the effects of NHMRC schemes at the level of the research performer, rather than at the organisation level of the NHMRC, as would be the focus of principal-agent theory.

Secondly, principal-agent theory has a narrow focus when examining the influences on science policy implementation. By concentrating only on the relationships between the state, research councils and researchers, this theory tends to neglect the multitude of conditions for research collaboration that were found to be important by this study, as will be discussed in Chapter One. These conditions are likely to be important in international research collaboration, so they need to be considered in any theoretical framework—a consideration that principal-agent theory cannot support. Other frameworks used include boundary crossing and multi-level systems. However, these also focus on the research council, rather than the effects on researchers. They also do not focus on researcher adaptation strategies.

Theoretical frameworks within the sociology of science that do focus on the researcher were also not appropriate for this study. This is because, ‘The approaches based on the constructivist social of scientific knowledge such as Actor Network Theory (Callon & Law, 1982; Callon, 1986; Law, 1987, 1988, 1996), the Mangle of Practice (Pickering, 1995) and Epistemic Cultures (Knorr Cetina, 1999) … combine idiosyncratic descriptions with “grand theories” that do not support comparative frameworks’ (Gläser, 2011:293). In addition, these theories do not examine the effects of institutions on international research collaboration.

In summary, these theories are either too narrow in their focus or too idiosyncratic to serve as a comparative framework. Merton (1949) argued that sociologists should concentrate on measurable aspects of social reality that can be studied as separate social phenomena, rather than attempting to explain the entire social world. Merton (1949:39) described middle-range theories as:
theories that lie between minor but necessary working hypotheses that evolve in abundance in day to day research and the all inclusive systemic efforts to develop unified theory that will explain all the observed uniformities of social behavior, organizations and social change.

For Merton, social mechanisms were the building blocks of middle-range theories, and this is the view this study adopted. Social mechanisms are important if one takes the epistemological position of opposing the dominant tradition of correlational analysis in quantitative research. This tradition establishes when A occurs after B, but does not explain how and why A occurs after B. To overcome this deficiency, the concept of causal reconstruction and other concepts along similar lines (Hall, 2003; as cited in Mayntz, 2004:238) have been offered. As stated by Mayntz (2004:238):

Causal reconstruction does not look for statistical relationships among variables but seeks to explain a given social phenomenon—a given event, structure, or development—by identifying the processes through which it is generated ... Causal reconstruction aims at generalizations ... involving processes not correlations. The identification of causal mechanisms is the hallmark of such an approach.

To avoid the epistemological and ontological limitations of past research, the goal of this research is to identify social mechanisms. Therefore, unlike previous research, this does not take the researchers' opinions of the effects of influences on their behaviour as a given, but rather looks for the social mechanisms. Social mechanisms are determined by undertaking an independent analysis of the structural elements of research based on many sources—not just based on scientific narratives from researchers (see Chapter Two). Social mechanisms were first presented by Merton (1968) to sociological theory, and later to the sociology of science by Whitley (1972), although they have rarely been taken up (with the exception of Hedstrom and Swedberg (1998)).

Mayntz defines social mechanisms as 'recurrent processes generating a specific kind of outcome' (2004:237). This definition has been further refined by Gläser as a 'sequence of casually linked events that occur repeatedly in reality if certain conditions are given and link specified initial conditions to a specified outcome' (2011:4).
He elaborates by stating:

Mechanismic explanations are quite different from the predominant understating of explanation as “subsumption under a general law”. It is rather specific in that a satisfying explanation of a social phenomenon has only been achieved if the social mechanisms by which the phenomenon was produced and the conditions that initiated and upheld the mechanism, are provided. The approach is not deterministic because it acknowledges that humans can always decide otherwise. Mechanismic explanations only point to likely sequences of events and outcomes. They are nevertheless superior to lists of causal factors that produce a phenomenon with a certain probability. This is because these lists (which are derived from statistical analyses of quantitative data) black box the process by which a phenomenon is produced, and thus constitute a contribution to an explanation at best (Gläser, 2011:4–5).

A middle-range theory about relationships between sets of conditions and changes in the content and conduct of research is very important in assessing the possible impacts of particular governance tools, including funding schemes of research funding councils. Currently, the views on these causal relationships are largely based on the personal experiences of researchers. These need to be systematically and empirically assessed to enable a degree of confidence in the effects of these instruments. ‘A middle-range will assist in providing knowledge about some of the strands of the causal web that are difficult to assess based on personal experience alone’ (Gläser, 2011:17). Therefore, this study seeks to add to the blossoming area that links science policy studies to the sociology of science in regard to international research collaboration.

**Outline of the Thesis**

This study contributes to a middle-range theory by identifying the social mechanisms that link variations in institutions—namely, NHMRC funding schemes—to their effects on international research collaboration conduct and content.

The thesis begins by situating the study in the literature on research collaboration and research funding councils. Attention is firstly given to what is known about the research actions that occur during collaborations. Bibliometric studies and studies on research collaboration within the sociology of science, higher education and
organisational studies are examined. This illustrates that surprisingly little attention has been given to the activities involved in research collaborations, with international research collaborations having been virtually unexplored. Little is known about the different types of national research collaboration, let alone the different types of international research collaboration. As a result, there is no evidence regarding what conditions facilitate or hinder different types of international research collaboration. This thesis argues that the research activities of international collaborators and the conditions that are required for these activities are two pieces of crucial information about which empirical evidence is lacking.

The literature on the effects of funding institutions on research is then examined. This reveals that studies have tended to neglect the effects of funding institutions at the level of the researcher. Conclusions on effects are usually not based on empirical evidence or are not mentioned at all. Therefore, the literature review exposes three major gaps in knowledge: firstly, the activities that international research collaboration entails; secondly, the conditions required for different types of research collaboration; and thirdly, if and how research council funding policies affect international research collaboration conduct and content.

Chapter Two details the methodology used to obtain the empirical base for this thesis. In order to identify the social mechanisms that link different institutions to changes in research, comparative case studies were developed to examine variations in multiple conditions and their effects. There were two levels of cases. First-level cases were five NHMRC funding schemes. Two schemes of Project and Program grants were chosen because they were the main vehicles by which NHMRC provided support to teams. They were termed in this study as ‘general schemes’. A further three schemes termed as ‘targeted schemes’ were chosen because they aimed to specifically support international research collaboration. These were chosen to enable a comparison with the general schemes. ‘Projects of investigation’ were projects supported through one of the five NHMRC schemes, in which Australian researchers were working with international collaborators. These were the second-level cases.
The levels of cases are illustrated in Figure 1 below.

![Diagram of levels of cases]

**Figure 1: Levels of Cases**

**Key to Figure 1:**

- **A&I**: An Australian and international collaborator working on the project of investigation were interviewed
- **A**: Only an Australian researcher working on the project of investigation was interviewed
- First-level cases: Five NHMRC funding schemes
- Second-level cases: Projects of investigation—20 cases, eight of which were double-sided, in which an Australian and an international collaborator working on the project of investigation were interviewed.

Interviews with Australian and international researchers and NHMRC managers provide the main empirical base for this study. In-depth scientific interviews were considered to be the most appropriate method to gain a detailed understanding of the researchers’ world. In-depth scientific interviews meant that I needed to prepare for each interview by researching each interviewee’s research field, research trail and publication history. As well as these interviews, bibliometric research trails were developed for the researchers interviewed, relevant scientific papers and reports were examined and a detailed policy analysis of NHMRC schemes was undertaken. This study is theory driven in the sense that it uses relevant previous findings, but
constantly challenged these to develop the contributions to theory. In addition, this study stretches over many research processes that are linked through their contributions to the proposed middle-range theory. As a result, this research is based on theory testing as well as theory building.

This study seeks to answer the following central research question and four second level research questions:

**Central research question:**

How do research council funding schemes affect international research collaboration conduct and content?

**Second level research questions:**

1. How do researchers work with international collaborators?
2. What are the conditions of action that affect the negotiation process in international research collaboration?
3. How do NHMRC institutions support the conditions for international research collaboration?
4. How do NHMRC institutions affect international research collaboration conduct and content?

Chapter Three examines how researchers are working with international collaborators. This is investigated because there is little understanding of the research actions that occur between international collaborators. There have been few types of research collaboration established that look at research actions, and these have not investigated international collaborations. This study uses national types of collaboration established in the field of experimental science, based on bilateral collaborations, as a framework to identify international research collaboration types that occur in experimental, clinical and public health research, and in bilateral and multilateral collaborations.
Four different types of international research collaboration were reported. These types of research collaborations range from low intensity (mutual inspiration), to mid-intensity (service and transmission of know-how), to high intensity (in-depth). The descriptions of research activities differ by research area and some types of research observed in national collaborations were not found to occur in international collaborations in this study. Multilateral collaborations are also either homogenous or heterogeneous in terms of the type or types of research collaboration they involve.

Chapter Four investigates what conditions facilitate, hinder or are essential to the different collaboration types identified in Chapter Three. Firstly, international collaborations are found to have additional conditions compared to national collaborations. Secondly, each collaboration type is found to have a different suite of conditions. Thirdly, different suites of conditions are not only linked to different collaboration types, but are also determined by the collaborating country and by the size of the collaboration.

After establishing the types of collaboration and their respective suite of conditions, Chapter Five assesses how each of the five NHMRC funding schemes directly or indirectly supports the conditions identified in Chapter Four. General schemes, which are the main vehicles through which NHMRC provides support to teams, were found to provide few of the necessary conditions for all types of international research collaboration. This was particularly apparent for in-depth collaborations, as this type of international research collaboration has the most necessary conditions. However, researchers were also unable to engage in transmission of know-how collaborations, which is the method through which researchers learn new, often world-leading, methods from international collaborators. Targeted schemes aimed specifically at supporting international research collaboration were found to support more of the necessary conditions. However, even though general schemes provided so few of the necessary conditions for all types of international research collaboration, most researchers undertook international research collaborations through general schemes because targeted schemes were few and funds for these schemes were small.
Chapter Six identifies the effects of NHMRC schemes on international research collaboration and conduct. Researchers funded through general schemes were found to work only with researchers in developed countries with whom they had worked previously, and were found to restrict their collaborations to low or mid-intensity collaborations. They also made significant changes to their research, which affected research quality. Their colleagues who were supported through targeted schemes were not found to implement these strategies, which led to different effects. Most notably, these researchers took a high degree of perceived risk in their research, while researchers funded through general schemes did not. There were also findings in regard to the effects on research when funding schemes have numerous demands relating to who researchers can collaborate with, and how they can do so - the collaborative contributions are not combined.

Chapter Seven discusses the implications of these findings for contributing to a middle-range theory that links variations in institutions to changes in international research collaboration and conduct. The overall argument is that where conditions for international collaboration are absent (as in the general NHMRC schemes through which most NHMRC researchers have to conduct international collaborations), researchers have to change who they work with and how they work. They have to make changes to their research that affects properties such as the degree of perceived intellectual riskiness and the research scope and scale.

Chapter Eight makes policy recommendations to improve NHMRC support for international research collaboration. The overriding recommendation is to better support the necessary conditions for the different types of international research collaboration.

Chapter Nine concludes this thesis by summarising the key findings and suggesting areas of further research.
The Science Policy Context and the NHMRC

Before beginning with an in-depth analysis of NHMRC funding schemes and how they affect international research collaboration conduct and content, it seems useful to provide a brief overview of the science policy context and the NHMRC. This overview is provided to give some background on the situation in which university health and medical researchers in Australia operate.

The Science Policy Context

In recent years, there has been a change in the way the state funds research in most developed countries. As highlighted by Morris (2000:425), 'the governments of Western countries have shifted away from the expansionist philosophy of the Vannevar Bush era, with its endorsement of academic autonomy, to an interactive and dynamic - and far more managed - relationship between academic, government and industry'. The changes in economic circumstances of many Western countries (Morris, 2004:4) and the increasing costs of science, as well as the expansion of the science system (Laudel, 2006a:489), have seen governments in many countries change their approach to funding research.

With the changes described above, the state has placed new emphasis on the need for publicly-funded research to contribute to public policy aims, and is more intent on steering research towards these aims. For example, the Australian government introduced its first national research priority areas in 2002 as an indication of public policy priorities (Allen Consulting Group, 2003). This was coupled with a new insistence regarding the accountability and management of science (Braun & Merrien, 1999; Morris, 2004). Research councils, such as the NHMRC, which are key sources of external funding, have included public policy goals into the selection and management process, requiring project proposals to demonstrate how the research will contribute to public policy research priorities, should it receive funding (Braun, 1998).
Government support for university research in Australia, as in other developed countries, has been based on the dual support principle, in which funding comes to universities from two sources:

- External agencies, such as research councils, for direct research costs
- Departments, such as that of education, in the form of block or recurrent grants that cover teaching and research infrastructure costs.

As stated by Laudel (2006a:492):

In the past, recurrent funding enabled scientists to develop a research trail by conducting research projects. It allowed scientists to apply for external funding for additional projects. This funding could be used to follow leads that emerged in the research undertaken with recurrent funding.

Australia has seen a change in the balance between recurrent and external funding of university research. The shift has been towards external funding, and has occurred most notably in the last 15 years (Commonwealth of Australia, 1999). As a result, ‘Researchers are receiving less and less of their funds via their organizations on a regular basis, and independent of specific projects. Instead they must apply for external funding from funding agencies’ (Laudel, 2006b:375).

This move to more competitive funding is a deliberate policy measure by governments to focus publicly-funded research efforts to, they argue, better deliver significant economic, social and environmental outcomes. For example, the Australian Government contends that, ‘Research—as a key source of knowledge and new ideas—is central to success in the global knowledge economy’ (Commonwealth of Australia, 1999:11). This shift is based on a deliberate policy measure to ‘maximise the national returns on investment in research’ (Commonwealth of Australia, 1999:4). As a result, researchers must seek funds from external funding agencies to support their research.

This change in policy is based on the ‘New Public Management’ (Schimak, 2005). New public management refers broadly to government policies, introduced in the 1980s, that aimed to make the public sector more effective. Schimank (2005:365) highlights that ‘At the core of New Public Management lies the principle of increased
competition among and within universities—competition for resources, students, and national as well as international standing’. He further stated that in New Public Management ‘the academic profession is the loser. External interests, university leaders and especially Government seem to be the winners’ (Schimank, 2005:366). The basic hypothesis of New Public Management is that market oriented management of the public sector will lead to greater cost-efficiency for governments, without having negative side-effects on government policies achieving their aims. New Public Management rests on the assumption that an increase in competition will result in an increase in effectiveness.

**NHMRC: The Only Major Source of External Funds in Australia**

In terms of the shift from recurrent to external funding, the NHMRC received a five-fold funding increase between 1995 (131 million AUD—approximately 85 million pounds and approximately 103 million euros, at April 2012) and 2011 (715 million AUD—approximately 436 pounds and approximately 563 euros, at April 2012) (Research Australia, 2011:23). As a result, the NHMRC has become an even more significant actor in the Australian research system. In terms of sources for external funding in Australia, ‘The Australian research environment is neither rich nor diverse’ (Gläser & Laudel, 2007:136). There is relatively minimal support from industry, compared to other Organisation for Economic Cooperation and Development (OECD) countries, and the funding available from the not-for-profit sector and state and territory governments is also limited: ‘Consequently, the national research councils are the only significant sources of research funding for many fields’ (Gläser & Laudel, 2007:137).

In Australia—unlike areas such as the UK, which has seven research councils united under Research Councils UK—there are only two research councils. These are the NHMRC, which funds research in biomedical, clinical, public health and health services, and the Australian Research Council (ARC), which funds all other research. Both councils fund a range of investigator-initiated and strategic funding schemes to support individuals and teams of researchers. Unlike in the UK, where the Medical
Research Council has its own institutes and centres, there are no NHMRC institutes or centres. The NHMRC has five strategic objectives:

1. To support the best and most relevant research
2. To base health policy and practice on evidence
3. To maintain high ethical standards
4. To increase investment
5. To build a better NHMRC.

Each council has one round of grants each year, and there is a nine-month delay between applications and advice regarding success. The NHMRC reports to the Minister for Health and Ageing, while the ARC reports to the Minister for Science and Innovation. The majority of NHMRC funds are awarded to universities with hospitals and independent medical research institutes also eligible for funding. The NHMRC and ARC grants are internationally unique in that ministers are required to approve the funding decisions of councils. Recently, a Minister exercised this right by intervening in some projects that had been approved by the ARC peer-review system. Some of these projects were subsequently not approved.

In summary, Australian health and medical researchers are dependent on external funds from the NHMRC to conduct virtually all of their research, as this is the only major source of external funds in Australia. This is because there has been a shift from recurrent funding to more competitive funding in recent years—indeed, the NHMRC budget increased five-fold between 1995 and 2001. Unlike other areas, such as the UK and the US, in Australia there are few private and public sources for external funding of research. As a result, the NHMRC is an influential actor in the research system.
Definition of Research Collaboration and International Research Collaboration

Research Collaboration

This section identifies the definition of research collaboration used in this study. Surprisingly, little attention has been given to the concept of, and detailed activities involved with, research collaboration (Knights & Wilmott, 1997; Katz & Martin, 1997; Newell & Swan, 2000:1289; Laudel, 2002; Shrum et al., 2007:7). Indeed, the term 'research collaboration' has suffered from being ill-defined. Studies have found that asking scientists, themselves, to define collaboration leads to confusion (Katz & Martin, 1997:26; Laudel, 2002). Scientists tend to identify different types of behaviours, which means it is not possible to base an empirical study on their implicit understanding of research collaboration. As stated by Katz and Martin (1997:8):

A research collaboration ... has a very ‘fuzzy’ or ill-defined border. Exactly where that border is drawn is a matter of social convention and is open to negotiation. Perceptions regarding the precise location of the boundary of the collaboration may vary considerably across institutions, fields, sectors and countries as well as over time.

However, any study must clearly identify the topic being investigated. In this study, collaboration was viewed as a phenomenon related to the functional level of collective action by individual, collective or corporate actors who do not necessarily have a common goal. Research collaboration in this study is defined as, ‘A system of research activities by several actors related in a functional way and coordinated to attain a research goal corresponding with these actors’ research goals or interests’ (Laudel, 2002:5). The consequences of this definition are that, firstly, a shared research goal is not necessary for collaboration (Laudel, 2002). Any actor may collaborate according to their interests; for example, they may be interested in conforming to a collaboration norm and hence in helping another scientist. Secondly, collaboration is defined by the activities, rather than by the actors involved. Thirdly, the concept of collaboration is strictly reserved for research that includes personal interactions.
It is also important to state that collaboration is referred to in different contexts. Collaboration can occur within teams and across teams. This study focuses on collaboration that occurs across Australian and international research teams based in different countries, rather than collaboration occurring within research teams.

**International Research Collaboration**

International research collaboration is used in this study to refer to collaboration that occurs between researchers located within research organisations in different countries. It refers to the location of the institute at the time of the project under investigation, rather than, for example, the nationality of the researchers (as this would have been difficult to determine). ‘International research collaborator’ and ‘international collaborator’ are used interchangeably, and refer to a researcher working on a project of investigation in a research organisation outside Australia.

**Why Focus on the NHMRC?**

Research councils are important actors in the research system, particularly because of the move towards more competitive funding. In addition, they are particularly significant actors in Australia, given there are only two research councils. I was employed by the NHMRC during most of this study, so I also hoped that this position would provide an avenue through which empirical findings could be translated into policy.

In this study, the term ‘research funding councils’ refers to publicly-funded organisations that financially support research performed mostly at public entities, such as universities. This term is used in Australia and countries such as New Zealand and the UK, while ‘research funding organisations’ is more commonly used throughout Europe.
Why Focus on International Research Collaboration?

All countries recognise the importance of international collaborations as a key element of national science and innovation systems. In a world of increasing globalisation, advances in science and technology can be sourced from all corners of the world. These advances provide opportunities to enhance national economic and social prosperity.

Australia’s distance from the rest of the industrialised world makes international research collaboration relatively more important for Australia than, for example, European countries, where large concentrations of research activity are located within short distances.

As a result, international collaborations have been a major funding priority:

Australia needs to ensure that its science and technology system will be able to respond to the challenges of China and India, as well as other countries’ responses, otherwise we will face erosion of our international competitiveness, given the critical role of science and technology for our future prosperity (Working Group for the Prime Minister’s Science, Engineering and Innovation Council, 2006:ii).

Given that Australia generates about two per cent of the world’s science and technology, it needs effective tools in order to access the other 98 per cent (Allen Consulting Group, 2003:100). The next chapter examines the pertinent literature on international research collaboration and the effects of funding schemes.
Chapter One: Literature Review

This chapter positions the thesis within the relevant literature. The literature review is divided into two sections. The first section examines previous studies on research collaboration between university researchers. When examining the effects of NHMRC schemes on international research collaboration, it is important to have a clear understanding of the research actions that international research collaboration entails. The review of the literature reveals how little is known about the internal dynamics of national research collaborations in universities. This is because international research collaborations in this area have previously been virtually unexplored. In addition, there has been little examination of the range of conditions required for research collaboration, and this lack is particularly apparent in international research collaboration.

The second part of the review examines the literature that explores the effects of institutions, including research council funding schemes, on research. Although the increasing role of research councils within the research system has been examined, there is a scarcity of investigations regarding how research councils affect the conduct and content of research at the level of the researcher. The gaps highlighted throughout the literature review serve as the basis for supporting the research questions that are the focus of this study’s results section.

What Problems Have Been Addressed by Studies on Research Collaboration?

The next section begins by examining studies that have examined the internal dynamics of research collaboration. It then explores studies that have examined the conditions required for research collaboration. Knowledge about both these issues is important when assessing the impact of funding schemes on international research collaboration.
What is Known About the Internal Dynamics of International Research Collaborations?

The following sections discuss studies about research collaborations in the fields of bibliometrics, the sociology of science, higher education studies and organisational studies.

Bibliometric Studies

Studies on research collaboration have been dominated by bibliometric studies—statistical studies of authorship patterns in published scientific literature. These studies demonstrate that over the past 50 years there has been substantial growth in national research collaborations (Smith, 1958; de Solla Price, 1963; Meadows & O'Connor, 1971; Beaver & Rosen, 1978, 1979a, 1979b; Balog, 1979/80) and in international research collaborations (Moed et al., 1991; Luukkonen et al., 1992, 1993; Georghiou, 1998). For example, in the OECD, the proportion of scientific publications with a foreign co-author more than doubled between 1986 and 1991, to 31.3 per cent (Australian Government, 1999:22). There was also a major increase in Australian international research collaboration, with Australian science publications trebling their representation in international collaboration between 1981 and 1999, to 34.9 per cent (Australian Government, 1999:22).

Other bibliometric studies have examined how collaboration affects productivity. As early as the 1920s, researchers revealed that high productivity, in terms of published output, correlated with high levels of collaboration (Lotka, 1926; as cited in Katz & Martin, 1997:8). This finding has since been validated by many others (de Solla Price, 1963; de Solla Price & Beaver, 1966; Beaver & Rosen, 1978; Beaver & Rosen, 1979; Balog, 1979/80; Lawani, 1986).

Collaboration also appears to have a positive effect when submitting a paper for publication. Gordon (1980:193–210) found a significant relationship between levels of multiple authorship and papers accepted by a leading astronomy journal. He found
that only 63 per cent of single-author papers were accepted, compared with 78 per cent of papers with two to five authors. Of papers authored by six people or more, 100 per cent were accepted for publication. The number of co-authors also appears to strongly correlate with the impact of a paper. A number of studies have demonstrated that as the number of authors per paper increases, the proportion of high-impact papers also increases (Crane, 1972; Goffman & Warren, 1980; Lawani, 1986:13–25).

International collaborative work has also been shown to have a higher impact. Studies such as that by Persson et al. (2004) showed that citations of articles that resulted from international collaborations grew faster than citations of articles from national collaborations. Similarly, Narin and Whitlow (1990) found that internationally co-authored papers are cited up to twice as often as single-country papers.

Although bibliometric studies reveal important insights—that international collaborative research is increasing, that it generally has a higher impact, and that it is often undertaken by highly productive researchers—these studies also have a number of deficiencies. Some studies have found that the bibliometric approach to assessing research collaboration reflects only a small component of the collaborative activity that takes place (Edge, 1979; Katz & Martin, 1997; Laudel, 2002:3). Indeed, Laudel (2002:3) found that ‘about half of the collaborations are invisible in formal communication channels’.

The co-authorship bibliometric approach to assessing research collaboration rests on the assumption that all people who appear on the paper as authors took part in the collaboration, and also that all people who took part in the collaboration became co-authors. This is not always necessarily the case. For example, an evaluation of the HFSP—an international research grants program that funds international research teams—showed that 91.5 per cent of papers of key journals acknowledging support from the HFSP did not have more than one grantee as an author (ARA & PREST, 1996). The scientists funded by the HFSP reported that while all teams had benefited from the collaboration, most had chosen to publish separately. Therefore, single author papers do not necessarily reflect that no collaboration has taken place. Other studies have revealed that bibliometric studies may reflect collaborators who may not
have contributed at all, but have been included for social reasons (Katz & Martin, 1997:3; Laudel, 2002). However, the most serious deficiency of the bibliometric approach to investigating research collaboration is aptly summarised by Shrum et al. (2007:8):

Co-authorship data cannot generate insights into the internal dynamics of collaborations. Bibliometric studies group specific collaborative projects into static snapshots, without any indication of the underlying processes of formation, organization and outcomes. The published results are the only evidence of collaboration, divorced from social organization and context. Why did these scientists collaborate? How important is the distinction between leaders and followers? How often did they meet? How did they resolve their difficulties? In short, what happened during the process of collaborative work?

Sociology of Science

Compared to the abundance of bibliometric studies on research collaboration, scholars note that there have been surprisingly few studies of the internal dynamics of research collaborations (Knights & Wilmott, 1997; Katz & Martin, 1999; Newell & Swan, 2000:1289; Laudel, 2002; Shrum et al., 2007:7). Hagstrom (1964) was one of the first science sociologists to examine research collaboration. He contended that while the need for teamwork was nothing new, 'In recent years the importance of teamwork has grown and its nature has transformed' (Hagstrom, 1964:242).

Hagstrom distinguished two forms of collaborative research: the traditional, and the modern. The traditional had, as its paradigm, the professor-student relationship, while the modern embodied a more complex form of organisation. However, Hagstrom (1964) did not detail what he meant by a more complex division of labour. Therefore, based on his work, it was not possible to distinguish between forms that involved collaborating throughout the whole research process with forms that involved simple forms of collaboration, such as using another researcher’s equipment. Hagstrom’s study was important because it signposted that ‘modern forms of scientific teamwork involve[ing] greater dependence on external authorities, greater centralisation of authority in research organizations and a complex division of labor involving professional technicians and professionals from different scientific disciplines’ (Hagstrom, 1964:256) were occurring.
Merton (1968) investigated collaboration and identified what he termed the Matthew Effect. This is the phenomenon in which the rich get richer and the poor get poorer. It refers to the reputational effects of collaboration, in which eminent scientists receive more credit than comparatively unknown researchers, even if their work is similar. However, Merton focused on vertical collaboration, rather than horizontal collaboration. Hagstrom and Merton also concentrated on the tangible products that scientists produced, such as publications, rather than on the activities conducted during knowledge production. These activities were ‘black boxed’ (Whitley, 1972).

Whitley (1972) criticised the sociology of science for focusing only on the internal organisation of science—science as a social institution, a profession and a communication system. He argued that in order to have a sound sociology of science, it was essential to understand the relationship between the producer of scientific knowledge and the knowledge that is produced. He contended that the view of scientific knowledge maintained by much of the sociology of science had led to an ideology of black boxism, which restricted research to the study of the observable inputs and outputs of a system.

For Merton (1968)—one of the sociologists of science who Whitley (1972) criticised—scientific knowledge consisted of the accumulation of discoveries that were identical in form, and the product of a particular pattern of behaviour—the scientific method. In the Mertonian tradition, the input to the black box was educational prestige or other structural variables, and the output was social recognition or promotion. Neither ideas nor any scientific activity was considered in this approach. Correlations between input and output indices were highly general, in that they could be applied regardless of the structure of the black box, or of the social institution being studied.

Whitley (1972) maintained that those in the Mertonian tradition appeared to be less concerned with the items of knowledge. They concentrated on correlating measurable assumed quantities in the social structure of science with output indices. Published papers were assumed to represent items of knowledge. Whitley (1972) argued that the
sociology of science—rather than examining the assumed social rational manner in which different ideas had risen and become accepted—had become the study of scientists’ careers. As a result, the sociology of science discounted the effect that issues of personal choice and individual traits had on scientific knowledge. Whitley (1972) contended that these factors were important to understand because social and cognitive factors interact to produce knowledge.

Social constructivists enthusiastically pursued this need to focus on the influence of social factors on knowledge. Research collaboration was taken up by early social constructivist sociologists, anthropologists and historians of science (Knorr-Cetina, 1981). However, these early social constructivist studies tended to focus on ‘Big Science’ (Price, 1963) and single projects, rather than comparative case studies. As a result, the internal dynamics that they reported represented idiosyncrasies of the single or few projects they investigated, and comparative frameworks were not developed (Knorr Cetina, 1981).

Shrum et al. (2007) undertook one of the most extensive sociological and historical studies regarding research collaboration. However, like the sociologists mentioned above, they too focused on ‘Big Science’—mainly in the area of physics. They also focused on collaborations’ organisations, rather than research activities. Shrum et al. (2007) were invited by the original archivist at the US Center for History of Physics to work on a project studying the historical and sociological patterns of collaborations in high-energy physics, geophysics, nuclear physics, medical physics, space science, astronomy and materials science. They adopted a comparative organisation approach, conducted interviews and compiled a database on 53 collaborations (Shrum et al. 2007).

Based on this work, Shrum et al. (2007) identified the structures of scientific collaboration. They stated that, ‘Instead of studying how people interact in scientific projects, we examine how organisations work jointly in a collaboration, the structural features of these combinations, their variations, and their patterned social consequences’ (Shrum et al., 2007:12). This study was not focused on looking at the breadth of activities that scientists collaborated on. They made it clear that ‘several
important modes of collaboration do not meet our criteria for multi-organisational collaboration' (Shrum et al., 2007:5). They went on to explain that they were not interested in cases in which one organisation contracted services out to another organisation, nor with researchers who periodically swapped findings or materials. They were also not concerned with collaboration in terms of the informal communication that occurred between scientists. Shrum et al. (2007:5) stated that, ‘Such groups often view themselves as “collaborating”, but they are not coordinating their resources or setting a common agenda’.

Using this limited view of collaboration, they developed a typology based on the degree of the collaboration’s organisation. Four types of collaboration organisation were identified. The first type was bureaucratic collaboration. This type of organisation was characterised by a high incidence of the classical Weberian features: hierarchy of authority, written rules and regulations, formalised responsibilities and a specialised division of labour (Weber, 1978; as cited in Shrum et al., 2007:97–104).

The second type—leaderless collaboration (semi-bureaucratic)—was characterised by the presence of some Weberian characteristics, but a lack of others. It deployed formally organised, highly differentiated structures, but did not designate a single scientific leader—the administrators attended to external relations and ignored internal politics.

The third type—a non-specialised collaboration—was bureaucratic in hierarchical management and leadership structure, but possessed lower levels of formalisation compared to leaderless collaboration. The fourth type—participatory collaboration—was characterised by the general absence of the Weberian features of bureaucracy. In this type, decision making was largely consensual, and organisational structure was developed and maintained without recourse to formal contracts or hierarchical management. Although this study provides interesting insights into the organisation of research collaborations, because of the focus on Big Science and its narrow definition of collaboration, it can offer little to the breadth of activities that could be expected to be supported through research councils such as the NHMRC.
Laudel (2001) developed collaboration types—based on research actions between national collaborators in an interdisciplinary field—that constituted an overlap of several sub-disciplines of physics, chemistry and biology. This study explored two collaborative research centres in Germany funded by Germany's largest government funding agency—the Deutsche Forschungsgemeinschaft. The study involved an investigation of nearly 500 collaborations between scientists at universities and non-university research institutes. To investigate scientists' broad scope of research activities, qualitative interviews were conducted with approximately 100 scientists. A framework was developed based on the following six types of research collaboration contributions—ranging in intensity from high to low—that were found in Laudel's (2001) study.

The highest intensity collaborations were termed as division of labour collaborations. These involved collaborating throughout the whole research process. Mid-intensity collaborations were service collaborations (in which one collaborator was providing a service, such as a cell line) and transmission of know-how collaborations (in which one collaborator, for example, taught another a particular method). The lowest intensity types were characterised as mutual stimulation. Mutual stimulation is not related to a single research process and does not contain an exchange of clearly defined contributions, but is more about exchanging a range of ideas. This type is a side-effect of scientific communication and is therefore related to scientists' research work as a whole, to their respective research programs, or even to the work of their colleagues.

While the five types of collaboration developed by Laudel (2001) all connected with the process of knowledge production itself, Laudel also adopted a sixth type that related to the process of publishing results, which was termed trusted assessorship. The concept of trusted assessors was introduced by Mullins (1972), who coined the term to describe colleagues who act as accepted and friendly critics (Mullins, 1972: 18).

These types have been adopted by other sociologists of science examining interdisciplinary research collaboration (Rafols, 2007). Rafols (2007) examined
strategies of knowledge acquisition in bionanotechnology. He found that projects often combined the different types of research collaboration developed by Laudel (2001). He concluded, 'The findings highlight that there are various organisational practices, that can support integrative efforts. This observation challenges the view that bionanoscience cannot do without specific organisation structures’ (Rafols, 2007:409).

In summary, researchers can work together in a broad range of ways—as demonstrated by the types identified by Laudel (2001)—to acquire knowledge, rather than only in formal ways. Therefore, the strength of the types developed by Laudel (2001) is that they allow an inclusion of a broad range of activities. This was important for this study because one of the key questions was to understand the breadth and depth of activities being supported through NHMRC schemes. As a result, these types were used as a framework in this thesis.

**Higher Education and Organisational Studies**

Higher education studies have tended to examine research collaboration from the organisational perspective, rather than the micro level of the researcher. The few that have looked at the micro level have tended to simplify activities between collaborators and describe the social characteristics, rather than the research actions, of the collaborators. For example, Smith (2001:143) developed three broad types of collaborative practice based on collaboration within universities. He adopted a case study methodology by looking at collaborations in 15 universities. He interviewed senior and middle managers and active research staff. He interviewed researchers working in chemistry, computer science, civil engineering, sociology and the performing arts. The three types he identified were interpersonal collaboration, team collaboration and corporate partnerships.

Smith (2001) maintained that the interpersonal collaboration model was pervasive in university-based research because it was the essential building block of research activity and the basis of individual career advancement. This collaboration develops through a combination of friendships and shared local knowledge and expertise.
Team collaboration, as Smith (2001) explained, is a variant of interpersonal collaboration. These relationships are more formal because they normally have a quasi-contractual element. Smith explained that corporate partnerships exist at a more formal level, again, than the previous two models. They serve a variety of purposes, including the creation of joint research infrastructure, arrangements for linking academic and industrial research interests, and a variety of teaching studentships and research fellowships (Smith, 2001:145).

The main deficiency with Smith’s (2001) types is that he did not detail the research activities that occur in the collaboration types. As Smith acknowledged, ‘These models ... inevitably simplify the range of practice found across the sector’ (2001:147). Other typologies of research collaboration have been developed within higher education (Heffner, 1981; Subramanyam, 1983; Qin et al., 1997); however, like Smith (2001), these approaches did not fully explore the breadth and depth of research activities that occurred in research collaborations.

There is a paucity of organisational studies regarding research collaboration. These studies have instead concentrated on production (Pfeffer & Salancik, 1978; Browing et al., 1995; Gulati, 1995; Powell et al., 1996), service and innovation (Alter & Hage, 1993), government (Clarke, 1989) and non-profit organisations (Kang & Cnaan, 1995). The few studies that have examined research collaboration have investigated industrial research between firms (Quintas & Guy, 1995), not the research mostly funded by NHMRC between university researchers. As a result, ‘Regrettably, although there is a vast literature on inter-organization relations, organizational studies have largely ignored scientific collaboration as objects of inquiry’ (Shrum et al., 2007:88).

Summary

In summary, the literature on the internal dynamics of national research collaboration is sparse, and the internal dynamics of international research collaborations have been virtually unexplored. Studies on research collaboration have either investigated the published outputs of collaborations, which show nothing of the contributions of each
collaborator, or have tended not to be comparative and have focused on Big Science. Also, rather than examining contributions to the research process, studies have focused on how the research process was organised.

This review of the literature on the internal dynamics of research collaborations between university researchers demonstrates that there is a significant gap in the knowledge of the different contributions to the research process that occur in international research collaborations. As a result of scarce evidence on the internal dynamics of research collaborations, Chapter Three investigates the question: What is international research collaboration? The next section moves from looking at the literature on the internal dynamics of research collaboration, to what is known about the conditions that facilitate, hinder or are essential to research collaboration.

**What is Known About the Conditions for Research Collaboration?**

Before discussing investigations that have examined the influences on research collaboration, it is important to note that all decisions on research are mediated by researchers. Laboratory studies have demonstrated that research decisions are made based on a range of considerations (Knorr Cetina, 1981; Lynch, 1985; Latour & Woolgar, 1986 [1979]; Fujimura, 1987). These studies have also shown that researchers decide how and what problems they investigate; they have also shown that all influences are mediated by researchers’ decisions. As highlighted by Gläser (2011:5):

> Researchers are autonomous in the sense that a direct intervention in their decisions on research is a rare exception. The formulation of problems and the selection of approaches to problem-solving reside with researchers who interpret knowledge of their community, derive problems and suitable approaches and from that knowledge assign themselves the resulting tasks. Although they need to adapt this decision to their situation, there is little direct intervention in the formulation of problems and selection of approaches.

While the ability to directly influence researchers’ strategic decisions is low, researchers’ decisions depend on their conditions of action. But what is known about these conditions for international research collaboration, and are certain conditions
more important than others? A number of conditions have been identified as being important in research collaboration, as will be discussed in the following section. Using the approach to distinguish these conditions as adapted from Laudel (1999:26–27, 42–49), these conditions can be broadly termed as being epistemic, social, cultural, institutional or economic. The literature on each of these will now be discussed.

**Epistemic Conditions**

Epistemic conditions of action are a specific case of cognitive and technical conditions of action. They are conditions produced by material objects, material means of actions and knowledge applied in human actions (Gläser & Laudel, 2004:31). It is obvious that there needs to be some form of epistemic link in order for researchers to collaborate, otherwise their respective inputs to a research process could not be linked. To undertake their research, scientists often need to access the knowledge of other researchers. They collaborate to develop their research problems, to further develop current methods or learn new methods, and to identify and access objects or populations. However, how do researchers establish these epistemic links between collaborators? Are different types of epistemic links required for different types of research collaboration? Furthermore, how are epistemic links developed and maintained by international researchers in particular?

Galison (1996, 1997:781–844) demonstrated that these problems can be addressed by developing shared research languages called ‘pidgin’ and ‘creole’. In Laudel’s (2004) study on interdisciplinary research collaboration between biologists, physicists and engineers, she found that in successful collaborations, ‘These artificial languages emerge in the communication of collaborators who use elements of their fieldspecific languages. This way a simplified, reduced language for mutual understanding is created’ (Laudel, 2004:5). This shared language is developed and implemented successfully only if there is a broad platform of shared knowledge.
Star and Griesemer (1989) developed the term ‘boundary objects’ to refer to concepts that enable actors to collaborate. They stated that when the worlds of different collaborative actors intersect, a difficulty appears:

The creation of new scientific knowledge depends on communication as well as on creating new findings. But because these new objects and methods mean different things in different worlds, actors are faced with the task of reconciling these meanings if they wish to cooperate. This reconciliation requires substantial labour on everyone’s part. Scientists and other actors contributing to science translate, negotiate, debate, triangulate and simplify in order to work together (Star and Griesemer, 1989:388–389).

Star and Griesemer (1989) stated that the use of method standardisation and the concept of boundary objects enable heterogeneity and cooperation to coexist, and actors to collaborate. They explained that boundary objects are ‘both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites’ (Star & Griesemer, 1989:393).

Although it may seem obvious that having epistemic links between collaborators is necessary, there is surprisingly little literature regarding these associations—specifically, what these links are, their strengths, and how they relate to different collaboration types. How these epistemic links are developed and maintained in international research collaborations appears to have not been assessed.

**Social Conditions**

Social conditions, including personal relationships, trust between collaborators, and interactions during projects, have been found to be important in research collaborations (Merz, 1997; Newell & Swan, 2000:1295; Laudel, 2004). For example, Merz (1997) discussed the importance of face-to-face communication during research collaboration. She investigated theoretical physicists and maintained that their laboratories included both a physical space and an electronic space. The physical space ‘is the space in which office, research centres and substances are located’ (Merz, 1997:313). Electronic spaces are the spaces in which emails,
computer files and programs are exchanged. Merz (1997:316) found that ‘email interaction is not a substitute for travelling and face to face interaction’. Merz (1997) also found that face-to-face contact was important in collaborations that were already underway: ‘Most projects of disembedded collaborations, however, are initiated face to face’ (Merz 1997:323). A key finding of Merz (1997:327) was that:

Electronic exchanges are an extension of face-to-face interaction and a precursor, but no direct substitute. These observations lead to the conclusion that travelling does not become obsolete because of electronic exchange. On the contrary the ease of email encourages scientists to join in collaborations with physically distant colleagues and this perpetuates the need for travelling.

Like Merz (1997), Olson and Olson (2000) demonstrated that face-to-face interaction is important. They found that even the best technology must be complemented by activities that build trust and understanding through sustained face-to-face social interaction. Keohane (1986:157) found that communication that is not face-to-face is ‘less social, more focused on the topic at hand, more planned, less ambiguous and more likely to contain misunderstandings than communication conducted in person’. Frequent and ad hoc interactions have been found to be important in research collaboration and to be promoted by local proximity (Laudel 2004; Griffith & Mullins, 1972; as cited in Laudel, 2004). Each of these aforementioned studies investigated national collaborations. Therefore, how international collaborations deal with this lack of proximity appears to deserve investigation. These studies provide useful insights into some social conditions; however, they only focused on these single conditions and thus give an incomplete picture of the conditions required for collaboration. In addition, while they highlighted the importance of face-to-face interaction, they did not discuss how international collaborations address this need.

Trust is another social factor that has received much attention in the literature, but the role it plays in collaboration has been found to be mixed. Many have found it to be crucial (Alter & Hage, 1993; Shapin, 1994; Browning et al., 1995; Gulati, 1995; Newell & Swann, 2000; 1295; Laudel, 2004), while others have found that a high level of bureaucracy within a team of collaborators can render trust as unimportant (Shrum et al., 2007). Newell and Swann (2000;1295) reported the importance of ‘competence trust’, which refers to trust in the research capabilities of the
collaborator in research collaborations. They also found that 'companion trust' was
ing important in collaborations. Companion trust 'refers to trust that is based on
judgments of goodwill or personal friendships' (Newell & Swann, 2000:1295).
However, other studies contended that the importance of trust has been
overestimated, and that higher levels of bureaucracy in research collaborations can
reduce the need for high levels of trust (Shrum et al., 2007). Therefore, the
importance of trust is unclear. It is also unclear how trust is developed and maintained
in international research collaborations.

Economic Conditions

In this study, economic conditions refer to the secured and unsecured funds of the
researcher, and the time required for research. Access to resources is essential for the
continuation of research (Knorr Cetina, 1981; Fujimura, 1987; Morris, 2000; Laudel,
2006; Gläser & Laudel, 2007; Leišytė et al., 2010; Gläser et al., 2010). As a result,
'Collaboration often depends on the resource availability provided via grants' (Lee &
Bozeman, 2005:689) The funding conditions for publicly-funded research have
changed over recent years, as discussed in the Introduction, and as will be discussed
further in the following section regarding the effects of institutions on research
collaboration. However, there has been little exploration regarding how these changes
affect international research collaboration, as is discussed in the second section of the
literature review. Economic conditions are noted here to highlight that they are one of
the conditions of action important for international research collaboration.

Cultural Conditions

Cultural conditions refer to research cultures and styles of doing research. In this
study, they also refer to ways of undertaking research within a country and national
culture. In regard to ways of undertaking research, experimentalists, for example,
have been found to collaborate with more than theoreticians (de Solla Price, 1963;
Meadows & O'Connor, 1971; Gordon, 1980). Another example is that researchers in
the social sciences have been reported as collaborating less than researchers working
in the natural sciences.
Social constructivist studies have tended to ignore the influence of the scientific community (Knorr Cetina, 1981:68–93; as cited in Gläser, 2011:7). However, researchers have been found to be influenced by their scientific community’s shared body of knowledge when deciding their research problems and approaches (Pinch, 1986; Pickering, 1995).

Cultural conditions, with respect to national cultures, have also been found to affect research collaborations. Barjak and Robinson (2008:23) found that, ‘The most successful teams have a moderate level of cultural diversity’. Bozeman and Lee (2005:681) also reported that, ‘Factors related to nationality, culture and language are likely to affect collaboration’, and that, ‘Collaboration as a social interaction cannot be understood without considering culture [and] languages’. Other researchers have reported that, low levels of collaboration might be explained by cultural and language problems (Di Tomaso et al., 1993; Choi, 1995).

In summary, social constructivist studies on the scientific community have downplayed the influence of this community, and studies on national research cultures have been broad in their conclusions and have not been based on empirical evidence. Therefore, this study investigates these cultural conditions in regard to international research collaboration.

**Institutional Conditions**

Institutions are viewed in this study as systems of formal and informal rules (North, 1990; Mayntz & Scharpf, 1995; Scharpf, 1997). Institutional boundaries, such as discipline or organisation, can hinder or prevent collaborative research. Conditions related to researchers’ employing institutes, such as universities, are discussed in the following section of the literature review, entitled ‘The Effects of Funding Institutions on Research’.

In terms of studies about other institutional influences, Cummings and Keisler (2005) investigated scientific collaboration across disciplinary and university boundaries to
understand the need for institutions' coordination of collaborations, and how different levels of coordination predicted success. They conducted a study of 62 scientific collaborations supported by a program of the US National Science Foundation in 1998 and 1999. They reported a valuable finding that projects using more coordination mechanisms were more successful, reporting that, using more coordination mechanisms partly made up for distance and organisational (Cummings & Keisler, 2005). International research collaborations suffered from issues associated with working across large distances and in different organisations, thus these findings are relevant to international collaborations. However, Cummings and Keisler's (2005) study focused on projects being funded under one funding scheme. As a result, the findings may be specific to this scheme, and not relate coordinating mechanisms to different types of collaboration. Therefore, overall, organisational studies have revealed little about how researchers in a range of fields work together—particularly how international collaborators work together.

In addition, research collaboration norms have been noted as increasing the likelihood of some types of collaboration that are often not rewarded through publications. This is because they 'press actors to respond positively to requests for these collaborations without a guaranteed reward' (Laudel, 2004:6). For example, Keohane (1986:19–24) reported the norm of diffuse responsibility. Such collaboration norms have also been reported by Patel (1973:81), Hagstrom (1965:118) and Kreiner and Schultz (1993:193). But how do these norms and the coordination of collaborations relate to international research collaborations?

The above review exposed a paucity of studies examining the breadth and depth of conditions of action. As stated by Laudel (2004:1), 'Empirical studies of collaboration usually address only single promoting or hindering conditions and do not relate them to different kinds of collaboration'. Even the studies that have examined single conditions of action have not examined the conditions for international collaborative research. Therefore, Chapter Four asks: What are the conditions that affect international research collaboration? The following section of the literature review assesses studies that have investigated the effects of funding institutions on research.
The Effects of Funding Institutions on Research

This second section of the literature review examines the effects of institutions on research. The effects these studies have investigated have included changes in the way research is funded, the effects of peer review and the fact that academics now have to act as entrepreneurs in the changing research system.

Laboratory studies have demonstrated that the content of research proposals is subject to explicit or implicit negotiations among scientists, peer reviews and funding agencies (Knorr Cetina, 1981:88–89). A valuable finding of these studies is that researchers, themselves, must self-identify research problems, approaches and collaborators. However, in terms of insights into the effects of institutions, laboratory studies tend to underplay these influences and can thus offer little information, other than that institutions did exert an influence. However, the form of this influence and the effect of this influence are not investigated.

There have been investigations that examined how changes in research funding can affect research. For example, some investigations have examined the links between funding and the growth of scientific fields (Noll et al., 1986). However, funding and knowledge growth was not explored at the micro level, and knowledge growth was assessed only quantitatively. Therefore, social mechanisms were not explored, which meant that these types of inquiries raised more questions than answers (Cozzens, 1986).

Effects of research funding on knowledge have also been reported in studies about the effects of peer review. Chubin and Hackett (1990:60–65) reported that the research council peer-review process reduced or possibly steered lines of research. They found that between one third and one half of the scientists whose proposals were initially denied through external funding mechanisms had subsequently ceased a particular line of research. They also found that 60 per cent of the respondents to one survey believed that reviewers were reluctant to support unorthodox or high-risk research.
This risk-averse perception of peer-reviewed grant distribution has been confirmed in Germany (Nature, 2002), Canada (Berezin, 1998) and the UK (Travis & Collins, 1991:336; Horrobin, 1996).

Interdisciplinary research has also been found to be perceived as having a reduced probability of winning grants through peer-review processes (Travis & Collins, 1991; Berezin, 1998). Therefore, peer-reviewed grant distribution appears to affect knowledge production indirectly, by possibly affecting the applications submitted to research councils. However, these studies about peer review took the statements that scientists made about changes to their research at face value, and did not investigate whether and in what manner the supposed changes in the production of knowledge were brought about. Based on these studies, it cannot be presumed that the changed proposal actually led to a changed research project. According to one study, peer review changed the style of applications, rather than the content of the scientific work aimed at being undertaken (Myers, 1990). Researchers employed a type of ‘grantsmanship’ to craft their application to be seen more favourably during the peer-review process, rather than making substantial changes to the scientific content of the proposal (Myers, 1990).

A range of other studies contended that researchers tend to need to act like entrepreneurs in the changing research system (Mulkay, 1972; Ziman, 1984; Latour & Woolgar, 1986 [1979]; Rip & Nederhof, 1986; Fujimura, 1987; Atkinson-Grosjean, 2001; van der Meulen & van der Most, 2002). However, due to methodological approaches, they reveal little about how this need to act like entrepreneurs affects research at the level of the researcher.

Other studies have specifically examined research councils and their role in the changing research system (Braun, 1993; Rip, 1994; Guston, 1996; Braun, 1998; van der Meulen, 1998; Silvani et al., 2005). However, these studies tend to make general statements about these changes, rather than making empirically-based assessments about the effects of these changes on the conduct and content of research at the micro level of the researcher. For example, Rip (1994:6) discussed a ‘new role that is emerging for the research councils’ and emphasised that the ‘overall evolution of the
research system and the role of research councils in particular seems to point again and again to a more active role of the research councils’. He also stated that, ‘Being awarded a grant now is as important for the reputation or status of a scientist as the money value per se: research councils have become part of the reward system of science’ (Rip, 1994:3). Other studies (Braun, 1998) have made similar assessments, but have also done so without empirical support.

While science policies have acknowledged the increasing role of research councils, but not explored the effects at the micro level, the sociology of science has focused on the micro level and downplayed the effects of institutions. Therefore, there is a gap in the analysis between science policy studies and the sociology of science. This gap between institutions and how they affect research has effectively been black boxed by nearly all previous investigations.

However, there are a few studies that have attempted to open this black box. These studies reveal the value of the approach of identifying the links between institutions and their effect on research. Laudel’s (2001) study examined how a specific funding scheme, that of the German Cooperative Research Centres, could promote interdisciplinary and cross-organisational collaboration. Importantly, Laudel (2001) found that a funding scheme could provide some of the necessary and facilitating conditions, and remove some of the hindering conditions for interdisciplinary cross-organisation collaboration. The German Cooperative Research Centres provided a boundary crossing institutional framework in order to achieve this.

Morris (2004) examined how life scientists in academic institutions in the UK responded to a number of policies, including steering, increased accountability and the requirement to work with industry. She found that, overall, policies resulted in the adaptation rather than transformation of researchers (Morris, 2004). Researchers were able to develop ‘compromise packages’ (Morris, 2004:28), which were achieved ‘by developing a repertoire of strategies to manage policy demands without sacrificing their long term goals’ (Morris, 2004:52). The above studies (Laudel, 2004; Morris, 2004) and others (Gläser & Laudel, 2007; Leišytė, et al., 2010) indicate the value of focusing on the level of the researcher when assessing the effects of funding.
institutions. At this point, it is useful to highlight the studies that have specifically focused on the effects of institutions on international research collaboration.

**Effects of Institutions on International Research Collaboration**

A study was conducted by Wagner et al. (2002) that aimed to provide insights into improving the efficiency and effectiveness of government-sponsored international collaborations in science and technology. This project had three goals. Firstly, it sought to improve the understanding of the dynamics of international collaboration in science and technology. Secondly, it sought to provide tools to policy-makers in order to improve the effectiveness and efficiency of collaboration. Thirdly, it sought to coordinate with those conducting similar studies in different countries. Collaboration in Wagner et al.’s (2002) study referred to the specific scientific activities (research and observation, experimentation, data collection and publication) conducted by scientists working together on a common research project. The four cases studied were the HFSP, the Human Genome Project, Intelligent Manufacturing System and the Intergovernmental Panel on Climate Change. Wagner et al. asked 30 scientists and policy-makers specific questions relating to the intent of government involvement in the program, and the motivations for being involved. They focused on questions about the origination, motivation and administration of the program; how the program succeeded in attracting excellent scientific proposals; and how the collaborations should be evaluated, particularly given the difficulty of quantifying basic research outcomes.

They found that, ‘Governments and scientists are both interested in collaboration for interlocking, but often different reasons’ (Wagner et al., 2004:16). It was also noted that ‘formal programs help open doors to foreign laboratories that otherwise may have been difficult to access’ (Wagner et al., 2002:17). However, conclusions about the effects of these four programs were largely based on survey results. In addition, the structural elements of research were not investigated. For example, what did ‘opening foreign doors’ mean for the research? Did it mean access to unique objects, or developing joint problems? These assessments appear to be fairly superficial and
cannot reveal insights about how these programs affect research and what these
effects were at the level of the researcher.

A few bibliometric studies have examined the relationship between grants and
international research collaboration. For example, Butler et al. (2001, 2003, 2005,
2009) examined the effect of the Australian NHMRC funding schemes on
publications. They reported that international collaboration was higher under the
NHMRC Program grants scheme (which provided large, five-year grants for
programs of research), compared to the NHMRC’s Project grants scheme (which
provided small, project-based grants, normally for three years) (Butler et al.,
2009:17). However, because of the quantitative nature of bibliometric studies, these
studies were unable to discuss why international collaboration was higher under the
NHMRC Program grants scheme. Therefore, it was not clear whether the NHMRC
Program grants scheme had any effect on researchers collaborating with international
colleagues, and if it did, how it had this effect. As a result, these studies were only
able to report correlation, rather than explore causation and social mechanisms.

Other studies have also drawn conclusions about the effectiveness of international
funding schemes, without examining how or why these were effective. These studies
used mostly surveys and bibliometric analyses of the citation impact to draw
conclusions. An example of this is the consultancy reviews that have been done of the
HFSP (ARA & PREST, 1996; KPMG & PREST, 2001; NIFU STEP, 2006; Edler et
al., 2010). The aim of the 2010 review of the HFSP was to assess the outcome,
impact and appropriateness of the six schemes of the HFSP. The outcome and impact
of, for example the Fellowship scheme, was ‘very positive’ (Edler et al., 2010:3) as
was evaluated through the survey. The HFSP Research grants—one of the five
NHMRC schemes investigated in this study—were found to trigger broader
collaboration in various dimensions and to increase interdisciplinary collaborations.
In addition, a ‘clear majority of grantees also report a broadening of their research
fields’ (Edler et al., 2010:7). Again, because this study was based on survey results, it
was not able to be ascertained in which way funding schemes were effective. For
example, while the funding may broaden the research fields, the study did not
demonstrate in what way this occurred—whether it was in regard to using new
methods or objects, or addressing new problems, or all three. As a result, these studies cannot reveal information regarding how the scheme affected the internal dynamics of the international collaboration, and how it affected the content.

Shove (2003) examined the effects of research council programs, including international research collaboration council programs. She highlighted how researchers, as agents, shape and undertake a range of ‘horizontal manoeuvrings’ (Shove, 2003:378) to facilitate research council funding schemes to fit into researchers’ own agendas. She argued that these horizontal manoeuvrings have been neglected in previous investigations, and that further research is required in this area. However, she also black boxed how these schemes affected international research.

In summary, the second part of the literature review regarding the studies that have examined the effects of institutions, including funding schemes, on research, illustrated that there is a scarcity of studies in this area. As a result, ‘Our knowledge about how funding mechanisms influence the content of knowledge production is fragmented at best, especially with regard to specific effects of particular funding mechanisms’ (Laudel, 2006:490). Therefore, Chapter Five examines how five specific NHMRC funding schemes support international research collaboration.

Mayntz and Schimank (1998:753) further argued that in order to understand the mechanisms that channel external expectations towards science, the ‘performance level of the science system’ needs to be included in the analysis (Mayntz & Schimank, 1998:753). Morris similarly contended that, ‘There has been less attention at the micro-level and the strategies open to research performers at the individual research group ... to negotiate a way through a changing research environment’ (Morris, 2004:21). Chapter Six responds to this lack of attention by exploring how the NHMRC schemes affect international research collaboration at the level of the researcher. What adaptations did researchers make in this regard because of the NHMRC funding scheme? What are the social mechanisms through which funding schemes affect research collaboration, and what are the effects of these?
This study endeavours to demonstrate the relationships between funding schemes and changes in the conduct and content of international research collaboration. By linking researchers’ perceptions of NHMRC funding schemes to adaptations, strategies, and changes in conduct and content, the mechanisms that lead to these changes can be identified.

**Summary and Research Questions**

To conclude, the first section of the literature review investigated studies on the internal dynamics and conditions for research collaboration. It was revealed that there are few studies regarding the concept and activities of research collaboration between university researchers, with international research collaborations having been next to unchartered. As a result, Chapter Three asks: What is international research collaboration?

The examination of the conditions of action required for research collaboration found that studies had focused on single conditions, not linked them to different types of research collaboration. They had also not focused on international research collaboration. Therefore, Chapter Four explores the conditions that affect international research collaboration.

The second section of the literature review examined studies on the effects of institutions, including funding schemes, on international research collaboration. This found that there was a lack of understanding of how specific funding mechanisms affect research, particularly in regards to international research collaboration. Chapters Five and Six respond to these gaps. Chapter Five investigates how the five NHMRC schemes support international research collaboration, and Chapter Six investigates how these NHMRC schemes affect international research collaboration conduct and content. The methods used to investigate these questions are described in the following chapter.
Chapter Two: Methodology

This study uses mainly qualitative methods to contribute to a middle-range theory that links variations in institutions to changes in international research collaboration conduct and content. The limited research that assesses the effects of funding schemes is usually based on statistical associations or researchers’ opinions. In addition, the effects at the level of the researcher are usually not investigated. As stated by Morris (2000:426), ‘The researcher’s standpoint is often neglected, but can give vital feedback to managers, policy-makers and sponsors on the needs of research and its outcomes’. Therefore, this study aims to address the methodological shortcomings of previous studies by conducting an independent analysis of the structural properties of research and by examining the effects of NHMRC schemes at the level of the researcher.

To achieve this, a triangulation of methods was implemented, including policy documents analysis, analysis of scientific papers and interviews with Australian and international researchers and NHMRC managers. Bibliometric research trails were also constructed for researchers interviewed. This study is theory driven in the sense that it uses relevant previous findings, but constantly challenges these. In addition, this study stretches over many research processes that are linked through their contributions to the proposed middle-range theory. As a result, this research is based on theory testing as well as theory building.

Comparative case studies were developed to examine variations in multiple conditions and their effects. This was done in order to identify the social mechanisms that link different institutions to changes in research, and link the analysis in science policy studies to that of the sociology of science. Mayntz defines social mechanisms as ‘recurring processes generating a specific kind of outcome’ (2004:237). This definition has been further refined by Gläser as a ‘sequence of casually linked events that occur repeatedly in reality if certain conditions are given and link specified initial conditions to a specified outcome’ (2011:4).
Analytical Framework: Actor-Centred Institutionalism

The independent variable in this study of NHMRC funding schemes was defined as institutions (North, 1990; Mayntz & Scharpf, 1995; Scharpf, 1997). When seeking a theoretical framework to guide this study, it became clear that there did not exist a theory of research collaboration, nor a theory regarding how funding institutions affect research (Chapter One).

However, there was an analytical approach that could support investigating the effects of institutions on changes in international research collaboration conduct and content. This approach was actor-centred institutionalism (Scharpf, 1997). This was adopted for this study because actor-centred institutionalism is an analytical approach that supports the specific theoretical interest in institutions, making them the central independent variable whose effects are to be investigated. This originates, and has been mostly used, within political science. However, this approach has also been used effectively by the few sociologists of science who have investigated the effects of other institutions, such as research evaluation systems, on knowledge production (Gläser & Laudel, 2007:127–151). Actor-centred institutionalism does not reduce explanations of actions to institutional influences, but treats the latter as a factor that can be enforced or counteracted by other influences. Figure 2 below outlines the relationships between variables and mediating processes.
Institutional Conditions of Action
NHMRC funding programs that support international collaborative research

Other Conditions of Action

- Epistemic
  - Technical/cognitive conditions produced by material objects, material means of actions and knowledge applied in human actions

- Economic
  - Secured funds to support research
  - Other sources of funding

- Social
  - Status and sonority

- Cultural
  - Research culture/styles of doing research
  - Rules of scientific communities, such as holding regular meetings. Collaboration is common in that field.
  - Publications rules—order of authors.

Other Institutional Conditions
- Regulation of research
- University conditions, such as supporting leave to work overseas

Individual Traits
- Collaborating researchers’ goals and interests

Actions of Collaborating Researchers:
Negotiation Processes
Considering whether to apply, with whom to collaborate, what type of collaboration is required, the type of research problem, method, and so on.

Adaptation
Conscious and subconscious decisions about possible application

Adaptations in the Conduct of Research
1. Type of collaboration
2. Countries of collaborating researchers
3. Were new collaborations commenced?
4. Size of collaboration

Adaptations in the Content* of Research
Changes in structural elements of research:
- Quality, innovativeness, the degree of risk taken, the heterogeneity of knowledge combined in the research (interdisciplinarity), time characteristics of research (long-term versus short-term processes), the relationship of research to the community majority opinion (non-conformist versus mainstream); and the basic versus applied character of research. Also character of the research—methodological, theoretical or experimental in nature—the reliability of results, and the form of its output (articles or book-length contributions)

*Decisions on research problems, methods and objects were used as proxies for content

Key:
- Independent variable
- Intervening variables
- Dependent variables
- Mediating processes

Figure 2: Relationships Between Variables and Mediating Processes
The list of structural properties of research content and conduct listed in the dependent variables in the above diagram were drawn from the few studies that have examined the effects of institutions on research content (Gläser & Laudel, 2007:132) and other collaboration research (Hackett, 1995). Epistemic properties are intervening and dependent variables. Responses of researchers to funding schemes can be assumed to depend on the characteristics of their field (Gläser & Laudel, 2007:127–151).

**Research Strategy: Comparative Case Studies**

In order to contribute to a middle-range theory based on mechanistic explanations, a comparative case study approach is required. This enables different sets of conditions and their outcomes to be assessed. Two levels of cases were compared in this investigation. Patton (2002:298) stated that, ‘When more than one object of study or unit of analysis is included in fieldwork, case studies may be layered’. This was the situation in this study. Given that the independent variable of this study was NHMRC funding schemes (see Figure 2), comparisons were made between different types of funding schemes that supported international collaborative research. These served as first-level cases. Second-level cases were projects funded through an NHMRC scheme, in which an Australian researcher was working with an international collaborator. These were termed ‘projects of investigation’ and were the focus of interviews with researchers.

A case study approach is powerful because it facilitates the complexity of social phenomena to be understood. It enables the investigator to gain detailed information about specific decisions and events, and about the broader context within which these occur. Patton (2002:297) asserted that, ‘The case study is the study of the particularity and complexity of a single case and coming to understand its activity within important circumstances’. Using a case study approach enabled this study to focus on both the phenomenon and the context in which it exists, through analysing a number of influences and their relationships. Case studies could support the level of investigation needed, as they facilitated a ‘thick’ (Geertz, 1973:3–30) investigation of
the phenomenon. Although case studies are not representative from a statistical point of view, causality can still be examined. According to Yin (1994:30), case studies involve ‘analytical generalisations’ of findings to theory, rather than ‘statistical generalisations’, which means that analysis is based on comparing the empirical data to an existing theoretical framework. Mitchell (1983:207) highlighted the importance of theory and stated the benefits of case study research:

In case studies statistical inference is not invoked at all. Instead the inferential process turns exclusively on the theoretically necessary linkages among the features in the case study. The validity of the extrapolation depends not on the typicality or representativeness of the case but upon the cogency of the theoretical reasoning. ... case studies may be used analytically ... only if they are embedded in an appropriate theoretical framework. The rich detail which emerges from the intimate knowledge the analyst must acquire in a case study ... provides the optimum condition for the acquisition of those illuminating insights which make formerly opaque connections suddenly pellucid.

Following Mitchell (1983) and Yin (1994), the case study research that is used in this work is designed to capture the explanatory, descriptive and exploratory components of international research collaboration, and the role that funding schemes play in this activity.

**Case Selection of NHMRC Schemes and Researchers**

**Selection of NHMRC Schemes**

In order to establish which NHMRC schemes to examine, and thus which researchers to interview, all NHMRC funding tools were explored to assess which supported international research collaboration. Schemes were identified through the NHMRC website and other public documents, such as NHMRC annual reports and policy documents. The search revealed six relevant schemes. Four schemes were specifically aimed at supporting international research collaboration. For this study, these were termed ‘targeted schemes’. There were another two schemes that could be used to support international research collaboration. For this study, these were termed ‘general schemes’. The four targeted schemes were the NHMRC European Union Collaborative Research Grants (NHMRC-EU), the International Collaborative...
Research Grants (ICRG), the HFSP and the Indigenous Collaboration Grants Scheme. The two general schemes were the Project and Program grants schemes.

Given that this study sought to obtain an understanding of the range of international collaboration NHMRC supports, all six schemes were initially included in the study. However, one of the targeted schemes identified—the Indigenous Collaboration Grants Scheme, which supported collaborative teams in Australia, New Zealand and Canada to work jointly on Indigenous health issues—had only funded one large project at the time of interviews. To ensure that this research team was not able to be identified, this scheme was not included in the study. The NHMRC also funds international fellowships, but given that this study investigates collaboration between teams, these were not included in the study. The five schemes included in the study covered all the research fields that the NHMRC supports (see Table 1). Further details on the schemes included in the study are outlined in Table 2 and are discussed below.

**Table 1: NHMRC Schemes by Research Field**

<table>
<thead>
<tr>
<th>NHMRC Scheme</th>
<th>Research Field</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Targeted Schemes</strong></td>
<td></td>
</tr>
<tr>
<td>NHMRC-EU Collaborative</td>
<td>Clinical and Experimental</td>
</tr>
<tr>
<td>Research Grants</td>
<td>Public Health</td>
</tr>
<tr>
<td>HFSP Research Grants</td>
<td></td>
</tr>
<tr>
<td>ICRGs</td>
<td></td>
</tr>
<tr>
<td><strong>General Schemes</strong></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td></td>
</tr>
<tr>
<td>Programs</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: NHMRC Targeted and General Schemes Included in Study

<table>
<thead>
<tr>
<th>Schemes</th>
<th>Aim and Research Supported</th>
<th>Role of International Collaborators</th>
<th>Funding</th>
<th>Selection Criteria</th>
<th>Success Rate</th>
<th>Financial Importance</th>
<th>Responsibility for Governing Scheme</th>
<th>Included in Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHMRC-EU Grants</td>
<td>Support Australian researchers to engage with European researchers under the EU Framework Programme.</td>
<td>Australian researchers must be engaging with EU researchers; NHMRC does not fund EU researchers. Research conducted in Australia and Europe.</td>
<td>5 years. 1 million AUD.</td>
<td>1. Value of the Australian component to the EU researcher</td>
<td>Normally 100% (Australian success rate under Australian scheme, not under Framework Programme).</td>
<td>LOW About 0.5% of NHMRC’s annual budget.</td>
<td>Australian component by NHMRC.</td>
<td>Yes.</td>
</tr>
<tr>
<td>HFSP Research Grants</td>
<td>Support innovative, interdisciplinary and intercontinental research teams.</td>
<td>Teams must be international and ideally intercontinental. Research conducted in Australia and overseas.</td>
<td>3 years. 250,000 USD for team of 2; 350,000 USD for team of 3; 450,000 USD for team of 4.</td>
<td>1. Innovative nature 2. Interdisciplinary approach 3. International, preferably intercontinental nature.</td>
<td>Around 15% from EOI and around 40% for full application.</td>
<td>LOW About 0.25% of NHMRC’s annual budget.</td>
<td>International Board of 26 member countries of which NHMRC represents Australia.</td>
<td>Yes.</td>
</tr>
<tr>
<td>ICRGs</td>
<td>Support collaborative research between Australia, New Zealand and developing countries in South East</td>
<td>Must have a principal investigator from a developing country and at least one Australian and/or New Zealand</td>
<td>5 years. Average grant is 3 million AUD.</td>
<td>1. Potential for health outcomes in developing countries 2. Scientific merit</td>
<td>25%.</td>
<td>LOW About 2% of NHMRC’s annual budget—one-</td>
<td>Jointly governed by NHMRC and Wellcome Trust and Health Research Council</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

2 These were success rates in the late 2000s.
3 The remainder of the NHMRC research budget is allocated to mainly NHMRC Fellowships and some small strategic schemes.
4 There was 100 per cent success rate at the time of interviews. NHMRC conducted its own peer review of proposals, but given the proposal had already gone through the EU peer-review process, this is likely to be the reason for the high success rate.
<table>
<thead>
<tr>
<th>Schemes</th>
<th>Aim of Research</th>
<th>Role of International Collaborators</th>
<th>Funding</th>
<th>Selection Criteria</th>
<th>Success Rate</th>
<th>Importance</th>
<th>Responsibility for Governing Scheme</th>
<th>Included in Study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Grants</strong></td>
<td>Main mechanism for supporting individual teams at all levels.</td>
<td>Cannot be chief investigators. Research must be in Australia.</td>
<td>3 years. Around 300–500 AUD.</td>
<td>1. Scientific quality (50%) 2. Significance and/or 3. Innovation (25%) 4. Track record (25%).</td>
<td>22% (2005). Normally around 20%.</td>
<td>HIGH About 50% of NHMRC’s annual research budget.</td>
<td>Governed by NHMRC.</td>
<td>Yes.</td>
</tr>
<tr>
<td><strong>Program Grants</strong></td>
<td>Provides support for broad areas of research for later career researchers.</td>
<td>Cannot be chief investigators. Research must be in Australia.</td>
<td>5 years. Based on team, rather than research. 5–10 million AUD.</td>
<td>1. Record of research achievement (60%) 2. Research plan (20%) 3. Collaborative gain (20%).</td>
<td>Around 25%.</td>
<td>MID Around 10% of NHMRC’s annual research budget.</td>
<td>Governed by NHMRC.</td>
<td>Yes.</td>
</tr>
</tbody>
</table>
Further details on the schemes are discussed below.

**Targeted Schemes: NHMRC-EU Collaborative Grants**

*Aim and Policy Development*

The policy for these grants is developed solely by the NHMRC and is funded only by the NHMRC. The aim of these grants is to support Australian researchers who are part of teams that are successful under the EU Framework Programme in health related fields. Currently, Australian researchers cannot access funds directly from the EU under the Framework Programme. The NHMRC established this scheme in 2002.

*Peer Review*

If an Australian researcher is part of a team that has been through the EU Framework Programme peer-review process and is identified as 'ready to proceed to the contract stage', they can then apply to the NHMRC under this scheme and go through a limited peer-review process compared to the normal NHMRC peer-review process.

*Management of Grants*

If successful through the NHMRC peer-review process, the funds are then awarded by the NHMRC and managed directly by the NHMRC. The institutes of the Australian researchers have to develop a schedule specific to the project and attach it to the Deeds of Agreement that the NHMRC has with administering institutions. The administering institution also has to sign a contract with the EU Framework Programme.
Targeted Schemes: HFSP Research Grants

Aim and Policy Development

This scheme supports novel, innovative and interdisciplinary basic research focused on the complex mechanisms of living organisms. A clear emphasis is placed on novel collaborations that bring biologists together with scientists from fields such as physics, mathematics, chemistry, computer science and engineering to focus on problems at the frontier of the life sciences. Australia, through the NHMRC, became a member in 2004.

The policy for this scheme is developed by a single international agency consisting of 14 membership countries (mostly developed countries) who contribute money to the program based on a percentage of their national Gross Domestic Product (GDP). These membership countries sit on the HFSP Board, which has final sign-off of all policies.

Peer Review and Management of Grants

The peer review is undertaken jointly by the membership countries through the single international organisation of the Human Frontier Science Organisation. It is managed by the secretariat of the international agency.

Targeted Schemes: International Collaborative Research Grants

Aim and Policy Development

The policy for these grants is jointly developed by the three national research agencies in the UK (Wellcome Trust), Australia (NHMRC) and New Zealand (New Zealand Health Research Council). These grants fund Australian researchers, New Zealand researchers and researchers in developing countries to undertake public health research in developing countries. There was only one round of these grants in 2004. A similar form of grant was introduced through the NHMRC Project grants in 2009.
Peer Review

The peer review is jointly undertaken by the three agencies. This is done with a single peer-review panel consisting of representatives from each organisation.

Management of Grants

The funds are provided separately by each funding organisation to researchers’ administering institutes, and are administered separately. The NHMRC provides funds to the institutes of Australian researchers; the New Zealand Health Research Council provides funds to New Zealand researchers; and the Wellcome Trust provides funds to developing countries, through the Australian and New Zealand administering institutes. The grants are then managed separately by each of the funding agencies, in terms of assessing annual reports.

General Schemes: Program Grants

Aim and Policy Development

NHMRC Program grants were introduced in 2001 following the NHMRC phasing out of block funding for a number of institutes. It is the main vehicle to support mid- to late-career research teams. This scheme provides support for teams of researchers to pursue broadly-based collaborative research activity. The Program is expected to provide support for all of the chief investigator’s research.

Peer Review and Management of Grants

The peer review is conducted by NHMRC. International panel members not normally involved in the peer review process. Grants are managed by NHMRC staff. NHMRC has one Deed of Agreement with an administering institution. Schedules that relate to the different funding schemes and individual projects, programs or fellowships are attached to this Deed of Agreement. The NHMRC only supports direct research costs and does not provide salaries for chief investigators through Program and Project grants.
General Schemes: Project Grants

Aim and Policy Development

The Project grants scheme aims to promote research that is initiated by investigators. It supports individuals and small teams.

Peer Review

The peer review is conducted by NHMRC. International panel members are not normally involved in the peer review process. Grants are managed by the NHMRC staff.

Selection of Researchers

After establishing the five NHMRC schemes that would be investigated for this study, it was necessary to select which researchers who were supported through these schemes would be invited to be interviewed. I initially decided on researchers with projects starting in the early to mid-2000s. I did this for three reasons. Firstly, because the interviews were planned for 2006 and 2007 and I wanted researchers to still be able to recall the collaboration with a high degree of detail and accuracy. Secondly, it was important for researchers to have had enough time to work together, so they could provide a detailed account of how the collaboration functioned. Thirdly, I thought that this time period may have given researchers time to publish some of the work they had done during the project under investigation.

Possible interviewees were identified through the NHMRC annual reports. While all the projects under the three targeted schemes involved international collaborations, it was not apparent, based on the publicly available information, which projects funded under the Program and Project grants were working with international colleagues. To determine this, a random sample of Australian researchers listed in the NHMRC annual reports were contacted via mail and asked if they were working with an international researcher as part of the
NHMRC-funded project. If they were, they were then invited to participate in the study.

**Reflexive Considerations in Selecting Researchers**

As noted in the Introduction, I was a manager at the NHMRC from 2000 to 2009, and I also represented Australia on the HFSP Board from 2004 to 2008. This was during the time that interviews were conducted for this PhD. As such, two measures were implemented to ensure that participants were confident that this was an independent study and that their participation was confidential.

I wanted to ensure that I was not aware who was invited to participate in this study because I was concerned about two issues. Firstly, I was concerned that researchers might feel pressure to be involved in the study—given that I worked at the NHMRC, they could believe that participation may affect their funding prospects. Secondly, I was concerned that researchers would not participate for fear that anything negative they reported about the NHMRC may also affect their funding prospects. Therefore I provided my supervisors with a random list of 62 researchers and, from that list, they selected researchers and invited them to be part of the study. The letter inviting researchers made it clear that I had given a large list to my supervisors, who had then forwarded the invitations. As a result, I was not aware who, of the 62 researchers, were invited to partake.

In addition, I wanted the study to be seen as independent of the NHMRC. I obtained signed statements from the Secretary General of the HFSP (see Appendix A) and the Chief Executive Officer of the NHMRC (see Appendix B) that stated that this PhD was an independent study and was not funded by either of these organisations in any way. These statements were included in the invitation letters and copies were also provided to interviewees at the time of the interview.

I aimed to interview researchers from all the fields of research that the NHMRC supported in order to investigate whether any effects caused by a particular field mediated the effects of the NHMRC scheme. Table 4 reflects the research area of interviews by scheme.
Table 3: Interviewees by Research Field

<table>
<thead>
<tr>
<th>NHMRC Scheme</th>
<th>Research Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clinical and Experimental</td>
</tr>
<tr>
<td></td>
<td>Public Health</td>
</tr>
<tr>
<td><strong>Targeted Schemes</strong></td>
<td></td>
</tr>
<tr>
<td>NHMRC-EU Collaborative Research Grants</td>
<td></td>
</tr>
<tr>
<td>HFSP Research Grants</td>
<td></td>
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<tr>
<td>ICRGs</td>
<td></td>
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<tr>
<td><strong>General Schemes</strong></td>
<td></td>
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<tr>
<td>Project</td>
<td></td>
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<tr>
<td>Programs</td>
<td></td>
</tr>
</tbody>
</table>

Twenty-nine in-depth interviews with researchers were conducted during 2006 and 2007. Twenty-one of these interviews were with Australian researchers, and eight were with their international colleagues on the projects of investigation. One interview was not included in the study because during the interview it was revealed that the Australian researcher was not working with international colleagues as part of the NHMRC-funded project. As a result, there were 20 projects of investigation (see Table 4).

Table 4: Researchers Interviewed

<table>
<thead>
<tr>
<th>SCHEME</th>
<th>RESEARCHERS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Australian</td>
<td>International</td>
<td></td>
</tr>
<tr>
<td>Aust EU</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>HFSP</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ICRG</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Program</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Total interviews</strong></td>
<td><strong>20</strong></td>
<td><strong>8</strong></td>
<td></td>
</tr>
</tbody>
</table>

Eight of the 20 projects of investigation were double-sided, with both an Australian and international collaborator on the project of investigation interviewed. In the remaining 12 projects, only the Australian researcher was interviewed. I aimed to gain an insight into a broad range of NHMRC international collaborations, so I interviewed Australian researchers working in
most states and territories with international collaborators in both developed and developing countries.

**Selection of NHMRC Policy Managers**

NHMRC policy and program managers were also interviewed in order to understand the policy goals and decision-making processes regarding how the schemes were developed, implemented and managed. I searched the NHMRC website to identify managers who had been involved in both targeted and general schemes. These participants were also provided with the statements that made it clear that this investigation was an independent study.

The steps taken to gather, process and analyse the data will now be discussed.

**Data Collection**

Interviews were conducted with researchers and NHMRC policy managers.

**Interviews with Researchers and NHMRC Managers**

In-depth interviews were held with Australian researchers regarding their NHMRC-funded projects. For half of this group, their main international colleague was also interviewed. In addition, interviews were held with NHMRC policy and program managers. The method of in-depth qualitative interviews was chosen because it could be used to ‘gain access to, and understanding of activities which cannot be observed directly by the researcher’ (Minichiello et al., 2008:66). This method encouraged researchers to describe what was meaningful or important to them using their own words, rather than being restricted to predetermined categories. In addition, in-depth interviews enabled me to probe for details to ensure that researchers were interpreting questions in the way that I intended. In this way, these interviews also enabled information from outside the initial framework to be considered.
Interviews with Researchers

Preparing for Interviews

I conducted scientifically-informed interviews (Laudel & Gläser, 2004) with researchers. Scientifically-informed interviews had to be conducted in this study for three reasons. Firstly, epistemic conditions of action must be included in sociological explanations. Secondly, the research questions must be operationalised. Thirdly, qualitative interviewing requires a depth than cannot be achieved without being familiar with the interviewee’s world. The research question and approach demanded that I know a great deal of detailed scientific information about the researchers’ interests, work and international projects of investigation. Therefore, I prepared for each interview by examining information regarding the researcher’s field, the researcher’s whole research trail, and the researcher’s international project of investigation. I prepared for interviews by using the following sources:

- Research proposals and research reports
- Published papers
- Major texts of the field
- A medical dictionary
- Public documents of the funding agency, university or research institute, such as annual reports and newsletters
- Publication lists from publication databases, such as the Science Citation Index.

Constructing Bibliometric Research Trails

As well as exploring cases through in-depth interviews, I developed information about the breadth of each researcher’s research area to investigate how the international collaboration affected this, prior to the interview. This entailed constructing a bibliometric research trail for each interviewee, as developed by Gläser and Laudel (2007:134–135). This method is based on bibliographic coupling and involved obtaining a list of all the interviewees’ publications between 1990 and 2006. These were obtained from the Web of Science. These publications were then mapped by year, using joint references to construct a
structured network of interlinked publications. This enabled an insight into topical changes and broad trends in each researcher's publication behaviour. This research trail was also used to examine publications that had resulted from the international collaboration, and to see if the collaboration represented a major change towards a new research area. These research trails were discussed with researchers at the beginning of interviews, and provided a useful starting point for discussions. An example of one of these research trails is shown in Figure 3, below.

![Figure 3: Example of a Bibliometric Research Trail](image)

(Strength of lines indicates topical proximity; size of circles indicates number of citations.)

**Conducting the Interviews**

Most of the interviews were conducted at the researchers' places of work. The interviews normally took 60 to 90 minutes, and were tape recorded and subsequently transcribed. Interviewees were asked questions based on a semi-structured interview guide. The interview guide was structured into three sections: research biography, the project of investigation, and other international research collaborations. There was one guide for Australian researchers and another slightly different guide for international researchers (see Appendices C and D).
asked more detailed questions of Australian researchers regarding their funding sources. The interview guide was developed around the following main themes:

1. Research biography
   - Current research projects, how they were funded and the projects' research area
   - Reasons for abandoning certain research topics and pursuing other leads—particularly the extent to which this behaviour was triggered by funding considerations
   - Strategic decisions (selection of problems, objects, methods and communication practices)

2. The project of investigation
   - Details of the epistemic properties of the NHMRC project of investigation in which they were collaborating with international researcher/s
   - How strategic decisions (selection of problems, objects, methods and communication channels) were made in the project design phase, and the reasons for making these selections
   - Details about how the international collaboration worked

3. Other international collaborations
   - Details about other actual and proposed international collaborations.

Questions were open so as not to predetermine answers, and to elicit a broad range of information. The questions mainly related to experience and behaviour in order to try to reconstruct the collaborative behaviour. The interview guide for Australian researchers was pre-tested with two of my supervisors in order to test the flow of the guide, my skills in probing and the pace at which I asked questions. The guide was also pilot-tested on one researcher, following which minor modifications were made.

The interview guide for international researchers was slightly different to that of Australian researchers. It asked specific questions about why these researchers worked with Australian researchers. In addition, because interviews with Australian researchers were conducted first, basic questions about the project in which they were collaborating were reduced in the international researchers’ guide, as this detail had already been discussed with their Australian counterparts.
Interviews with NHMRC Managers

Semi-structured in-depth interviews were conducted with two NHMRC policy and program managers. For reasons of privacy protection, I will not describe the characteristics of these interviewees. An interview guide for the NHMRC managers is included in Appendix E.

Analysis

This study analysed interviews using computer assisted qualitative content analysis, rather than the mainstream approach of coding. Following each interview with researchers and NHMRC managers, my handwritten notes were read and summarised for initial interpretation. Once all interviews were completed, they were uploaded to a computer program, MIA (Makrosammlung für qualitative InhaltsAnalyse—MIA) which is specifically designed to support qualitative content analysis (Gläser & Laudel, 2011).

Qualitative content analysis has advantages over coding in particular circumstances, such as when the position within the text and the way in which the information is reported is not relevant to the research question. This was the case in this study. This approach extracts the relevant information and processes it separately, rather than coding it within the text. This extraction leaves the investigator with a reduced body of text to process.

Qualitative content analysis means that data is reduced to only that which is relevant to answering the research question. The relevant information is separated from the original text, thus information is systematically reduced and structured according to the aims of the investigation. By extracting the information from interviews, I could reformulate the interview descriptions and other relevant information in my own analytical language, using the variables and dimensions I had developed for the study. Thus, the first step of extraction resulted in a significant reduction of the material. This process firstly involved variables and their dimensions being developed based on previous research (see Chapter One).
Secondly, the relevant information was extracted from the text. Thirdly, the extracted data was processed. These steps will now be described.

**Developing Variables and Dimensions for Extraction**

The core idea of qualitative content analysis is to work with a system of categories that is derived from theoretical consideration, but that can be changed and extended during the process of data analysis in a way that enables the observation of theoretical considerations (Gläser & Laudel, 2011:22). Each variable also has a time, cause and effect dimension. Any contradiction between theoretical considerations and data is not resolved when it occurs in the text, but at a later stage when the decision can be made in the context of all data and theory.

Prior to data collection, I developed a set of variables and related dimensions for each variable (see Appendix F). These variables were based on previous research. For example, social conditions have been found to be important in research collaboration—particularly trust and frequent interactions—so these dimensions were included in the ‘social’ variable. These variables were inputted to MIA to enable analysis based on my theoretical considerations, relevant to the effects of funding schemes on international research collaboration. An example in regard to the epistemic variables is given below.

**Table 5: Dimensions of Epistemic Variable**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Time</th>
<th>Field</th>
<th>Aspect</th>
<th>Value</th>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of collaboration</td>
<td>Research field</td>
<td>Size of field</td>
<td>How expensive research is to do in this field</td>
<td>Small/large</td>
<td>Scarcity of objects</td>
<td>Forced collaboration because of scarcity of objects</td>
</tr>
<tr>
<td>Riskiness of objects</td>
<td>Eigentime</td>
<td>Cheap/expensive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intervening variable: Epistemic (field-specific conditions and conditions of the local working environment. Specific case of cognitive/technical conditions of human action. These are conditions produced by material objects, material means of actions and knowledge applied in human actions).

**Extracting Relevant Information from Interviews**

Locating the text containing information relevant to the research question was the next step. Each paragraph of each interview was assessed, then allocated to the
relevant variable and dimension. Each paragraph was then put into the variable and dimension in which it belonged. Qualitative content analysis can be demanding, as it means that the investigator must have a clear understanding of the variables. However, it is flexible and allows variables and dimensions to be added as patterns in the data appear. For example, under the cultural variable, I added government connections because it became evident that these were a common theme when collaborating with researchers in developing countries. This was not something that I had anticipated, as it was not reported in the literature in regard to research collaboration.

Processing

Following the extracting process, I had eight variables, with all the relevant information extracted from the interviews. This information was then further summarised and reduced in a number of ways. For example, if the same information was reported in different areas in the interview, the information was noted once, but had multiple paragraph references. From this condensed version of relevant information, I wrote summaries of each of the 20 cases and developed typologies on issues such as collaboration types and effects of the scheme on collaboration and content. I also created summaries based on each of the five schemes. I noted the causal chains and their effects. However, it was not an easy process to identify, for example, the necessary, facilitating and hindering conditions for international research collaboration.

Valuing Qualitative Research from a Realist Perspective: Reflexive Considerations

As Weber states, sociology is the ‘interpretive understanding of social action’. Therefore, it needs to be acknowledged that this research is not free from researcher input. The way in which a researcher makes sense of the world has an impact on how he or she orders a study (Becker, 1998). Reflexive considerations should not be seen to represent all researchers’ experiences of international research collaboration, but should be viewed as providing an insight into these experiences. My role as an NHMRC policy and program manager had both advantages and disadvantages in conducting this study.
At the time of the study, I was working at the NHMRC, and had done so for close to 10 years. I was also a board member on one of the targeted schemes—the HFSP. I had an in-depth understanding of the schemes, having developed and managed some of them. I believe my background gave me valuable credibility and legitimacy with my interviewees. As a result, I contend that the interviewees were open about the project and were generous with their time because they believed that I understood their situation. I discussed earlier the measures that were implemented to reduce any possible negative effects of my position as an employee of the NHMRC and a HFSP board member.

Confidentiality and Ethics

Ethical obligations to participants were considered in the design of this study. The identity of participants has been kept confidential and pseudonyms have been used in place of real names (Kellehear, 1993). I also did not identify participants by specific scheme and I modified descriptions of their research in order to ensure they could not be identified. For example, if a researcher was undertaking a clinical trial in heart disease using aspirin, I may have changed the study to something similar to, ‘Nick was undertaking a clinical trial looking at a non-communicable disease and the effects of a commonly-used low-cost drug’. It was challenging to maintain a balance between ensuring interviewees’ confidentiality and describing the project of investigation in a meaningful and interesting manner. Participants also each signed consent forms (see Appendices G and H), and this study was approved by The Australian National University Ethics Committee.

Reliability of the Results

There are two possible criticisms relating to the reliability of the results of this study. The first relates to how valid conclusions can be drawn from such a small sample (20 cases). I maintain that causal statements based on the interpretation of statistical associations between variables measured for a representative sample of interviewees leaves a big gap in explaining a connection between A and B. By looking at the structural elements of research, and identifying the social mechanism, this study has filled the gap that is exposed in statistical association.
arguments of causation. Statistical association arguments cannot identify how NHMRC schemes affect research.

The second possible criticism relates to whether I am confident that this study does identify the effects of NHMRC schemes, rather than only common complaints of researchers, or reports of desires for more money for international collaboration. That is, does this study just report what researchers told me, rather than the actual effects of NHMRC schemes that caused changes to the conduct and content of research? Like Laudel and Gläser (2012) I am confident that this study has a balance between reporting what researchers described in interviews, and making decisions about the conduct and content of the interviewees' research. This is because this study focused on the structural properties of research when reaching conclusions. Indeed interviewees were not directly questioned about most of the categories used in the analysis.

Through conducting interviews based on eliciting scientific narratives regarding the epistemic properties of the research—such as time characteristics, approaches and equipment, and uncertainty—opportunities were limited for interviewees to produce ad hoc rationalisations or to respond in ways that they could assume that I or the NHMRC might have expected. The study’s findings were triangulated with information from many different sources. Many of interviewees' statements were corroborated from additional sources. This is why I am confident that in the cases investigated, the findings reflect the effects of NHMRC schemes. The next Chapter explores the research activities of international collaborations.
Chapter Three: What is International Research Collaboration?

International research collaboration is now a normal form of research (NHMRC, 2012). However, the internal dynamics of international collaborations have been virtually unexplored (see Chapter One). Research collaboration has effectively been black boxed (Whitley, 1972), with the concept and activities receiving little attention (Spender, 1989; Knights & Wilmott, 1997; Katz & Martin, 1999; Newell & Swan, 2000:1289; Laudel, 2002; Shrum et al., 2007:7). The few research collaboration typologies that have been developed have not investigated international research collaboration, and have instead focused on interdisciplinary collaboration (Laudel, 2001; Rafol, 2007). Therefore, this chapter seeks to explore what research actions occur between international collaborators. This chapter illuminates that it is not impossible to define research collaboration, as has previously been argued (Katz & Martin, 1997:8), and that there is a range of different types of international collaboration being supported through NHMRC schemes.

A key aim of this study was to ascertain the breadth and depth of international collaborations supported by the NHMRC. This meant that the breadth of Laudel’s (2001) types was significant. These types were expanded in three ways in this study. Firstly, they were expanded to examine international and national collaborations, rather than only national collaborations. Secondly, they were expanded from experimental to public health and clinical trial research. Thirdly, they were expanded in regard to the size of collaborations. Laudel’s (2001) types examined bilateral collaborations (Laudel, 2001:5). This study examined bilateral, trilateral and multi-partner collaborations.

Definition of Research Collaboration

Before discussing collaboration types, it is worthwhile to mention the definition of research collaboration used in this study (see Chapter One). In this study, research collaboration is viewed as a phenomenon related to the functional level of collective action by individuals and collective or corporate actors who do not
necessarily have a common research goal. Research collaboration in this study is defined as ‘a system of research activities by several actors related in a functional way and are coordinated to attain a research goal corresponding with these actors’ research goals or interests’ (Laudel, 2002:5). The consequences of this definition are that, firstly, a shared research goal is not necessary for collaboration—researchers may collaborate based on a shared research interest. Secondly, collaboration is defined by the activities, rather than by the actors involved. Thirdly, the concept of collaboration is strictly reserved for research that includes personal interactions (Laudel, 2002).

Collaboration Types Used as a Framework

Laudel (2001) identified types of collaboration based on collaborators’ contributions to the activities outlined below. Given that this study also investigated public health and clinical trial research, these types were expanded for the purposes of this study, as indicated by the italics:

- Formulation of research question
- Preparation of research object and selection and/or recruitment of population, and selection of site of study
- Development or adaptation of one or several methods
- Measurement itself (production of data) and gathering information in the field
- Interpretation of data.

Based on contributions to the above activities, four bilateral national collaboration types that relate to knowledge production were observed. These types are outlined below.

In-Depth Collaborations

These are the highest intensity collaborations and they span the whole research process. Each collaborator contributes equally in creative and technical terms. In these types of collaborations, researchers jointly develop the research proposal and the aims and decisions regarding the methods and objects to be used. They also regularly communicate about the progress of the project, and results are
jointly interpreted. This type is often coupled with the other types of collaboration that are discussed below. This type of collaboration presupposes a shared research goal between collaborators.

**Transmission of Know-How Collaborations**

These collaborations occur when one researcher gains a specific set of knowledge from another. For example, a researcher may spend some time in a collaborator’s laboratory to learn a new method. This is a mid-intensity collaboration. For this and the following four collaboration types, a shared interest is what links the collaborative contributions. These types have different intensities but there is no hierarchy of types.

**Service Collaborations**

These are also mid-intensity collaborations. They take place when a collaborator provides a service to another. This could be when a collaborator provides objects to another collaborator, such as patients for a clinical trial or an assay.

**Provision of Research Equipment**

These collaborations occur when collaborators use another’s equipment for their research. These are also mid-intensity collaborations.

**Mutual Inspiration**

These collaborations entail a stimulation of ideas between researchers. This is not tied to a specific research project, but is more general. Through this type of collaboration, researchers are inspired with new ideas. This study used the term ‘inspiration’, rather than ‘stimulation’ (Laudel, 2001).

**Collaboration Types in the Projects of Investigation**

A key aim of the study was to investigate the breadth and depth of international research collaborations supported by the NHMRC. The below types were
identified through eliciting scientific narratives from the Australian group leaders and, in half of the cases, the international group leaders, regarding their contributions to the projects of investigation. These types are based on the strongest collaboration between the Australian group leader and the international group leader in bilateral collaborations. In multi-partner collaborations, the types are based on the strongest collaboration between the Australian researchers and their primary international collaborators. The way in which the Australian researcher collaborated with other international collaborators in multi-partner collaborations is also discussed and noted in the tables.

There was a mixture of heterogeneous and homogenous research collaboration types in multilateral collaborations. Heterogeneous research collaborations occurred when the Australian researcher was conducting different types of collaboration with different collaborators. For example, they could be conducting an in-depth collaboration with their main international collaborator, and a service collaboration with another international collaborator. Homogenous collaborations occurred when the Australian researcher was conducting the same type of collaboration with all collaborators. Of the 20 cases in this study, there were six bilateral, nine trilateral and five multilateral collaborations.

**In-Depth Collaborations**

Eleven of the 20 cases examined were undertaking in-depth collaborations as the strongest type of collaboration with their main international research collaborator through the project of investigation. Ten of these cases were supported through NHMRC targeted schemes, and one through a general scheme. Table 6 below demonstrates that there were three bilateral, six trilateral and two multi-partner cases of in-depth collaborations. In-depth collaborations were reported in experimental sciences, as well as population health. None were reported in clinical trial research.
Table 6: Cases of In-Depth Collaboration with Main International Collaborator by Size of Collaboration

<table>
<thead>
<tr>
<th>Type of Collaboration</th>
<th>In-Depth</th>
<th>In-Depth With Primary and Service With Other Collaborators</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Collaboration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bi</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Tri</td>
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<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Multi</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Total Cases</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
</tbody>
</table>

For in-depth research collaborations, the idea for the project of investigation emerged from one, both, or all of the collaborators, and the research proposal was jointly written by at least two of the collaborators. Decisions about aims, methods and approaches, and objects (or, in the case of population health projects, populations) were all joint decisions. After these creative decisions were jointly made, the research for the project was jointly carried out and the interpretation of results was a partnership exercise. Research activities in relation to the project of investigation occurred in two or more of the researchers’ countries.

For the in-depth collaborations explored under the projects of investigation in the experimental sciences, the work was usually divided in the following ways. Following the joint formulation of the research problem, one research group prepared the research object, synthesised substances, purified proteins, cultivated cells and so on. The properties of the prepared object were then investigated by the second research group, which had developed or adopted a suitable method or methods.

With regard to the in-depth collaborations in public health, the work was usually divided as follows. After jointly formulating the research problem, each collaborator made contributions to the fieldwork based on their expertise. The idea was usually identified by one collaborator, but the research proposal was jointly written. The interpretation of results was also a joint exercise.
Bi-Lateral In-Depth International Collaborations

Three cases of bilateral in-depth collaborations were observed in this study. One of the collaborators interviewed, Stuart, had experience that was typical of those conducting bilateral in-depth international collaborations. Stuart and Ray, another collaborator, both investigated the same infectious disease. They had the same research goal of preventing and better treating this disease, and had complementary skill sets and approaches to the problem. They had known each other and worked in an in-depth manner on joint projects for about five years prior to the project of investigation. As Stuart explained, ‘He [Ray] had been my principal collaborator for five years on another grant, and we had a track record of working together in the areas we wanted to be working in’.

The project of investigation for Stuart and Ray was supported through an NHMRC targeted scheme. The fieldwork for the project of investigation and their previous joint project took place in Ray’s developing country. This was done because this country had a larger population with the relevant infectious disease. The laboratory-based components took place in Australia. Through the project of investigation, Stuart stated that he and Ray had been able to ‘meld our two research backgrounds, interests and skills’. Stuart explained, ‘It’s an extension of what we’d been doing in collaboration before’. Ray’s focus was on community-based prevention and treatment of the disease, while Stuart’s was on pathophysiological studies of the disease. Stuart was particularly interested in complications that occurred following severe infections from the disease. In earlier years, Stuart had also worked on community-based prevention and treatment of the disease.

The funding for Stuart and Ray’s current joint project was due to end the year that the NHMRC targeted scheme was announced. This meant that they had already had lengthy discussions about their next grant application. At the time, they were funded by an overseas funding agency, after their project was rejected through an NHMRC general scheme on a number of occasions. Stuart stated that the feedback from the chair of the NHMRC panel that had considered the most recent application was that, ‘The project was not funded because the NHMRC does not fund research offshore’.
When the NHMRC targeted scheme was announced, Stuart and Ray were in Ray’s developing country. They discussed and jointly wrote the proposal and subsequently met a second time in Australia a short period later to further discuss the project proposal prior to its submission. They had also corresponded via email regarding drafts of the application between meeting face-to-face. They were able to meet by using funds from the joint project they were already undertaking. Stuart reported that they were excited to apply for a project that supported offshore research. He stated that this was because, prior to the announcement of the targeted scheme, there were no funding sources in Australia that supported offshore research. Stuart had previously had project funding through the targeted scheme fail twice under an NHMRC general scheme.

The project of investigation had two levels, which reflected Stuart and Ray’s expertise. There was a population level, which investigated options for better preventing and treating the disease—this was Ray’s area of focus. Then there was an individual level, due to Stuart’s expertise, through which they examined the pathophysiology of the disease and focused on one particular type of injury that was a major cause of death from the disease. The project of investigation reflected an extension of their previous work together. These researchers had a shared goal and complementary approaches and methods. However, significantly, they both developed the creative ideas for the project. The project reflected a synergy of their interests. It was a jointly-driven and jointly-conducted project. They met at least three or four times a year to discuss the project and always jointly interpreted the results.

The experience of another interviewed collaborator, Paul, is another example of an in-depth collaboration being conducted under a project supported through an NHMRC targeted scheme. Paul was working with a collaborator, Tina, in a developing country on a population health study. He described the project of investigation as a ‘truly collaborative project—a marrying of ideas’. On further analysis of what he meant by this, I ascertained that the project of investigation allowed two innovative methodologies to be combined for the first time, then applied in a developing country.
Paul reported that he had wanted to work with the developing country as ‘they had the expertise, need and desire to be involved’. The developing country had implemented one of the two methodologies, but the grant provided the opportunity to combine both methodologies for the first time. In terms of writing the proposal, Paul stated that he had written the section about the first methodology, and his international collaborator had written the section about the second methodology. He stated that writing the proposal ‘was pretty much a joint effort’.

Paul’s research was conducted in the developing country because the combined methodologies had not previously been applied to the developing country’s population. Paul spoke about the funding scheme being ‘ideally suited’ to supporting the marrying of the two methodologies. He spoke about having two pieces of a puzzle that would support the ability to make strong policy recommendations to government. He stated:

They [the collaborating developing country] were very excited about this. They tended, in my view, to have the experience to respond well to these kinds of initiatives. They’re global leaders in new, innovative approaches. They’re also not afraid of hard work in doing such a project ... We have a very close collaboration and it’s working very well. We had an idea and we had a potential collaborator who had an innovative idea, and we wanted to marry the two.

These types of collaboration were highly active, with ongoing communication through email and Skype, and a number of face-to-face meetings each year, in which all the chief investigators and their teams came together to discuss the project.

*Tri-Lateral In-Depth Collaborations*

There were three cases of trilateral in-depth research collaborations identified in this study. Within these were two variations. One variation was that all three cases were conducting in-depth collaborations. This occurred in one of the three trilateral cases (see Table 6). The other variation occurred when two collaborators were conducting an in-depth collaboration, and a third collaborator was providing them with a service.
Vince’s case was an example of the latter. Vince, an Australian researcher, was working with Geoff and Adam on the project of investigation. Vince and Geoff had been working together for many years developing theoretical models for neurological responses in relation to the particular biological process they investigated. They each used different methods and different animal models, but were aiming to answer the same research question. Vince worked with human specimens, while Geoff worked with animals. They had previously undertaken laboratory work together and had also exchanged knowledge about different methods they had used over the years.

Vince had been living and working in a developed country for a number of years. Adam had the idea for the project of investigation and approached Vince and Geoff to be involved because they had been working in the area for many years. Adam had met Vince and Geoff about five years before. As Vince explained:

The idea came from Adam who is the lead chief investigator in [the developed country]. I think we all had met previously at a scientific meeting and we ... got talking about it and saying, well, what could we do together? ... The three of us talked about the proposal at a scientific meeting and said ... let’s get together and put together a project.

Adam had the same research goal as Vince and Geoff, but was using a different animal model and novel assays. Geoff and Vince had not worked with the animal model with which Adam worked, and Adam had unique knowledge in regard to the assays he had developed. These were the reasons that Vince and Geoff were keen to work with Adam. Adam’s experience meant that he would conduct the biochemistry work for the project of investigation on behalf of all three collaborators.

*Multi-Partner In-Depth Collaborations*

Two cases of multi-partner in-depth collaborations were observed. In these collaborations, Australian researchers were engaged in in-depth collaborations with their primary international collaborator or collaborators, and were conducting service collaborations with the other members of the research team. This was, as described earlier, a heterogeneous collaboration.
Mal's project demonstrates how ideas were developed in these types of collaborations. Mal was collaborating with a large number of partners. He was undertaking an in-depth collaboration with his main partner, Turner, and two other collaborators, and he was also undertaking service collaborations with the rest of the collaborators in the group.

Mal was investigating the genetic causes of a non-infectious disease. His other collaborators had the same research goal. Mal and Turner had met during post-doctoral research, when Mal was working in a laboratory in a developed country. He and Turner had jointly developed the aims for their part of the large project of investigation. Mal and other members of the team used different methods and assays to answer the same research questions. Mal was keen to be part of this large group because it expanded his research area and enabled him to work with objects that were not available in Australia. He had two main research areas: hematology and autoimmunity. He was brought into the project by Turner because of his unique expertise in regard to the objects he had developed and the novel assays he used on these objects. Mal explained:

He [Turner] was really the person who suggested that I would be a good person to bring in because I already had an animal model of this knockout animal ... so it was thanks to him that the group decided it would be a good idea if I came in.

Mal and Turner wrote their part of the larger project together. Mal stated that they had both discussed the aims and, while Turner had completed the initial draft, Mal had provided extensive comments, particularly regarding the methodologies used for two specific genes that were his focus. The project involved using the methods and reagents of other collaborators on the two genes that were Mal's focus. Mal explained:

We exchange reagents and ideas with Art, James and Turner to do with a range of molecules and genes. They were applying a number of different methods to the same genes. We're all about understanding different biological pathways between different genes involved in disease. So I thought it was a very good idea to be part of larger group of people with the same concrete goal of trying to cure [the non-infectious disease]. Being part of this group definitely expanded my research program.
Conducting In-Depth and Other Types of Collaboration with Main Collaborators

In-depth collaboration was often coupled with other types of collaboration, including transmission of know-how and mutual inspiration. Vince, who was undertaking a trilateral collaboration as part of the project of investigation, was also involved in a transmission of know-how with Geoff in regard to some of the methods they both used. Vince reported that they spent short amounts of time at each other’s laboratories learning methods that could then be employed in their own laboratories. Four other cases involved the transmission of know-how between junior researchers of the lead collaborators, in which there was an exchange of personnel between teams.

All researchers engaged with in-depth collaborations were also engaged with mutual inspiration collaborations. The example of Mal, in which reagents were exchanged between collaborators, is also an example of in-depth collaborations occurring with other types. In Mal’s case, this was a two-way service collaboration because Mal was receiving and providing reagents.

Role of Australian Researchers in In-Depth Collaborations

Of the 11 cases of in-depth collaborations, Australian researchers were the leaders in five cases and partners in the others. When Australian researchers were leaders, they formulated the ideas for the projects and contacted the international researchers. The writing of the proposal was a joint effort, with the Australian taking the lead in co-coordinating input from all the team members. When Australian researchers were the leaders, they also normally identified the NHMRC scheme in the case of targeted schemes and brought it to the international collaborators’ attention. In the case of Australian researchers being partners, although they were heavily involved in the project, they were not usually the overall drivers and senior researchers. They had normally been contacted by the international collaborators to be involved.

In summary, more than half (11) of the 20 cases in this study were undertaking in-depth collaborations as their strongest type. What all these collaborations have in common is that at least two collaborators were involved creatively in the project.
in terms of deciding the aims, methods and/or objects and population studied in the project of investigation, as well as conducting the projects and interpreting results from the research.

Transmission of Know-How

In one case, the strongest type of collaboration was transmission of know-how. This case was supported under a general scheme. The Australian researcher was receiving, rather than providing, the transmission of know-how. Transmission of know-how refers to a project in which procedural knowledge (knowledge that is required to undertake a specific research process—about features of the research object, tricks in applying methods, and so on) is transferred from one researcher to another. This was found to be taking place under one of the general schemes, and none of the targeted international schemes. The transmission of knowledge is often the result of a request for special knowledge to efficiently solve a problem. This kind of collaboration is necessary during situations in which all the experimental details required to learn a new methodology are not able to be gleaned from a research paper.

Edward was an Australian neuroscientist working on a particular method with Peterson, a collaborator in a developed country. Peterson had developed a unique method of preparing the brain of an animal in a certain way that Edward was keen to apply to his own research. After meeting Peterson at a scientific meeting and learning about his method, Edward stated that he was keen to learn the method Peterson had discussed at the meeting. Edward spent approximately three months in Peterson’s laboratory to learn this method. As Edward explained:

I went there to learn a new methodology, which I don’t have here. I went to his lab[oratory] and answered a question for which I would otherwise have to spend one year to answer here. We are currently using the whole animal, either conscious or anesthetised, and Peterson had developed a method [with] reduced preparation. I don’t know anyone else who does this.

Aside from teaching Edward this method, Peterson was not involved in Edward’s project. Peterson admired Edward’s work ethic and enthusiasm, and was keen for other researchers to use the methodology he had developed and apply it in new
applications. He also stated that by Edward coming to learn the method, they had been able to discuss other methods that Peterson had developed.

*Role of Australian Researcher in Transmission of Know-How*

The Australian researcher was seeking the transmission of know-how under a general scheme.

**Service Collaborations**

Of the 20 cases investigated, seven reported undertaking service collaborations. Of these cases, one was funded through a targeted scheme and the other six were supported through NHMRC general schemes. In one case, the Australian researcher was providing the service (targeted scheme), and in the other six cases, the international researcher was providing the service to the Australian researcher (general schemes). For the cases of service collaborations in the experimental sciences, either the preparation or measuring of the research object was a routine process that was undertaken by one collaborator. Neither collaborator was involved in the entire research process.

Service collaborations were necessary when collaborators could not learn the methods required to solve a problem because the learning process was too time-consuming, or because they lacked the necessary knowledge to learn the methods. While the collaborators did not have a shared research goal, they did have shared interests.

*Multi-Lateral Service Collaborations: Providing and Seeking a Service*

Peter’s project is an example of providing a service to international collaborators. Peter was provided objects by a number of different international collaborators. These objects were prepared in different ways, but were all tracked using a unique Australian method. Peter stated, ‘Because of our unique expertise … that’s the component we took’. Thus, the Australian researcher provided the service of tracking the objects of his international collaborators using his unique method. The idea for the project of investigation had originated with the international
collaborator, who then asked Peter to be involved because of his unique expertise with a specific cell-tracking method.

Ned’s project involved seeking services from international collaborators. He was undertaking a number of clinical trials and was also analysing patient biological samples. He was investigating a rare genetic disorder, and there were insufficient patients in Australia to conduct studies that would achieve statistical significance. Ned collaborated with researchers around the world in order to obtain access to patient data. These collaborators were not involved in developing the aims of Ned’s project of investigation. In describing his work with Bruce, one of his international collaborators, Ned explained, ‘He supplies patients to me. Patients are the main thing. That’s his only involvement’.

These service collaborations were not as active or intense as the in-depth collaborations. The researchers did not have as regular contact via email, Skype or any other online means of communication. If they had face-to-face meetings at all, these were irregular.

**Role of Australian Researchers in Service Collaborations**

The Australian researcher was providing the service in the one case of service collaboration reported under the targeted schemes. Of the six other cases of service collaboration reported under the general schemes, the Australian researcher was seeking the service.

### Table 7: Cases of Service Collaboration with Main International Collaborator by Size of Collaboration

<table>
<thead>
<tr>
<th>Size of Collaboration</th>
<th>Service</th>
<th>Service with Primary and Service with Other Collaborators</th>
<th>Total Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bi</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Tri</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Multi</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Cases</strong></td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>
Provision of Access to Research Equipment

A weaker type of collaboration is the provision of access to research equipment. The collaborator does not conduct the required routine work. The collaborator only provides access to the necessary research equipment available in his/her laboratory or research office. This was not found to occur in any of the collaborations taking place under the projects of investigation. One reason for this could be the large distances between Australia and other countries, making it impractical to undertake this form of collaboration. This study was also investigating mostly bilateral and trilateral collaborations in public health and clinical trial research, as well as experimental research. The need for research equipment in population health and clinical research would be expected to be lower than in experimental research.

Mutual Inspiration

Mutual inspiration occurred as the strongest form of collaboration in one case. Mutual inspiration occurs when ideas are being shared, but are not related to a single research process and do not contain an exchange of clearly-defined contributions. Mutual inspiration was reported by all of the 11 cases conducting in-depth collaboration, and by the one case of transmission of know-how.

Mutual inspiration is different from the other four types because it is not related to a single research process and does not contain an exchange of clearly-defined contributions. Mutual inspiration is a side-effect of scientific communication and can therefore be related to scientists’ research work as a whole, or to their respective research programs, or even simply to the work of their colleagues. The communications between scientists may inspire them to think about unsolved problems in their field, about possible new research projects, or even about the reinterpretation of old data. During this informal exchange of ideas that accompanies every personal scientific communication, scientists may develop new ideas about problems and solutions. In contrast to transmission of know-how, the important contribution is not the knowledge that is passed on, but this knowledge’s function of inspiring the creativity of one or more partners. Mutual inspiration arises from personal interactions, in contrast to simply reading papers.
Ben had been working with Andrew for many years through an in-depth collaboration. They were experimental scientists working on a specific class of genes. Andrew had supported Ben for many years through his grant from a developed country to enable them to work in this way. However, Andrew had recently retired so they had to scale back their type of collaboration. As Ben explained:

Because he [Andrew] was retired, it was just a collaboration in ideas and discussions from the point of view of looking at reaction mechanisms … By the time this grant actually started [for the project of investigation], he was retired, so we weren't pursuing so much collaborative laboratory work; it was more like he was in a consultant sort of position.

**Mutual Inspiration: Ongoing in All Collaborations**

An noteworthy finding of this study is that all researchers interviewed, even those not conducting in-depth collaboration, were conducting mutual inspiration. As stated by Vince, ‘I’ve had a long-term collaboration with him [Geoff], but without any funding’. Mal stated that he had ‘been working with for Turner 15 years, but with no funding’.

This is an important finding because NHMRC funding is project based. This reflects a tension between the project-based funding of external research and the ongoing nature of international research collaboration. Given the shift to more external funding, rather than continuous recurrent funding, researchers have difficulty funding ongoing activities, such as mutual inspiration international research collaborations. It is also important to note, as outlined in the Introduction, that Australian health and medical researchers have no other major source of external funding within Australia, other than the NHMRC.

**Collaboration Types by Funding Scheme and Research Area**

This chapter, for the first time, identifies the range of ways that international collaborators work together, based on their research actions. It also demonstrates that NHMRC schemes support a range of these types (see Table 8). An important finding is that only one case of in-depth collaboration was reported under general
schemes, while 10 of the 11 targeted projects of investigation were conducting this type of research collaboration. This study also found that types were occurring in most research areas (see Table 9).

Table 8: Collaboration Types Reported by Funding Scheme

<table>
<thead>
<tr>
<th>Primary Collaboration Type</th>
<th>Targeted Funding Schemes</th>
<th>General Funding Schemes</th>
<th>TOTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NHMRC-HFSP</td>
<td>ICRG</td>
<td>Project Grants</td>
</tr>
<tr>
<td>In-Depth</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Service</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Access to Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of Know-How</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mutual Inspiration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL CASES</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

*Orange shading refers to the main type of collaboration

**Dark grey shading refers to the secondary type of collaboration

Table 9: Strongest Collaboration Type by Research Area

<table>
<thead>
<tr>
<th>Strongest Collaboration Type</th>
<th>TOTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td></td>
</tr>
<tr>
<td>Clinical Trial Research</td>
<td></td>
</tr>
<tr>
<td>Public Health</td>
<td></td>
</tr>
<tr>
<td>In-Depth</td>
<td>5</td>
</tr>
<tr>
<td>Service</td>
<td>3</td>
</tr>
<tr>
<td>Access to Equipment</td>
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</tr>
<tr>
<td>Transmission of Know-How</td>
<td>1</td>
</tr>
<tr>
<td>Mutual Inspiration</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL CASES</td>
<td>10</td>
</tr>
</tbody>
</table>

Summary

Through analysing, in detail, the research activities occurring between Australian researchers and their international collaborators, it was revealed that ‘collaboration’ refers to a number of different types of collaborator contributions and different levels of engagement. A key finding of this chapter was to empirically establish that NHMRC schemes support a broad range of types of international research collaboration. This is the first study that I am aware of to
examine the range of research activities that occur in international research collaborations.

This study also contributes to the literature by identifying collaboration types that appear to be less likely in international collaboration than national collaboration—provision of access to research equipment did not occur, and transmission of know-how occurred only once as the major type of collaboration. I also further develop the literature on research collaboration by expanding Laudel’s (2001) typology in three ways: from national to international, from bilateral to multilateral, and from only including experimental research to including public health research and clinical trial research. This study also found that Australian researchers were of a high enough standard to be partners in, and, in fact, leaders of, international research collaborations.

This chapter provides evidence that Australian researchers have unique knowledge that is requested by international collaborators. In turn, international collaborations enable Australian researchers to access knowledge that cannot be accessed in Australia. In summary, international collaborations are critical to providing access to state-of-the-art knowledge.
Chapter Four: Conditions That Affect International Research Collaboration

This chapter examines the conditions that were found to affect the different international research collaboration types identified in Chapter Three. This analysis was conducted because the analytical framework used in this study, actor-centred institutionalism, contends that the effects of institutions are mediated by other conditions of action. As a result, it was important to ascertain the influence of all conditions of action on international research collaboration, not just NHMRC schemes, which are the focus of Chapters Five and Six. This chapter provides evidence that international research collaboration has extra conditions, compared to national collaborations. Additional conditions are also required when collaborating with developing countries and when engaging in collaborations with more than three members.

Five condition categories were used in the analysis: epistemic, social, cultural, institutional and economic (Laudel, 1999:26–27, 42–49). These categories reflected the single conditions that have been reported in the literature as being important in research collaborations (see Chapter One), but were also broad enough to allow for the inclusion of new conditions that were reported in this study. The strength of each of these conditions was also established. Necessary conditions were those that were required for the collaboration to begin or be successful, while facilitating and hindering conditions made collaborations easier or more difficult. Before beginning a detailed discussion of the conditions found to affect international research collaboration, the following two vignettes provide an introduction into the breadth of conditions found to affect international research collaboration. Only when conditions were reported by several researchers were they identified as necessary, facilitating or hindering.

Vignette One

Ken was an Australian clinician working with Richard, a researcher in a developing country, on a public health issue. All the field research and most of the laboratory work was being conducted in Richard’s developing country. Some
laboratory work was being conducted in Australia. Ken and Richard were investigating the epidemiology and a range of prevention and treatment programs for a highly prevalent self-inflicted injury. The developing country had the highest prevalence of this injury in the world. Ken had the toxicology expertise. Richard also had toxicology expertise, but, in addition, had been involved for many years in community treatment and prevention programs. Ken and Richard were funded jointly through an NHMRC targeted scheme, and thus did not have to coordinate funding from two national sources in the way that researchers conducting international collaborations through NHMRC general schemes do—the funding tools that most Australian researchers conducting international research collaborations have to use, as they perceive there is no other alternative in Australia.

Ken and Richard were undertaking what was described in Chapter Three as an ‘in-depth’ collaboration. They jointly developed the research project, and were both intimately involved in all stages of the research process, from deciding on the aims and approaches, to the daily management and implementation of the project, to jointly writing publications. Prior to the project of investigation, they had known each other and had tried to work on projects together, but this was the first project for which they had received funding to work together.

Richard had been involved in developing the aims and approaches used in the project, but he said his biggest role was facilitating the completion of the project and ensuring it was supported by locals, and seen as a local project. Richard spoke about ‘showing his face’ to ensure that the project was seen as his project by the locals, and also by the Minister of Health, in the developing country in which the research was being conducted. He noted that there had previously been problems with foreigners seeking to undertake projects in this area, as locals were suspicious that foreigners were ‘trying to steal their research’. Richard also spoke about the importance of his government connections for the completion of the project:

I ... sort it all out at the central level with the Ministry of Health. I have easy access to the Minister of Health and if Ken [the Australian researcher] wants to discuss issues in terms of suggested changes to policy, then I actually take Ken and make appointments and talk to the minister and say that it’s my project ... and they [the Australian researchers] are helping us.
Richard stated that, ‘If something like this is not supported at these political levels [such as by the Minister of Health], then it won’t even get off the ground’. Ken echoed similar sentiments, stating:

Without Richard, we couldn’t have been able to do this … He’s got the technical expertise and practical experience, but his most important contribution is his political connections. He is very well known in [the developing country] and can really get things done. He knows the right people.

Therefore, not only was Richard central in obtaining government support for the project, he also had the same research goal as Ken. Richard was also instrumental in ensuring that study populations and hospitals in the developing country agreed to be part of the project.

Ken stated how important it was that they were able to receive more funding through this NHMRC targeted scheme, than was normally allocated through NHMRC general funding schemes. He commented that this project would not have been possible without these high levels of funding. He stated that he and Richard met face-to-face at least three to four times a year, and that he also spent months at a time in the developing country, learning about its research system. As he explained, it took time for him to learn ‘how to get research done there and how the systems work there’.

In terms of the challenges of the collaboration, Ken reported that while they worked very well together, they had different views regarding where their work should be published. Richard was keen for their work to be published in the local public health publication, as he believed this would assist the practical implementation of their research. Ken believed that this was important; however, he also wanted to ensure their work was published in prestigious international journals.

Another challenge was that Richard had many commitments, given he was one of the most eminent researchers in his field in his country. There were few other researchers with his expertise in his country. He also had a number of ‘government commitments’, which Ken took some time to understand and accept. Richard was often called into the Minister of Health’s office to discuss and advise
on a range of matters. As a result, Ken said that Richard was sometimes unable to
commit as much time to the project of investigation as had been initially
envisioned, and this affected the timing of the project of investigation.

Both Ken and Richard reported how important the NHMRC scheme was for their
research. Without it, they would not have been able to undertake the project. Ken
explained that he had previously applied to obtain funding for the project through
an NHMRC general scheme. However, he stated that the peer review panel had
advised that the NHMRC did not fund offshore research, and the project had
subsequently been rejected.

Vignette Two

In another project of investigation, Drew was working with William, from a
developed country, through a service collaboration. They were conducting the
project of investigation through an NHMRC general scheme and thus had to
coordinate each of their national sources of funding to collaborate. Drew was
investigating biological pathways related to a certain category of pain. Drew was
undertaking laboratory-based experimental work. He was using particular
peptides to understand normal pain pathways, and then using these models to
better understand the category of pain that was his research interest. Drew and
William were examining some of the same peptides, but were examining them in
regard to different biological processes. Therefore, they had shared research
interests of the same peptide, but had different research goals, as they were
focusing on the role of these peptides in different disorders. William had
developed a unique characterisation of a specific peptide and had developed a
knockout animal model based on this peptide. As Drew explained, ‘That’s a
unique opportunity to have access to that unique knockout’. Drew stated that no
one in Australia had this knockout model—William was the only source of this
object.

Drew and William had initially met face-to-face at a scientific meeting, but had
only once been able to meet face-to-face during the project of investigation. Drew
stated that this was because he did not have the funds to do this in his NHMRC
general scheme. On the one occasion that they had met face-to-face, William had
provided funds for Drew’s travel. Drew discussed the fact that not only was it difficult to conduct the collaboration without being able to meet face-to-face regularly, but it was also hard to maintain an ongoing relationship with William over the years. This problem was exacerbated by the fact that they did not have funds to specifically support the international research collaboration. Drew explained:

Unfortunately, because there’s no money for international collaborators, it’s not easy to maintain a real interest. Because there’s no funding, you really have to have overlapping interests. Not only overlapping interests, but someone who is able to justify and be prepared to work with us.

When I asked Drew how their collaborative work was funded he stated:

William has his own grants and there is some overlap there to run the animal modelling. We’d like more funding, but we’re happy to get something interesting out of it. If, at the end, it leads to a good publication … that’s what’s most important.

Drew went on to explain that, ‘William is quite well funded. He’s on tenure and he has a number of [National Research Council] funding grants and he’s got a lot of European funding as well’. Drew spoke about the importance of William’s funding. This funding meant they were able to maintain their collaboration over the years. It was particularly difficult for them to maintain their collaboration when Drew received no funding from the NHMRC for a short period of time: ‘It was tough when I didn’t have NHMRC funding for a bit, but William was able to help send [the animals] to me, which was great because that normally costs a lot’. Drew stated that both he and William could work more closely on a joint project, but, as a result of the lack of funding, they were unable to do so at that time.

**Overview of Vignettes**

In terms of necessary conditions, these vignettes indicate that Ken and Richard had epistemic links that appeared to be stronger than Drew and William’s because they were working on the same problem. Thus, in-depth collaborations appear to require epistemic links based on a shared research problem, while service collaborations require epistemic links through sharing of research interests. In the first vignette, external funds from the NHMRC scheme were necessary. Collaborating with developing countries appeared to have additional requirements in comparison to developed countries and national collaborations. These
requirements included building an understanding of national research cultures and national cultures, such as understanding the importance of government links for the success of projects in developing countries, and also the importance of the developing country researcher being seen to ‘own’ the project, rather than the foreign researcher. There also appeared to be different hindering conditions compared to developed countries, such as lack of researchers. In addition, these vignettes indicated that more funds were required for international collaborations, when compared to national collaborations. For example, more funds were required to enable collaborators to meet face-to-face. More time was also required to understand different institutional, national and national research cultures.

These vignettes indicate that different types of collaboration appear to have different conditions. They also suggest that international collaboration has additional requirements compared to national collaborations. The next section discusses each condition in detail. This study, unlike most other previous studies on research collaboration, investigates all the conditions of action found to affect the collaboration, rather than only investigating one or two (Merz, 1997).

**International Research Collaboration Conditions: A Closer Look**

**Epistemic Conditions**

Epistemic conditions of action are a specific case of cognitive/technical conditions of human action. They are conditions produced by material objects, material means of actions, and knowledge applied in human actions (Gläser & Laudel, 2004). The importance of these conditions was reported in Chapter One to have previously been ignored in much of the social constructivist literature (Latour & Woolgar, [1979] (1986); Woolgar, 1988:83–96).

**Necessary Epistemic Conditions**

*Shared Research Goal or Interest*

In this study, an epistemic link between the international collaborators was found to be necessary for all types of research collaboration, otherwise the collaborators’
activities would not be connected. However, the form of these connections was different for the different collaboration types. For in-depth collaborations, there were epistemic connections through having a joint research goal, and also through the objects and methods used. All 11 cases of in-depth research collaboration had the same research goal and epistemic links through the approaches, in terms of methods and objects or populations used. For example, Dean, Nigel and Ricky, when conducting an in-depth collaboration, were all aiming to address the same public health problem through using generally the same community-developed and community-based approaches.

For all other collaboration types, epistemic links through shared research interests was a necessary condition. These epistemic links took the form of the methods and/or the objects. Researchers undertaking service collaboration may each have different research goals, but have coinciding research interests. For example, John, an Australian researcher, was collaborating with Evan in a developed country. Evan undertook bio-informatics analysis on some micro-assay studies for John. John wanted to collaborate with Evan because he had special expertise—a range of software and computer capabilities not available in Australia. However, each of these researchers’ laboratories had different research goals. John’s research goal related to understanding the mechanisms of a particular tissue formation, while Evan’s research goal related to developing bio-informatics analysis tools for more broad use.

The necessary nature of these epistemic links became clear when these links were missing. When they were missing, collaborative contributions were not combined. For example, Ted, an Australian researcher funded under the HFSP to participate in a trilateral collaboration, spoke about the effort required to develop an understanding of the developed collaborator’s chemistry methods, and how they could be best applied to his objects as part of the project. He spoke about how difficult this had been, given that he was a biologist and the collaborator from a developed country was a chemist. Ultimately, the collaboration had not met his expectations. Ted stated:

We haven’t actually published things together. How can I put this? [The main developed country collaborator] has put in papers that haven’t required anything I’ve done. The other collaborator has put in papers that haven’t required anything I’ve done, and I’ve put in papers
that haven’t required any input from either of them. So we currently
don’t have any co-authored papers. We’ve all published on our own.

Thus, because these collaborators did not have a great deal of shared knowledge,
they were not able to develop a shared communication base. This eventually
affected their ability to work collaboratively.

Another Australian HFSP-funded researcher had similar issues. He explained:

I understand they [the HFSP] explicitly want to bring in physicists,
engineers, modelling people and so forth, and I think that it has a level
of strength in that it gets very different people with very different
backgrounds to talk to each other. The disadvantage ... is that it takes
a while to learn how to talk to one another and, you know, find a
common language, and to ... work out how different people think.

He reported achieving this as a difficulty with the collaboration: ‘Each
individual’s lab[oratory] drove the work separately’, and they also published
separately. The interview with this researcher took place after the project of
investigation had been completed. The collaborators had not continued to work
together and, at that stage, had no plans to do so. This was because, as the
Australian researcher commented, ‘The lab[oratorie]s had kind of gone their own
directions and the work had moved on’.

Shared Language Based on Shared Knowledge

Prior to approximately the last 10 years, little attention had been given to how
these epistemic links were executed in micro-level research collaborations
(Aldrich & Herker, 1976:218–221; Becher, 1989). This study found that a shared
language, based on shared knowledge, was a necessary condition for all types of
international research collaborations. More recent studies have explored the
difficulties of different research languages between disciplines (Duncker, 2001;
can be addressed by developing shared research languages called ‘pidgin’ and
‘creole’.

In Laudel’s (2004:5) study about interdisciplinary research collaboration between
biologists, physicists and engineers, she found that in successful alliances, ‘These
artificial languages emerge in the communication of collaborators who use
elements of their field-specific languages. This way a simplified, reduced language for mutual understanding is created. This shared language is successfully developed and implemented only if there is a broad platform of shared knowledge. For example, Ben, who is undertaking a mutual inspiration collaboration, referred to this shared language when discussing genes and particular classes of proteins, such as the Zeta and Omega classes that he worked on with his collaborator.

Star and Griesemer (1989) argued for the use of method standardisation, and introduced the concept of boundary objects to explain how heterogeneity and cooperation coexist to enable actors to collaborate. Boundary objects are ‘both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites’ (Star & Griesemer, 1989: 393). The terms, Zeta and Omega class, refer to boundary objects that indicate a shared deeper meaning between the collaborators. Developing this shared language, often using boundary objects, was found to be critical to the success of the international collaboration. Therefore, this was a necessary condition for collaboration.

The necessary nature of a shared language for a collaboration’s success became particularly apparent in this study in projects in which collaborators’ contributions to the project of investigation were not integrated. Specifically, the importance of boundary objects was highest for interdisciplinary collaborations. This investigation found, as with many previous studies (Laudel & Gläser, 1998), that those from different fields found it harder to develop this common language. Researchers from three of the four HFSP supported projects investigated in this study reported that the condition of a shared language was absent in their project of investigation.

The HFSP supports novel, innovative and interdisciplinary basic research focused on the mechanisms of living organisms. A clear emphasis is placed on novel collaborations that bring biologists together with scientists from other fields, such as physics, mathematics, chemistry, computer science and engineering, to focus on problems at the frontier of the life sciences. As the researchers are required to
come from different fields, their shared knowledge was found to be sparse, which
made communication on the project of investigation difficult.

Hindering Epistemic Conditions

Lack of Researchers in Developing Countries

This study found that a lack of researchers and personnel with particular skills in
developing countries was a hindering condition for in-depth, transmission and
mutual inspiration collaborations. All Australian researchers working with
researchers in developing countries stated that this was a difficulty that arose
during the project of investigation. A lack of researchers affected the timing and
progress of projects, and the quality of papers produced. As Dean, who was
conducting a public health project in a developing country, explained, ‘One of the
biggest problems that we’ve had is Nigel being able to have enough ... time on
this project’. Dean went on to explain that there were few well-qualified
researchers in some developing countries, which meant that those who were
qualified were in high demand:

So you’ve got a smart person and when he goes off and does a WHO
[World Health Organisation] consultation somewhere, he gets paid per
diem—you know, 100 dollars—and stays in a cheap place, makes 50
dollars a day ... That’s more than he ever gets here [in the developing
country]. And this is where, if there was some funding for salaries in
this grant, we could have held them to it, but we’ve got nothing to
bargain with.

This hindering condition was reported by all Australian researchers working
within developing countries.

Researchers working with developing countries reported that papers took longer
to get to publication standard, so publishing was a lot slower than in national
collaborations. Dean spoke about how some of the junior developing country
researchers had submitted papers to conferences without them being seen by the
chief investigators. This resulted in these papers being of poor quality:

Yes ... it was like bang, bang, bang and then we found out after the
event that they had submitted the papers. We’re very big on co-
analysis, but it’s been a challenge with some of the researchers. In
many ways, it’s been challenging trying to find enough people in the
island to help with the co-analysis. And his story of the islands is low
capacity and struggling capacity and this is no different. So, you know
it’s a long and tedious process [co-analysing results], but we’re committed to it. That’s what it is, that’s what it takes. And it’s a bit of a struggle, it’s a bit of a learning curve for some of them ... It’s a bit of a cultural difference in terms of quality of research expected and it’s a learning experience for some of the investigators here as well.

Table 10 summarises the necessary epistemic conditions by research collaboration type and compares them to those found in national collaborations (Laudel, 2004).

<table>
<thead>
<tr>
<th>Epistemic Conditions</th>
<th>Collaboration Type</th>
<th>Transmission of Know-How</th>
<th>Mutual Inspiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessary</td>
<td>In-Depth</td>
<td>Service</td>
<td>Research interests</td>
</tr>
<tr>
<td>Epistemic Link Through</td>
<td>Research problem/ methods and/or populations/ objects</td>
<td>Research interests through method and/or objects</td>
<td>Research interests through methods and/or objects</td>
</tr>
<tr>
<td>Shared Language Based on Shared Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hindering</td>
<td>Lack of Researchers in Developing Countries</td>
<td></td>
<td>Research interests</td>
</tr>
</tbody>
</table>

*Orange shading refers to the occurrence of the condition

Therefore, this study found that there were two epistemic conditions identified as necessary for all collaboration types (although epistemic links differed in strength), and a third epistemic condition was found to be hindering when collaborating with researchers from developing countries.

**Social Conditions**

Social conditions that have been found in previous research to be important in research collaborations include companion and competence trust, proximity and interactions of collaborations (Chapter One). Newell and Swann (2000:1295) reported the importance of competence trust, which is a trust in the research...
capabilities of the collaborators in research collaborations. They also found that companion trust was important in collaborations. Companion trust ‘refers to trust that is based on judgments of goodwill or personal friendships’ (Newell & Swann, 2000:1295).

However, there is mixed evidence regarding the importance of trust in collaborations. Laudel (2002), like Newell and Swann (2000) and others (Alter & Hage, 1993; Ring & Van de Ven, 1994; Shapin, 1994; Browning et al., 1995; Gulati, 1995), found trust to be important in her study on research collaboration. However, Shrum et al. (2007) found that if a collaboration had high levels of bureaucracy, then trust was not critical for the project’s success. There has been a lack of examination about how international collaborators interact with regard to different types of collaboration.

**Necessary Social Conditions**

*High Levels of Companion and Competence Trust*

The notion of having high levels of companion and competence trust was strong in all of the interviews. In this study, high levels of companion and competence trust were necessary for all collaboration types. Researchers spoke about being good friends with their international collaborators, and how important this relationship was when deciding to collaborate in the first place. This relationship was also important for the smooth operation and success of the project. As Rod, an Australian clinical researcher stated, ‘You simply would not work with someone you did not like’. This high value of friendship was echoed by many other researchers, and was illustrated in John’s description of why he decided to collaborate with his colleague from a developed country:

> All collaborations arise out of knowing people for some time. Usually you have met at meetings. In the case of Evan, I spent a little time doing a short sabbatical at his institute. I was a consultant there about 15 years ago and he was a post-doc [postdoctoral researcher]. I advised him a lot then, and then we became quite friendly and we’ve done things together ever since. Personal friendships develop and you work together. If they don’t have that sort of basis, they can be a lot more difficult to get going.
In fact, companion trust appeared to be more important than competent trust. Several researchers said that they would not have collaborated without these strong personal relationships, even if they thought it would have been beneficial for their research. This was reflected in a comment by William, an international investigator in a developed country, when describing the reasons he worked with Drew, his Australian collaborator:

Sort of two reasons. There was a clear synergy in a subject of common interest, and ... he's a very sympathetic character and we're good friends. That's important I think. Yes, if we didn't like him, we probably wouldn't collaborate with him, even if it was fruitful.

William, also spoke about how important trust was in his relationship with Drew: ‘Everybody is completely open. We ask each other’s opinions and so that’s fine. I think it has to be like that. There’s a lot of trust’.

The fact that this condition was necessary became apparent because when it was not evident, collaborative contributions were not synthesised. Vince, an Australian HFSP-funded researcher, expressed this same belief when speaking about how he did not collaborate with a new collaborator on the project of investigation. (The HFSP supports interdisciplinary research and at least one of the collaborators has to be a new collaborator.) Vince stated:

It’s a personal relationship and that’s something that has to build up over the years, and, you know, to be brutally honest, we, to a considerable extent, have probably gone on with our own thing. I mean, to get people to collaborate—I don’t think you can force it.

Having this companion trust appeared to be particularly important because of the extra effort that was required to create and maintain international collaborations, compared to national collaborations. For example, more time is required to develop and maintain international collaborations. More time is required because researchers may have to spend time understanding their international colleagues’ different institutional conditions. For example, their collaborators’ national research councils may have different timing of grants and may fund different elements regarding the direct and indirect costs associated with research.

In summary, unless there are strong personal relationships as a basis, collaborators are less inclined to expend the extra effort required to understand the issues that are specific to international collaborations. All researchers spoke about
competence trust and how important this was in deciding to undertake the collaboration. This study found that when researchers engage in national collaborations, they do not have to negotiate the aforementioned issues. The issues that are specific to international research collaborations will be discussed in more detail throughout this chapter.

**Interactions**

Personal interactions were necessary for all types of collaboration. Email interactions were necessary for all types of collaboration, and all types required face-to-face interaction to begin the collaboration. However, the frequency and length of time that was required was different for different types of research collaborations.

In-depth collaborations required face-to-face meetings a few times a year in order to discuss the project in detail and to co-analyse results. For example, the researchers in Dean's collaboration all met face-to-face three times a year for approximately one week. Dean would co-analyse data in preparation for this team meeting. The first couple of days of the week-long meeting would involve only the chief investigators, in order for them to discuss policy, budget and staffing issues. The whole team would then normally meet on days three, four and five to discuss issues regarding data collection, results and the interventions or field studies. There was also discussion about possible papers. In terms of the joint analysis of results, Dean emphasised, 'We're very big on co-analysis of results'. The joint interpretation of results was an ongoing exercise that also occurred outside of the face-to-face meetings. Researchers conducting in-depth collaborations also engaged in electronic interactions to continually discuss the progress of the project.

Researchers reported that maintaining these frequent interactions was one of the difficulties of collaborating with international colleagues. While the effectiveness of email was highly reported, the requirement of the scientific community that ensures researchers attend regular conferences and meetings was reported as a highly-used mechanism through which frequent interactions were maintained.
The transmission of know-how type of collaboration was found to require an intense period of face-to-face interaction, during which the transfer of knowledge occurred. These collaborations continued to have a high intensity, but this was in relation to the particular method, rather than the overall project of investigation. Researchers also discussed the knowledge that had been transferred prior to and following the short face-to-face meeting time.

Service and mutual inspiration collaborations required face-to-face meetings for the collaboration to commence, but only required electronic communications thereafter.

**Facilitating Social Conditions**

*Attendance at Scientific Conferences*

Researchers regularly attend conferences as a requirement of being a member of the scientific community. These events were found to be a facilitating condition for beginning and maintaining collaborations. As Leonard, an Australian researcher, explained, 'The main reason this network now exists is because I've met them or communicated with them through my publications and research, talking at conferences, being on panels'. He went on to explain how important conferences were for not only meeting new international collaborators, but also for further developing relationships with international collaborators:

> It’s a reinforcing thing because they get involved in one project and are therefore more likely to get involved in future projects. You meet up with them at conferences because they’re involved in your projects. So, like any relationship, it gets built on and develops.

Attending scientific conferences was also found to be important in providing opportunities to discuss current joint projects. Some researchers, such as Leonard, stated that their project grants did not include the budget for specific meetings with their international colleagues. Instead, they would use scientific conferences to meet and discuss their project of investigation.
Table 11: Social Conditions by Collaboration Type Compared to National Collaborations*

<table>
<thead>
<tr>
<th>Social Conditions</th>
<th>Collaboration Type</th>
<th>In-Depth</th>
<th>Service</th>
<th>Transmission of Know-How</th>
<th>Mutual Inspiration</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Levels of Companion and Competence Trust</td>
<td>Interactions</td>
<td>Face-to-face to establish, and regular face-to-face and email to conduct</td>
<td>Face-to-face to establish, and intense period of face-to-face to conduct</td>
<td>Face-to-face to establish, and email to conduct</td>
<td></td>
</tr>
<tr>
<td>Facilitating Attendance at Scientific Meetings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Orange shading refers to the occurrence of the condition

In summary, there was one facilitating and two necessary social conditions for all types of researcher collaboration. The hindering condition of competition was only reported in a few cases undertaking service collaborations.

Cultural Conditions

Cultural conditions in this study were viewed as referring to scientific cultures and national cultures. In terms of the effects of scientific cultures, experimentalists, for example, have been found to collaborate more than theoreticians (de Solla Price, 1963; Meadows & O’Connor, 1971; Gordon, 1980), and researchers in the social sciences are less likely to collaborate than researchers in the natural sciences. Knorr-Cetina’s (1999) famous study on epistemic cultures also demonstrated the influence of different scientific cultures in knowledge production.

National cultures have also been found to affect the success of research collaborations. Barjak and Robinson found that, ‘The most successful teams have
a moderate level of cultural diversity’ (2008:23). However, the ways in which national culture affects research collaboration have largely been ignored within the research collaboration literature.

**Necessary Cultural Conditions**

**National Cultural Conditions: Strong Government Connections**

Strong government connections were found to be necessary for all collaborations with developing countries. All collaborations with developing countries in this study were in-depth research collaborations. The connections were with the government health bureaucracy and/or the health minister in the developing country. These connections were necessary for the collaboration to begin, and for the project to be successful. All Australian and international researchers spoke at great lengths about the importance of government connections in establishing and conducting the project of investigation.

Dean, spoke about how important it was to establish whether there was government support for the public health project he was conducting in a developing country. He said that without government support, the project could not have been successfully completed.

The importance of government links was also reflected in Paul’s description of why he collaborated with his international colleague, Tina:

Tina is not only a great supporter of the project, but she’s very well connected with the minister … the ministers change all the time, but she seems to have connections with all of them, so we have good access to senior people in the Ministry of Health. So we’ve managed to permeate the [developing country’s] health establishment very well. Tina is very well connected to the [developing country’s] government. I was a little worried about their [the collaborators’] academic credentials, given what I know about the NHMRC standards and the standards that we were putting forward, but I said, well, we can argue on the other hand that these are extremely influential advisors. And they are in the Ministry of Health and that was part of the reason why they were chosen—because they were so well connected. They were seeing the minister regularly, they had led, or were leading, higher research institutes, so they were very well connected in places. So I thought what they lack in academic credibility, they certainly have in terms of political weight in [the developing country], and the ability to
use evidence. They were literate in how to do that, so I thought we could make a case, which we clearly did.

Dean also spoke about the importance of these connections when deciding the sites for their in-depth public health project: ‘Nigel [from the developing country] was critical in deciding the sites, where the sites would be, [whether there was] sufficient political support for it [and] ... sufficient personnel’.

**Hindering Cultural Conditions**

*Different National Research Cultures (Valuing Different Research Outputs)*

An issue that arose during all collaborations involving developing countries was the fact that the collaborators had different national research cultures and valued publishing in different journals. As noted earlier, all collaborations with developing countries in this study were in-depth research collaborations. Therefore, this may be an issue with other types of collaboration, though this could not be explored in this study. Researchers in developing countries wanted to publish in their local public health journals in order to achieve the maximum effect in their local community, but the Australian researchers preferred international publishing journals with high-impact factors. As explained by Dean:

> There is a drive, of course, for high-impact papers ... within our university ... but the impact factor is not an issue at all for them [in the developing country]. The main results will be published in high-impact journals, but that will probably be more at the end of the study.

Stuart, an Australian researcher conducting an in-depth collaboration with Ray, from a developing country, had similar issues. As he explained:

> Their research culture is [that] reports to government [are] the research output. If it’s published in the literature, well, more the good, but it’s not essential. And so changing the culture through [the developing country] to try and maximise the likelihood or the perception that publishing in international literature is important and making the results available to everyone is important and raising the profile of the research within the Ministry of Health [in the developing country] is critical. So that’s been a cultural issue and that’s been difficult.

For these two projects, these issues were addressed during face-to-face meetings, and decisions were made to publish in both types of journals. This agreement was
reflected in the publishing protocols that the collaborators developed for the project of investigation. These publishing protocols are discussed below under institutional conditions of action.

Table 12: Cultural Conditions by Collaboration Type Compared to National Collaborations*

<table>
<thead>
<tr>
<th>Cultural Conditions</th>
<th>Collaboration Type</th>
<th>Identified in National Collaborations</th>
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</thead>
<tbody>
<tr>
<td><strong>Necessary</strong></td>
<td>In-Depth Service</td>
<td>Transmission of Know-How Mutual Inspiration</td>
</tr>
<tr>
<td>Strong Government Connections (Developing Countries)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hindering</strong></td>
<td>Different National Research Cultures (Developing Countries)</td>
<td></td>
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</tbody>
</table>

*Orange shading refers to the occurrence of the condition

This study did not find any differences in scientific community cultures that affected the collaboration. This could be because the areas of public health research, clinical trial research and experimental research are not distinct enough research areas, particularly given that all the researchers, including the experimentalists, were working in health and medical research.

Institutional Conditions

Institutions are viewed in this study as systems of formal and informal rules (North, 1990; Scharpf, 1997). Institutions have been found to both prevent and inhibit research collaborations (Laudel & Gläser, 1998). Overall, institutional conditions have received little attention within the research collaboration literature, which is a main reason for them being the focus of this thesis. This study divides institutions into two categories: funding schemes of the NHMRC and ‘other institutions’, which include all other formal and informal rules that affect the collaboration. The next section addresses the ‘other’ institutional conditions. The NHMRC institutions—the funding schemes that support international collaborative research—are the focus of Chapter Seven.
Necessary Institutional Conditions

Flexible Use of Funds

It was important that funds were able to be used in a flexible manner for all types of international research collaboration. For example, it was important that funds could be used overseas. Overseas activities included conducting research in another country (such as undertaking a public health study in-depth collaboration), attending face-to-face meetings, or spending time at an overseas research institute to learn a particular method or approach, as is the case in transmission of know-how collaborations. In regard to service collaboration, funds needed to go overseas in order to pay for patients to be part of an Australian clinical study, or to pay for the services of an overseas collaborator. This latter requirement was done, for example, to conduct assays or undertake bioinformatics analysis.

This study found that it was not only important that funds be able to be used overseas, but that there was flexibility in what these funds could be used for, particularly in cases involving developing countries. Flexibility in the use of funds was an issue for all projects of investigation being conducted with researchers in developing countries. Funds needed to be used to reflect the local research funding conditions (or lack of them).

All Australian researchers conducting collaborations with researchers in developing countries spoke about the need for the funds to be able to be used for salaries, as well as for indirect costs. Being unable to do this caused a number of significant problems in the projects of investigation. In Australia, as in most developing countries, researchers’ salaries were paid by the employing research institute. As a result, funds from NHMRC could not be used to support international investigator salaries. However, this study found that because researchers in developing countries did not have salaries paid by their employing institute, this created situations in which the Australian project of investigation was vulnerable to other studies who were able to pay the researchers for their time. As a result, researchers from developing countries often accepted offers
from other organisations, such as WHO, to undertake short-term projects. This meant that the projects of investigation were often delayed. As Dean stated:

One of the biggest problems that we’ve had is the developing chief investigator being able to spend enough of their time on this project. We couldn’t put in costs for chief investigator salaries, so the developing country institution thinks, why should they give up his time?

In addition, developing country researchers did not receive funds from their employing institute for the direct costs of research—such as computers and paper supplies—that Australian researchers take for granted. As reflected again in Dean’s experience:

All they get is direct funding. That’s all they get. So all these other infrastructure things that we absolutely take for granted, they have none of. So that makes it a real struggle for them. We hadn’t ... understood the full impact, the full realisation of the lack ... what the lack of infrastructure in the [developing country] means when you try and do these things. The developing country CI [chief investigator] did not have experience in putting in proposals to Australia where the funding structure is different and the universities get the infrastructure dollar automatically. So we’re working in different paradigms here. If we were to do this again with a developing country, we would have to put in money for infrastructure. You know, in buildings, paying CIs ... even the cost of putting up a building, paying for all your power and your computers—it’s all a cost ... You’re screwing the developing country institution, so it could easily be a disadvantage.

Therefore, the flexibility to use funds for the indirect costs of research—which is not currently permitted by NHMRC—was also found to be important for in-depth collaborations.

**Facilitating Institutional Conditions**

*Mid-Levels of Bureaucracy*

A mid-level of bureaucracy within the collaboration was found to be a facilitating condition for collaborations that were multi-partner (more than three) and that were with developing countries. This study uses the term ‘bureaucracy’ in the vein of Weber (1978): hierarchy of authority, written rules and regulations, formalised responsibilities and a specialised division of labour.
Two specific issues relating to bureaucracy arose during the interviews regarding multilateral collaborations and collaborations with developing countries. These were firstly in relation to guidelines about how the collaborations generally operated, and were secondly in relation to the development of publishing protocols.

Operational Guidelines

Guidelines for how the collaboration worked ensured the issues related to publishing in different forums were resolved, and a strategy agreed upon. Researchers stated that guidelines enabled clarity about deliverables and the roles and responsibilities of each researcher. Guidelines also ensured there was a timetable and agenda for face-to-face meetings, and protocols around publishing joint works. These issues were similar to those that need to be addressed during national collaborations. However, it appeared that guidelines needed to be explicitly stated in international collaborations. International collaborators stated that there were not opportunities for guidelines to evolve through face-to-face communication, which is how researchers address these issues in national collaborations.

Not only did international collaborators require explicit guidelines relating to the issues that are common with national collaborations, but because of the lack of face-to-face interaction during international collaboration, these guidelines also needed to address issues that were found to be specific to international collaborations—and that were not addressed in the research collaboration literature. Having guidelines around these additional issues and their impacts on research was particularly important for the success of international projects.

These additional conditions firstly related to developing an understanding of the different institutional rules of overseas research agencies, and secondly to developing an understanding of national cultures and their impacts on the research project. Therefore, having collaborators jointly develop guidelines helped negotiate some of these issues, and facilitated a shared understanding of how the collaboration worked. The guidelines that state how the collaboration works are important because researchers engaging in international research collaboration
have to negotiate more issues than those undertaking national collaboration, and negotiating these issues, as well as the usual collaboration issues, is more difficult because of the lack of frequent face-to-face interaction. Many researchers spoke about the importance of publishing protocols, as will be discussed next.

Publishing Protocols

The importance of having publishing protocols for the international project of investigation was a common theme raised by researchers conducting in-depth and service collaborations. However, researchers cited different reasons as to why these protocols were important. For some, they were important because of the type of collaboration. For researchers undertaking service collaborations, publishing protocols were important because there was a lack of clarity regarding how the collaborators’ contributions should be rewarded, and in previous collaborations this had caused tension. As Leonard, who was undertaking a large multinational clinical trial, explained:

Experience has taught me that you should have that up front before you start ... therefore, I have a printed authorship agreement that’s sent out to all collaborators before they sign up. They therefore understand that they usually won’t be an author, themselves, but they’ll be named in the paper. If they recruit a lot of patients, then we sometimes have a new agreement that means they might be a co-author on one of the secondary papers. So that authorship agreement is signed by them and sent back to us before that’s [publishing of papers] done.

The need to have publishing protocols to ensure that authorship was clear was echoed by Ned’s comments:

For joint publications we’re trying to put together some sort of almost a contract ... like if he sends me his patients and I get a hit here, who gets the credit? Is it me, because I found it first, or him because it’s his patient? How do we work that out? So, we’ve worked it out almost like a contract to decide what will happen with that information—how it might be published, under what criteria, and who would be the senior person. We’re still in the process of sorting those sorts of issues out. So I’ll actually go over there later in the year to sort that out.

For other researchers, having publishing protocols was important to address differences in national cultures. These differences—such as valuing different journals, having different views on the quality of work, and selecting appropriate journals for publication—were discussed previously in the cultural conditions
section of this paper. A number of researchers who were collaborating with
developing countries spoke about the need to control what was being submitted
for publication, as some of the developing country researchers had submitted
articles based on work of the group as a whole, without consulting other members
of the team. These issues were negotiated and agreed through the development of
these publishing protocols. A number of collaborations failed, even when there
were guidelines in place, if there was not a leader who acted in a scientific and
administrative role to coordinate and enforce the agreed procedures.

Collaborating Research Norms

Collaborating research norms was a facilitating condition for service and
transmission of know-how collaborations. It increased the likelihood of these
collaborations. This norm has also been found in other studies (Hagstrom,
1965:118; Patel, 1973:81; Keohane, 1986:4, 19–24; Kreiner & Schultz,

Hindering Institutional Conditions

Lack of Alignment Between Funding Agencies

Coordinating schemes between funding agencies was identified as a hindering
condition for all types of international collaboration. Four main coordination
issues were raised. The first hindering condition was the issue that agencies in
different countries have different numbers of grant rounds each year. In Australia,
grant rounds occur only once a year, compared to at least twice a year for the
Medical Research Council in the UK and the National Institutes of Health in the
US. As Henry explained:

The whole thing [the project of investigation] was delayed by many
years and ... that's very bad for the competitiveness of Australian
researchers. Even a one-year gap can negatively affect your
competitiveness. Many of the projects—you put them up and they get
a fundable score, but just miss out. The second time they get a
fundable score, there’s a year’s delay before we get up and get started,
and then, in the meantime, someone who had the same idea at the
same time overseas gets funding a bit quicker, gets the study,
publishes it and then when we come to publish ours, they say ‘Oh,
yes, but this is just the same as someone else’s’. So, you know, it’s the impact that falls down the chain.

The different timing of awarding grants was raised as an issue for reducing Australian researchers’ competitiveness. It was also reported as being an issue when researchers were trying to coordinate funding resources between schemes.

A second hindering condition was the fact that different agencies make payments at different times during the year. A common theme among collaborators related to the difficulty of undertaking a project when the funding was being paid by different agencies at different times during the year. The NHMRC makes payments prospectively each quarter, while other agencies, such as the UK Wellcome Trust, make payments retrospectively each quarter.

A third hindering condition that researchers spoke about was having excessive administrative requirements from different funding agencies. For example, they may have had to submit two annual reports to two different agencies about the same project.

A fourth hindering condition that researchers raised related to different agencies advising upon the success of applications at different times of the year. This made collaboration difficult, particularly when collaborating with researchers funded by the EU Framework Programme. Australian researchers reported that the primary concern for them was the delay in the NHMRC process, and the effect this had on their contracts with the European Commission. Researchers reported being under pressure to sign contracts with the European Commission, before the NHMRC application process had been finalised.

The NHMRC funding policy stated that applications were not reviewed until the EU Commission had advised that the application had progressed to contract negotiation stage. Once this advice had been received, the Australian application began to go through the NHMRC application process, which, if it was supported, included external referees. The application then went through an internal approval process of the research committee, the NHMRC council and the Minister for Health and Ageing. Therefore, there was normally a six-month delay between the commencement of contract negotiations with the Commission, and the Australian
researchers receiving notification regarding the funding for their component of the EU project. As Peter reflected:

It was so bad, we thought, ‘Oh, god, it’s possible that we’ll get approved by the EU, the EU won’t actually give us money and we’ll be relying on the NHMRC to give money. And maybe the NHMRC will say, “We don’t know anything about this, we’re not going to give you any money”’. So, we actually thought at one stage that we’d be left out in the cold.

Coordination of Regulations Between Countries

A number of researchers spoke about the impact that coordinating regulations between countries had on the project of investigation. There was a range of issues raised, including the long and complicated process of importing and exporting cells. Another issue specific to clinical research related to the difficulty of obtaining indemnity for clinical trials in other countries. As Leonard explained:

The biggest problem for international collaboration in clinical research is indemnity. I guess the really serious problem, and that is something that actually happened, we fed back to NHMRC, is that when a drug company sponsors a trial, they pay us a lot of money and they wear the indemnity insurance for these studies. This study [the project of investigation] is an independently designed and run study. NHMRC provides research funds, but doesn’t in any way provide indemnity for the conduct of that research.

He then stated that because his clinical trial was a national and international trial, he effectively requested that hospitals in other jurisdictions wear the indemnity costs of his research project. Although this had not been a problem in Australia until that time, he expected it would become one, as it was already an issue with the international collaborating countries. Leonard further detailed:

We currently have a problem with Singapore and Hong Kong. I mean, why would the Singapore government or a Singapore hospital wear the indemnity responsibility of a study being driven by Australia? It’s my research, it’s not their research. I’ve got to pay them to do it. Their research office is a problem at the moment—asking me to pay for their indemnity.

Lack of Knowledge of Institutional Funding Conditions in Developing Countries

All researchers conducting collaborations with developing countries spoke about the challenges and the time required to understand that country’s institutional conditions. For example, Dean did not fully understand that his collaborators were
expected to obtain all their funds externally—in Australia, researchers obtain external funds only for direct costs. Dean spoke about his collaborators in developing countries as having no money for indirect costs, such as computers and even paper on which to print their work. Dean was also unaware that developing country researchers were expected to obtain their salaries from external funding because this is also not the case in Australia. Dean reported that his developing country collaborators were often taking opportunities to consult in order to obtain a salary, and that this affected the timing and progress of their project of investigation.

*Western Approach to Track Record*

The issue of researchers from developing countries preferring to publish in local journals, rather than international high-impact journals, has been discussed in the cultural conditions section of this study, but it is worth mentioning under institutional conditions as well. This is because the NHMRC has a Westernised approach to assessing track record. Because of its heavy reliance on bibliometric indicators as indicators of research quality, researchers from developing countries are 'collateral damage' in this system because their effect on their local community is not considered when assessing their research quality or impact.
### Table 13: Institutional Conditions by Collaboration Type Compared to National Collaborations*

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<tr>
<th>Institutional Conditions</th>
<th>Collaboration Type</th>
<th>Identified in National Collaborations</th>
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<tbody>
<tr>
<td><strong>Necessary</strong></td>
<td>In-Depth</td>
<td>Service</td>
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<tr>
<td>Flexible Use of Funds</td>
<td></td>
<td></td>
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<tr>
<td><strong>Facilitating</strong></td>
<td></td>
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<tr>
<td>Levels of Bureaucracy</td>
<td>Mid (Multilateral and with developing countries)</td>
<td></td>
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<tr>
<td>Research Norm of Reciprocity</td>
<td></td>
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<tr>
<td><strong>Hindering</strong></td>
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<tr>
<td>Western Approach to Assessment of Track Record (Developing Countries)</td>
<td></td>
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<tr>
<td>Coordination of Regulations Between Countries</td>
<td></td>
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<tr>
<td>Lack of Alignment of Funding Schemes Between Countries</td>
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<tr>
<td>Lack of Knowledge of Institutional Funding Conditions</td>
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*Orange shading refers to the occurrence of the condition

**Economic Conditions**

Economic conditions refer to resources such as the secured and unsecured funds of researchers, and the time required for the research to be undertaken.
Necessary Economic Conditions

External Funds

Researchers require funds to undertake research and to collaborate. Therefore, it was not surprising that this study found that financial resources were necessary for all types of international collaboration. What was surprising was the extent of dependency that Australian researchers had on funds that were external from the NHMRC. Of the 20 cases examined, all reported that they could not have conducted the international project of investigation without the funds from the NHMRC. This finding confirms those of other studies—that researchers are heavily dependent on external funds to conduct their research (Laudel, 2006a). However, this finding adds to the literature by demonstrating that researchers are particularly vulnerable in their ability to obtain funding for collaborative international research.

It is important to note that, at least from the perspective of grantees, these researchers could not have funded the project of investigation without NHMRC funds. Objectively substantiating that this was the case would require a systematic investigation and comparison of all relevant funding schemes, and this was beyond the scope of this study. However, I did ask researchers about their perceptions of other funding opportunities, other than the NHMRC, that could have financed the project of investigation.

Researchers spoke about how NHMRC funding was limited. In practical terms, this meant that these researchers had no flexibility to direct funds from projects currently funded by the NHMRC to support internationally collaborative components, even if this would be beneficial for their research. For example, when I asked Ned if he could have funded the project of investigation from current funding sources, he replied:

Absolutely not. NHMRC budgets are very tight and you get funded for specific things. I had already allocated my resources to the individual projects and there is no way that this money [for the project of investigation] could have come from somewhere else.

All Ned’s funding for his research was from the NHMRC at the time of the interview.
Dean’s response also reflected the sentiment of all researchers interviewed when asked if they could have funded the project of investigation from current funding sources: ‘Get a life. Holy cow. No way. Without this funding, nothing like this would have happened. It [the targeted funding scheme] was a great opportunity. A fantastic opportunity’.

*High Levels of Funding*

High funds were found to be required for all types of international research collaborations. This was because more time was required to establish and maintain the collaboration, specifically in terms of learning about different institutional conditions, national cultures and research cultures. In addition, more funds were required to enable researchers to meet face-to-face, particularly for in-depth collaborations.

Drew, an Australian researcher conducting his project of investigation under the NHMRC general funding Program grants scheme, spoke about the difficulty of maintaining relationships with international collaborators because of the lack of funding:

Unfortunately, because there is no money for international collaborators [under the NHMRC Program grants scheme] it’s not easy to maintain a real interest because there is no funding for that. So, really, you have to have a program that overlaps sufficiently so you can justify spending your research money on a joint project—and not only be able to justify it, but be prepared to do it. So if the research area is peripheral [to the international collaborators’ main research area] or they perhaps can’t weld it to their own internal programs and because they have to afford it on the grants they’ve got it makes it very difficult to maintain a long term relationship.

Drew managed to maintain a collaboration by coordinating his Program grant with his colleague’s Medical Research Council grant. However, he discussed the difficulty of maintaining this working relationship over the years, particularly because his proposal had failed to obtain NHMRC funding during the previous year.

Lack of funds was reported as affecting the appeal of Australian researchers to their international counterparts, limiting their ability to maintain working
relationships with current international colleagues, and limiting their ability to conduct international collaborations with researchers with whom they would like to work. As Devon, an Australian clinical researcher, stated:

We have considered doing research with China or India, but we don’t think we would have the funding to actually start a major project in any of these countries. We would probably have to look for a special fund or grant of some kind. We considered these countries as they have large cohorts of patients that could be studied, but they [the researchers in China and India] don’t have that funding there for the kind of work that we would be interested in doing there. Certainly, we would like to set up studies with the Chinese and Indian investigators if we had good funding for those.

In summary, higher levels of funding are required to realise the full epistemic potential of current international collaborative relationships. This is necessary for Australian researchers to be internationally appealing collaborators—so that international researchers will seek to collaborate with Australian researchers—and so that Australian researchers can successfully invite international collaborators to work with them.

**Long Duration of Funding**

Long duration of funding was found to be a necessary condition for all types of collaboration, with in-depth collaborations requiring the most time. A common theme in interviews was that international research collaborations required more time compared to national collaborations. Dean described international projects as requiring 'a decent amount of time'. Many researchers commented that three years (the length of funding time for NHMRC's largest funding scheme—Project grants—and HFSP's project grants) was not long enough for international collaborative projects.

More time was required for two main reasons. Firstly, more time was required for personal relationships and trust to develop. Researchers spoke about the value of these developing through face-to-face interactions. The lack of local proximity and the fact that face-to-face interactions did not occur as often as those with national research colleagues meant that these relationships took longer to develop. In particular, researchers funded under the HFSP three-year grants stated that the project had effectively failed because personal relationships had not developed. A
number of researchers stated that, because the HFSP required that collaborators had not worked together before, most did not have existing productive or personal relationships with their collaborators. Interviewees commented that three years had not been long enough for these personal relationships to develop, and the project had not been as productive as hoped.

More time was also required in order to conduct international collaborative projects, due to the additional conditions international collaborators had to address. These additional conditions included the need to develop an understanding of the local research conditions in other countries. When conducting international research collaborations, a key local research condition is developing an understanding of the rules of the local research institute. For example, in developing countries, researchers are not paid their salaries from their employing institute, and do not receive funds for indirect research costs, such as computers. Other issues Australian researchers spoke about related to the length of time required to understand the importance of the project being supported by the local government, and the time required to negotiate support issues. All Australian researchers working with colleagues in developing countries spoke about how much was required to understand the local circumstances of their international collaborators, such as institutional conditions, the national culture and the national research culture. Other Australian clinical researchers spoke about the time required to address local indemnity in regard to conducting clinical trials.

Another common theme was the time required to send cells to overseas collaborators who were participating in the project. As Ben stated, ‘Importing cells between countries is a long process’. It took extra time and effort to coordinate the collaboration—an important task in ensuring the collaboration was productive. The key point is that the conditions for international research collaboration take more time to address (such as developing personal relationships), or are additional elements (such as understanding national research conditions and negotiating regulations) in comparison to conducting a national collaboration.
Hindering Economic Conditions

Lack of Targeted Schemes

All researchers identified the lack of targeted schemes as a hindering condition.

Table 14: Economic Conditions by Collaboration Type Compared to National Collaborations*

<table>
<thead>
<tr>
<th>Economic Conditions</th>
<th>Collaboration Type</th>
<th>Identified in National Collaborations</th>
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<tbody>
<tr>
<td>Necessary In-Depth</td>
<td>Service</td>
<td>Transmission of Know-How</td>
</tr>
<tr>
<td>External Funds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Amounts of Funds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of Funding</td>
<td>At least 5 years</td>
<td>More than 3 years</td>
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*Orange shading refers to the occurrence of the condition
<table>
<thead>
<tr>
<th>Facilitating Conditions</th>
<th>Necessary Conditions</th>
<th>Collaboration Types</th>
<th>Identified in National Collaborators</th>
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<td>Attendance at Scientific Conferences</td>
<td>Epistemic Link Through</td>
<td>In-Depth</td>
<td>Face-to-face to establish, and regular face-to-face and electronic to conduct</td>
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<td></td>
<td>Shared Language Based on Shared Knowledge</td>
<td>Service</td>
<td>Face-to-face to establish, and electronic to conduct</td>
</tr>
<tr>
<td>Norm of Reciprocity</td>
<td>Companion and Competence Trust</td>
<td>Transmission of Know-How</td>
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</tr>
<tr>
<td>Mid-Levels of Bureaucracy (Multilateral and Developing Countries)</td>
<td>Interactions</td>
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</tr>
<tr>
<td>Overseas Agency Visiting Programs</td>
<td>Strong Government Links (When Collaborating with Developing Countries)</td>
<td>External Funds</td>
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<td></td>
<td>High Levels of Funding</td>
<td>Flexibility in Use of Funds</td>
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<tr>
<td></td>
<td>Long Duration of Funding</td>
<td>At least 5 years</td>
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Table 16: Hindering Conditions by Collaboration Type*

<table>
<thead>
<tr>
<th>Hindering Conditions</th>
<th>Collaboration Types</th>
<th>Identified in National Collaborations</th>
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<td></td>
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<td>Lack of Researchers in Developing Countries</td>
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<td>Lack of Researchers in Developing Countries</td>
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<td>Different National Research Cultures</td>
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<td>Western Approach to Assessment of Track Record (Developing Countries)</td>
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<td>Coordination of Regulations Between Countries</td>
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<td>Lack of Alignment of Funding Schemes Between Countries</td>
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<td>Lack of Knowledge of Institutional Conditions (Developing Countries)</td>
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<td></td>
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<tr>
<td>Lack of Targeted Schemes</td>
<td></td>
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*Orange shading refers to the occurrence of the condition

Summary

In this chapter, I established the necessary, facilitating and hindering conditions for the four international research collaboration types described in the previous chapter. These conditions were examined by collaboration type and then compared to the conditions required for national collaborations. Different types of international research collaboration were found to have different conditions, with in-depth collaborations having the most necessary conditions. Another finding was that international collaborations have additional conditions compared to...
national collaborations. An example of these is that of economic conditions, in which international collaborations require high levels of funds and flexible use of funds. Multi-partner collaborations, compared to bilateral collaborations, were also found to require high levels of bureaucracy, as was the case when collaborating with developing countries. This is the first such study to link international collaboration types to this suite of conditions.
Chapter Five: How the NHMRC Schemes Address the Conditions for International Research Collaboration

In Chapter Four, the important conditions for each type of international research collaboration were identified. Identifying these conditions was a significant task, given previous studies have not examined multiple conditions of action for different international research collaboration types. Chapter Five assesses how the five NHMRC funding schemes meet the necessary conditions for international research collaboration that were identified in Chapter Four.

It is important to highlight that an external funding scheme has a limited ability to directly provide all of the conditions described in the previous chapter. For example, it is difficult for a research funding council, such as the NHMRC, to force collaborators to have strong personal relationships with other researchers. However, a research council can create institutional and economic conditions that provide time, funds and flexibility in the use of these funds to enable researchers to meet. These institutional and economic conditions could support the development and maintenance of strong personal relationships. Therefore, a research council has the ability to directly provide some conditions, and indirectly support others, through setting up certain institutional and economic conditions through its funding schemes. The conditions discussed below relate to in-depth collaborations because these collaborations have the most conditions.

Project Grants and the Conditions for International Research Collaboration

The Project grants scheme, as discussed in Chapter Two, is the NHMRC’s main scheme for supporting collaborative projects. It normally accounts for around half of the NHMRC’s annual research funding budget, and funds more than half of all the researchers that the NHMRC supports.
Direct Support: Economic and Institutional Conditions

Economic Conditions: External, High Funds and Long Duration

In terms of the necessary economic conditions, the Project grants scheme provides one of the three necessary conditions: external funds. However, these funds are not offered at high levels and are normally for a duration of only three years. Most projects are funded for about 400,000 AUD over three years, although there is the ability to renew.

Institutional Conditions: Flexible Use of Funds

Project grants did not support any of the necessary institutional conditions. The Project grants scheme did not permit the flexible use of funds. There were strict categories regarding how funds could be allocated. The first category related to payment of salaries. Funds could be used to pay the salaries of research staff, but not for chief investigators or associate investigators. Other salary requirements were that staff had to be Australian citizens or permanent Australian residents, and the research had to be based in Australia. The level of salary support was based on Personnel Support Packages (PSPs), which many researchers said were low compared to those provided in other developed countries. Researchers also stated that the fact that researchers had to be based in Australia and be Australian citizens or permanent residents meant that they could not invite international colleagues to work with them in Australia, and could not fund a collaborator to undertake research for them if the collaborator was based overseas.

The second category of the Project grants scheme related to direct research costs. The third category related to the limited budget allowance of no greater than 10,000 AUD for research equipment. Under the conditions of this scheme, neither the funds nor the people involved in the project were able to cross borders. There was limited flexibility in using funds outside the three specific categories.

A facilitating institutional condition found in Chapter Four was a mid-level of bureaucracy for large collaborations, and when collaborating with researchers in
developing countries. Project grants did not support these structures being developed.

Indirect Support: Epistemic, Social and Cultural Conditions

Epistemic Conditions: Epistemic Links Through Problems and Approaches

A necessary condition for all collaboration types was an epistemic link, though the form of these links differed by collaboration type. The Project grants scheme made it difficult for Australian researchers to develop and maintain epistemic links with international collaborators. This was because, in effect, international investigators could not be part of a Project grant. International researchers could not be chief investigators on Project grants. They could be listed as associate investigators, but could not receive a salary if they were not Australian citizens or permanent Australian residents.

In addition, funds could not be used for overseas research activities. As a result, the project of investigation could not be submitted under the Project grants scheme as a joint project. Australian researchers could not apply for a joint Project grant, so they had to coordinate their project with an international collaborator’s project, which was usually funded via one of their international collaborator’s national schemes. Researchers spoke about how hard it was to maintain epistemic links when they or the international colleague was not successful in obtaining funding approval for one year. Although they had shared research interests and areas they could collaborate on, their reliance on external funding (because they had no ongoing funding for research from their employing institute) meant that any collaborative work had to cease when either party was not externally funded. In this manner, the Project grants scheme hindered, rather than supported, the necessary condition of epistemic links. Australian collaborators had to coordinate between national funding schemes because they could not obtain funding for a joint project under this scheme.

Although these national schemes made their funding decisions based largely on investigator-initiated research areas, each country also had its own research
priority areas. This compounded the difficulties for researchers who were trying to coordinate their grant applications with international colleagues.

**Social Conditions: Relationships, Trust and Interactions**

Having strong personal relationships and high levels of trust were necessary social conditions for all collaboration types. A common theme in interviews was that productive personal relationships developed over time. The fact that Project grants were normally only funded for three years affected Australian researchers' ability to develop personal relationships. Also, as noted above in the section on epistemic conditions, there were sometimes lulls in projects due to a lack of external funding, which meant it was often hard to maintain personal relationships.

Another theme noted during interviews regarded how personal relationships developed through face-to-face interactions. Project grants did not support funds being used for travel and to meet with international colleagues, or for attendance at conferences. This was reported as a difficulty in developing and maintaining personal relationships.

An important finding of this study was that the quality of relationships between international collaborators was crucial for collaborations, and that the quality of relationships greatly influenced researchers' decisions regarding with whom they would collaborate. A number of researchers commented that even if there was very valuable knowledge to be gained by working together, if the personal relationship was not strong, they would not consider collaborating. This study contends that this is because of the extra efforts that are required to undertake an international collaboration, compared to a national collaboration. These extra efforts include developing knowledge of national and research cultures and institutional conditions. In summary, the Project grants scheme did little to support the necessary condition of strong personal relationships.

The Project grants scheme also impeded the necessary social condition of frequent face-to-face interactions that was found to be required for in-depth collaborations, and to commence the relationship for all others types of collaboration. Neither did it support the need for intense periods of face-to-face interaction, such as those
required for transmission of know-how collaboration, or for the infrequent interactions required for service collaborations. This was because funds from the Project grant could not be used for the researchers to travel overseas and meet face-to-face to discuss the joint project of investigation. Researchers stated that in order to meet face-to-face, they had to rely on other opportunities, such as scientific conferences. As a result, face-to-face meetings were often sporadic and did not coincide with critical times in the project of investigation.

*Cultural Conditions: Strong Government Links in Developing Countries*

The Project grants scheme had virtually no effect in supporting the necessary condition of strong government connections when working with developing countries during in-depth collaborations. Project grants also did not support the facilitating conditions of attending scientific conferences or fostering the research collaboration norm of reciprocity. This was because funds were strictly forbidden to be used to attend conferences, and there was no opportunity to support the norm of reciprocity.

Therefore, the Project grants scheme was found to support one of the nine necessary conditions for in-depth international research collaborations—external funds. Crucially, funds could not be used overseas and international investigators could not be partners on these grants.

**Program Grants and the Conditions for International Research Collaboration**

Program grants were the other main funding scheme of the NHMRC. These supported researchers to undertake a broad program of research, rather than specific projects.
Direct Support: Economic and Institutional Conditions

Economic Conditions: External Funds, High Levels and Long Duration

The Program scheme provided limited support for the three economic conditions. It provided external funds to a high level—most grants were at least one million AUD over five years.

Institutional Conditions: Flexible Use of Funds

The Program grants scheme did not support the necessary institutional condition. Although teams were funded for a research program, rather than specific projects, funds could not be used overseas. In terms of facilitating the condition of mid-levels of bureaucracy, for large collaborations and those with developing countries, although the scheme specified that applications had to demonstrate how the team would operate and be coordinated (including meeting, planning, decision-making and financial arrangements), this did not affect international collaborators. This was because, as with Project grants’ international collaborators, they could not be true partners under the requirements of the Program grants scheme.

Indirect Support: Epistemic, Social and Cultural Conditions

Epistemic Conditions: Links Through Problems and Approaches

In regard to the necessary condition of epistemic links, this scheme provided limited support. These grants were for five years, providing adequate time for developing epistemic links. In addition, because they supported a research program, rather than specific projects, epistemic links were more readily developed and maintained. However, as with Project grants, international investigators could not be part of the program supported by the NHMRC. This was because, as with Project grants, international investigators could not be partners in a Program grant.
Social Conditions: Relationships, Trust and Interactions

In regard to the necessary social conditions of strong personal relationships, trust and frequent interactions, the Program grants scheme went some way in supporting these. In particular, the length of the program (five years) better facilitated the ability to develop strong personal relationships. However, this scheme did not provide support for the necessary social condition of interactions because funds could not be used to meet face-to-face.

Cultural Conditions: Strong Government Links in Developing Countries

The Program grants scheme did not support this necessary condition or the facilitating condition of reciprocity.

The Program grants scheme was found to support three of the nine necessary conditions for in-depth international research collaborations: external funds, high levels of funds and a long duration of funding. As with Project grants, crucially, funds could not be used overseas, and international investigators could not be partners on these grants.

NHMRC-EU Collaborative Research Grants and the Conditions for International Research Collaboration

Direct Support: Economic and Institutional Conditions

Economic Conditions: External, High Funds and Long Duration

The EU-NHMRC collaborative grants scheme supported the three necessary economic conditions for in-depth international research collaborations. In 2005, the NHMRC increased its budget allowance per project from up to 200,000 AUD to up to 1,000,000 AUD. This budget was noted by interviewees as greatly increasing Australia's ability to be effective partners in these grants. Several researchers, including those not supported by this scheme at the time of the interviews, also reported that they had been approached by other EU researchers to be partners in further grants, following the increased budget allocation. These
researchers noted that having access to their own source of funds through the NHMRC gave them a competitive advantage to be part of the Framework Programme. They noted that many other developed countries outside the EU did not have schemes to support involvement.

**Institutional Conditions: Flexible Use of Funds**

This scheme also supported the flexible use of funds. Funds could be used to travel overseas, to make overseas purchases and to conduct research overseas. All researchers interviewed who were supported under this scheme (three) had spent time at their European collaborator’s institute during the project of investigation.

This scheme also supported a reduction of the effect of the hindering condition of lack of understanding of institutional conditions. This was because funds could be used to spend time at the European institutes, which facilitated an understanding of these conditions.

**Indirect Support: Epistemic, Social and Cultural Conditions**

**Epistemic Conditions: Links Through Problems and Approaches**

The EU scheme that supports Australian researchers to be part of EU Framework Programmes did support the development of epistemic links between collaborators. This was because there was flexibility to choose a research area. Although there was a possibility of a mismatch between the research priorities of the NHMRC and those of the EU Framework Programme, the health-related priority areas for the Framework were broad enough to allow for the NHMRC’s remit of funding health and medical research.

**Social Conditions: Relationships, Trust and Interactions**

This scheme facilitated the necessary social conditions of strong personal relationships and high levels of trust. The five-year grant period enabled personal relationships and trust to develop over the course of the project of investigation. In addition, it enabled personal relationships with current EU researchers to develop
into collaborations. A number of Australian researchers stated that this scheme enabled them to pursue unique opportunities to work with EU colleagues. For example, Mal had undertaken his post-doctorate studies in an EU institution. He wanted to continue working with some of his colleagues there, but without funding had been unable to do so. Once he obtained an NHMRC-EU grant, he was able to continue the personal and working relationships he had developed earlier in his career. This scheme also supported the necessary social condition of frequent interactions, including face-to-face interactions, by allowing funds to be used for travel so that Australian collaborators could meet their EU collaborators throughout the project of investigation.

Cultural Conditions: Strong Government Links in Developing Countries

This condition was not relevant under these schemes because it only involved collaborations with researchers in developed countries. Therefore, this scheme supported all the necessary conditions for international in-depth research collaborations.

HFSP Research Grants and the Conditions for International Research Collaboration

Direct Support: Economic and Institutional Conditions

Economic Conditions: External, High Funds and Long Duration

The HFSP scheme supported one of the economic conditions: external funds. However, high funds were not available under these research grants and the grants were only for three years. Many researchers commented that this was not enough time to conduct the project of investigation.

In addition, although this scheme provided external funds, there were some issues relating to the fact that it was calculated in US dollars. While the scheme paid collaborators in their own currency, it was based on the value of the US dollar at the time of payment. This was done over the duration of the grant, rather than at
the beginning of the grant. This meant that budgets could fluctuate throughout the project, based on the strength or weakness of the US dollar.

**Institutional Conditions: Flexible Use of Funds**

The HFSP research grants provided flexible use of funds, as there was flexibility in the budget. Although the overall budget under this scheme was determined by the number of collaborators (250,000 AUD for a team of two; 350,000 AUD for a team of three; 450,000 AUD for a team of four or more, per year, for a period of three years), there was flexibility in how this grant was awarded. Under this scheme, although the budget was based on the number of members, the distribution of funds was decided by the team members and transferred by the HFSP to each team member separately.

Furthermore, this scheme acknowledged both direct and indirect costs. A maximum of 10 per cent of the direct costs of the award, at each research institution, could be used for indirect costs. It was required that these were taken from the funds awarded, as no further funds were provided by HFSPO for indirect costs. Allowable items to be included in these indirect costs included equipment, materials and supplies, services, salaries (non-chief investigators), communication expenses (conferences and team meetings), domestic and foreign travel and other expenses. Funds could be used for conferences and for the collaborators to meet. In addition, the HFSP organised an annual awardees meeting, and all HFSP-funded researchers were expected to use funds from the grant to attend this meeting in the third and final year of their grant.

In terms of the facilitating condition of mid-levels of bureaucracy, these grants made it clear that the principal applicant was the leader of the project. In addition, the HFSP acted as a support for the principal applicant if a member was underperforming. This meant that there was a process to take action based on underperformance. The HFSP research grants policy (2004) stated that:

The Principal Applicant will be responsible, on behalf of the team, for planning and coordinating the research. He/she will also act as the liaison with HFSP and be required to submit annual budgets as well as progress reports. If, on the basis of those progress reports, the Principal Applicant considers that a team member is not contributing as planned to the project, then, in liaison with HFSPO, he/she may
propose a reduction in that member’s budget, or, exceptionally, ask them to leave the project.

However, it is interesting to note that although most of the HFSP-funded projects of investigation ended up working separately, none of the principal applicants chose to use this measure to manage their collaborators’ work if problems arose. Instead, they essentially allowed the collaboration to disintegrate—collaborators worked separately on their own elements of the collaborative project and published separately.

**Indirect Support: Epistemic, Social and Cultural Conditions**

*Epistemic Conditions: Links Through Problems and/or Approaches*

The HFSP supports novel international collaborations that bring biologists together with scientists from fields such as physics, mathematics, chemistry, computer science and engineering to focus on problems at the frontier of the life sciences. The HFSP prides itself on funding risky research that is usually not supported by the national research funding schemes of other countries. The HFSP places a clear priority on funding intercontinental collaborations. Therefore, because international researchers could submit joint projects, and because these projects had to demonstrate collaboration between all team members, it was essential to achieve the aims of the project. This scheme appeared to support epistemic links. However, three of the four researchers funded under this scheme who were interviewed reported that it was difficult to develop and maintain these epistemic links over the life of the project of investigation.

Under this scheme, researchers had to ‘develop new lines of research through the collaboration’ (HFSP, 2004) and these projects had to be distinct from applicants’ other research. All teams interviewed had to have at least one person on the team with whom they had not previously worked and the project had to be interdisciplinary. Therefore, although the HFSP clearly stated that concerted action programs—in which each team member performed a self-contained project under a general theme, without extensive interaction with the other team members—were not considered to be collaborative, this was exactly what actually occurred in nearly all the HFSP projects of investigation.
In the one HFSP-funded project in which collaborative contributions were combined, collaborators were broadly within the one discipline. This project was funded earlier than the other projects, and this interviewee commented that because of how close the collaborators were in terms of disciplines, it was unlikely that the project would be funded by the HFSP if it were submitted now. This emphasis on developing new lines of research with collaborators with whom researchers would not normally work caused epistemic links to be effectively forced. This resulted in researchers not collaborating well, undertaking what eventually become separate projects, and not publishing together. Researchers spoke about the challenges of finding a collaborator with whom they had not previously worked, and how this compromised the value of epistemic links in the research process.

Although researchers could submit joint proposals, which would appear to facilitate the development of epistemic links, the need to develop new lines of research with unknown colleagues from different disciplines actually made epistemic links difficult to develop and maintain over the three years of the project. The inability to develop epistemic links subsequently affected the success of the project of investigation.

The epistemic condition of a shared language was difficult to create due to the wide gaps in epistemic links and knowledge based on the emphasis to be multidisciplinary. As a result, many researchers spoke about how difficult it was to develop this common language. Three out of four of the HFSP grantees were not able to combine collaborative contributions because they could not develop a common language.

This scheme appeared to support the development of epistemic links. It placed great importance on the need for all of the collaborators to contribute, and encouraged extensive interaction to achieve the aim of the project. However, the lack of natural epistemic links made these projects untenable.
Social Conditions: Relationships, Trust and Interactions

The HFSP scheme hindered the necessary social conditions of strong personal relationships and trust. The need for a new combination of skills meant that there had to be at least one collaborator with whom the others had not previously worked. Personal relationships and trust were found to be low because these take time to develop through working together. Without a prior base, these relationships had to develop over the life of the project, and three years was not sufficient time. As a result, the lack of personal relationships and trust affected the conduct of the project.

This scheme appeared to support the condition of frequent interactions because funds could be used for researchers to travel to meet and discuss their work. However, some researchers commented that because the budget was a one-line budget, funds were subsequently used for the research, rather than for the airfares and accommodation required for joint meetings. Therefore, frequent face-to-face interactions did not occur. Face-to-face interactions were reported as being important because of the need to develop epistemic links between researchers from different disciplines. They were also important in developing personal relationships because most collaborators had not worked together before.

Cultural Conditions: Strong Government Links in Developing Countries

No researchers supported under this scheme were collaborating with researchers in developing countries.

ICRGs and the Conditions for International Research Collaboration

Direct Support: Economic and Institutional Conditions

Economic Conditions: External, High Funds and Long Duration

This scheme provided all the necessary economic conditions for in-depth
collaborations. These grants were for five years and, on average, were three million AUD.

Institutional Conditions: Flexible Use of Funds

There was flexibility in use of funds, but there were also some hindering conditions. Under this scheme, the NHMRC paid the Australian researchers, and the Wellcome Trust paid for the developing country component. However, funds were provided for project-based costs, including equipment, salaries, training of researchers in developing countries and travel. Neither NHMRC nor Wellcome provided institutional overheads.

Another issue was that funds were not paid directly to the developing country. This caused delays and affected the relationships between collaborators. The funds were also not paid in local currency. While the funds could be used overseas and had some flexibility, there was not enough to be used for the institutional overheads (indirect costs), for which the developing country was expected to obtain external funding.

This scheme required collaborators to have a clear agreement regarding how the collaboration worked. Applicants had to provide documentation that formally established the research collaboration and ensured there were mechanisms in place to maintain the alliance for the duration of the grant, and that there also was an Intellectual Property agreement between parties.

There were challenges reported by researchers in understanding different institutional conditions, for example, the fact that researchers from developing countries were expected to obtain external funds in order to purchase paper on which to print their publications.
Indirect Support: Epistemic, Social and Cultural Conditions

Epistemic Conditions: Epistemic Links Through Problems and Approaches

The ICRG scheme supported the development of epistemic links based on shared research goals and interests, through shared research problems, methods and objects. The scheme supported large interdisciplinary projects that had clearly-established goals and research objectives. Projects had to have a clear focus on major health issues in developing countries, translation of findings into health outcomes, and an ability to influence the development of research capacities in both the developing country, and either Australia or New Zealand. Joint projects in which all partners could be equal collaborators were possible under this scheme. Although there was a focus on interdisciplinarity, unlike the HFSP research grants scheme, researchers did not have to demonstrate that the project reflected new lines of research. Therefore, proposals were in areas in which researchers were already working, and, in many cases, with collaborators with whom they had previously worked.

In terms of a shared epistemic language, researchers did not report this as being a problem between the Australian and New Zealand researchers, given that many of them had previously worked together on smaller projects. However, some commented that developing a common epistemic language was difficult with some of the developing country collaborators because of the different skill levels. This was also an issue in regard to the quality of papers submitted for publication. For example, some found that researchers from the developing country submitted papers for publication without consulting the rest of the collaborators.

Social Conditions: Relationships, Trust and Interactions

This scheme supported the necessary social conditions of strong personal relationships, trust and frequent interactions, including face-to-face interactions. The project did not need to reflect new lines of research. Applicants were encouraged to develop innovative collaborations between researchers in different countries, as well as fostering existing links. This gave researchers the flexibility to choose with whom they wished to collaborate, rather than being forced to
collaborate with those they may not have ideally chosen (as with the HFSP scheme). This scheme supported the social conditions because most collaborators had worked together previously, and the five-year grant period meant that even new collaborators were able to develop friendships and trust within the alliance. Funds could be used for travel for collaborators to meet and discuss the project of investigation.

_Cultural Conditions: Strong Government Links in Developing Countries_

This scheme supported researchers in developing country’s having the governments links. Part of the criteria for the grant was to ensure the project had support from the local community.

**Table 17: NHMRC Schemes and the Necessary Conditions for International Research Collaboration**

<table>
<thead>
<tr>
<th>Collaboration Type</th>
<th>EU</th>
<th>ICRG</th>
<th>HFSP</th>
<th>Program</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Depth</td>
<td></td>
<td></td>
<td></td>
<td>Only external funds and time</td>
<td>Only external funds</td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of Know-How</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

*Orange shading refers to the occurrence of the condition

**Table 18: Collaboration Types Reported by Funding Scheme**

<table>
<thead>
<tr>
<th>Primary Collaboration Type</th>
<th>Targeted Funding Schemes</th>
<th>General Funding Schemes</th>
<th>TOTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NHMRC- EU</td>
<td>HFSP</td>
<td>ICRG</td>
</tr>
<tr>
<td>In-Depth</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Service</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of Know-How</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Mutual Inspiration</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

*Orange shading refers to the main type of collaboration
Dark grey shading refers to the secondary type of collaboration
Summary

This chapter provided an assessment of how each of the five NHMRC funding schemes directly or indirectly created the necessary, hindering and facilitating conditions for each collaboration type identified in Chapter Three. The general grant schemes of the NHMRC (the Project and Program schemes) provided very few of the necessary conditions for each type of international research collaboration. As a result, international collaborations occurred almost in spite of these schemes, rather than because of them.

The three targeted schemes provided more of the necessary conditions, particularly in regard to the economic and institutional conditions. The ICRG scheme provided the most necessary conditions. However, targeted schemes were infrequent and not a major element of the NHMRC’s funding schemes. These schemes serve more as ‘life boats’ for international research collaboration. These schemes occur very infrequently, and thus cannot provide the stable, long-term support mechanisms required for international research collaboration.

The general schemes provided few of the conditions, but were the main tools researchers used to conduct international research collaborations. This leads into the next section, which discusses how, despite the lack of support provided by the general schemes, researchers are still able to conduct international research collaborations. The strategies that the NHMRC general schemes and targeted schemes trigger in researchers, and how these strategies affect the conduct and content of international research collaboration, are the subject of Chapter Six.
Chapter Six: How the Different NHMRC Schemes Affect International Research Collaboration

The aim of this chapter is to answer the central question of this thesis: How do NHMRC funding schemes affect international research collaboration? This section of the thesis opens the 'black box' to answer not only if, but how, NHMRC schemes affect research. Rather than solely relying on researchers' personal experiences to assess effects, this systematic information about the effects of NHMRC funding schemes is crucial to ensure science policies achieve their desired aims.

A threshold effect of all the five NHMRC schemes was to fund research that would not otherwise have been funded. All researchers in this study reported that without funding from the NHMRC, the project of investigation could not have occurred. The researchers' current funding sources could not have supported the project, and there were no other funding sources perceived to be available by researchers. Therefore, a first link between NHMRC funding schemes and effects can be established by demonstrating that the NHMRC scheme was necessary for the research. That is, without the NHMRC funding, it is unlikely that the international collaborative project would have occurred.

It needs to be made clear that I did not objectively establish that there were no other funding sources—this was beyond the scope of this study. However, as noted in the Introduction, the Australian research system is neither rich nor diverse. There are only two research councils (the NHMRC and the ARC) and the charitable and industry sectors are small in relation to similar OECD countries. I asked interviewees if they could have funded the project of investigation from current funding sources and all reported that they could not. As Ben, an Australian researcher, aptly summarised the position of all Australian researchers interviewed 'Basically if I don't get NHMRC funding the lab folds'.

Additionally, all the projects funded through the targeted schemes had either been previously rejected (some multiple times) through the NHMRC general schemes (all ICRG and EU-NHMRC grantees), or researchers had not even tried because
they perceived that the NHMRC did not fund risky research or international collaboration research (which is explicitly the type of research for which HFSP invites applications). The fact that the projects funded through the targeted schemes had been rejected, some on multiple occasions, through the NHMRC general schemes is further evidence that the targeted schemes are particularly important for international research collaboration. This finding indicates that there are many international collaborative projects that are worthy of funding, given that they were funded through the targeted scheme but are not successful under the NHMRC general schemes.

Stuart’s account summarises the difficulty of obtaining support for international research collaborations in Australia, how unsuitable the general schemes are, and how vital the targeted schemes are:

It [the targeted scheme] provides a mechanism that would otherwise not be there to undertake and [allow] Australian-based researchers to work offshore. There are incredibly limited support mechanisms for that and this is a fantastic system [the targeted scheme]... to ensure that. It’s surprising how much Australians can get done offshore. We are incredibly creative at trying to get funds, but it’s also often done on the smell of an oily rag. And you can’t do all those things that are really important, like training and the travel and the meetings and the capacity building and all the rest of it. [They] are incredibly hard to fund ... let alone the fieldwork—the actual work, itself. So it’s a fantastic scheme to link Australian researchers—brilliant—and it’s also a much more cohesive research program ... as opposed to focused research projects. Project-specific funding doesn’t enable a joint pragmatic research program and it wouldn’t fund the training and post-grad[uate] training and ... the on-course work training and ... professional development lab[oratory] skills. So it’s very difficult to fund those development skills and other areas through the available project schemes.

Effects on the Project of Investigation

After establishing that there were no perceived funding sources other than the NHMRC, this thesis argues that the NHMRC schemes triggered a number of strategies in researchers. This section analyses the strategies and effects these had on the conduct and content of research in the projects of investigation. The previous chapter highlighted that different NHMRC schemes have different properties, and that these schemes have different matches to the necessary conditions for the different international collaboration types. The different types
of international research collaboration described in Chapter Three create requirements that must be met in order for the international research collaboration to be conducted with some chance of success. These necessary conditions for the international collaboration types must be met by the NHMRC because there is a high dependency on external funds for all research, and the NHMRC is the only major source of external funds in Australia.

Series of actions were termed as strategies only if they were deliberately applied by a number of scientists. Decisions regarding changes to problems addressed, methods employed, and objects used or populations investigated were viewed as proxies for changes in research content. Decisions regarding with whom Australian researchers collaborated, and how they did so, were viewed as changes in collaboration conduct (see the diagram about relationships between variables and mediating processes in Chapter Two).

In identifying the effects of NHMRC schemes, it is important to note that mechanistic explanations are not deterministic because they acknowledge that actors can choose otherwise. Rather, they are explanations that point to likely sequences of events and outcomes (Gläser, 2011:4–5). This section compares the strategies of research of those conducting international collaborations through general schemes, with those of targeted schemes, to allow a comparison of conditions, strategies and effects. Before discussing the strategies of Australian researchers, I present a vignette. This vignette of a targeted scheme researcher’s experience provides a comparative backdrop for the experiences of researchers supported through the general schemes that are discussed first in this chapter.

**Vignette**

Dean, supported through a targeted scheme, was undertaking a large public health study in Australia, another developed country and a developing country. He was engaged in an in-depth collaboration with Nigel, from a developing country, and Ricky, from a developed country. The work was largely based on developing, implementing and assessing community-based health interventions that were tailored to the specific populations in each country.
Dean had not met Nigel prior to the announcement of the targeted scheme, but Nigel had approached Dean to be part of the project because of his expertise. Dean had been working with Ricky in an in-depth manner in the health area of focus for many years and subsequently invited him to join the project. As Dean explained:

I hadn’t known Nigel at that time [when the scheme was announced], but Ricky and I had spent a lot of time previously trying to build research capacity in that region. So this was a golden opportunity for Australia and [Ricky’s developing country] to support building capacity in the region.

While Dean had taken the lead in writing the grant proposal, it had been a team effort, with all three researchers instrumental in deciding the aims and methods to be used in the study. Although Dean had wanted to work with developing countries in the region on this health issue for many years, he stated that there had been no funding sources available to do so. He emphasised, on a number of occasions throughout the interview, how critical the targeted scheme was for the project:

The scheme triggered us into working together. It was a very natural place for us to go, but the scheme triggered us into doing that. I mean, the types of money to be able to do research in the [geographical area] are tiny … I’ve done one very tiny project that was funded through [an overseas funding agency] back in the early 90s, but, you know, with small money … so nothing like this could ever come of it. It [the NHMRC targeted scheme] was a great opportunity. Fantastic opportunity.

The collaboration was highly intensive, with face-to-face meetings held four times a year, and continuous emailing. Dean explained that he applied under the NHMRC targeted scheme because:

It was a decent whack of money. The amount of money was substantial and it was applied to an area that had a huge need and where we had previously been working … so you know an absolute gold and a magic opportunity. I mean it’s really substantial. This project … it was a big project, probably the biggest health research project [in that region] … The other valuable thing about the scheme was that it had capacity building upfront as an objective and that has long been an objective of mine and Ricky’s. And Nigel’s as well, obviously. Yes, it was a bloody good scheme with a decent amount of money over a decent amount of time.
Dean explained that ‘as a Project grant this had failed’. Dean then discussed how this project was not the sort that NHMRC funds through general schemes because the project involved methods that had not been tested before. He stated:

You cannot go to NHMRC and say, ‘We want to do this intervention, but we don’t know what the intervention is because we haven’t talked to the community. And we want to measure it, but we don’t know exactly how and what the measurements are yet ... we don’t know what we’re going to be measuring as it hasn’t been worked out’. You know it won’t even get past the secretary at the [NHMRC] door ... So [it meant we were] able to branch out into more high-risk areas, which public health needs and [which] with developing countries is one of the benefits of this scheme. You have to have faith in your investigators to be able to ... work out what’s best without requiring it all to be ... written down to the last dotted ‘i’ ... I would really, really encourage another round of this.

Dean elaborated by further noting, ‘We could take more risks as this [the NHMRC targeted scheme] wasn’t the usual NHMRC model [in which] you already know all the results’. Dean’s project of investigation was undertaken so successfully that the collaborators were keen to expand to other international sites. At the time of the interview, Dean was looking for funding sources outside Australia because there were no funding sources in Australia, other than the one he was currently being funded through.

Dean’s story typifies that of researchers supported through targeted schemes, and illustrates that because of the targeted scheme, he was able to undertake research that he would have otherwise have been unable to complete. The selection criteria enabled him to work with colleagues in developed and developing countries, and expanded his network of international collaborators to enable him to work with Nigel. He was also able to employ methods that did not have data to support them, given the tools were developed as part of the project. This project had previously been rejected through an NHMRC general scheme. The flexible way in which the funding could be used, and the high level of funding the grant offered enabled the project to be conducted in multiple countries. As a result, Dean and his colleagues were able to increase the scale of their study. Dean could engage in an in-depth collaboration because funds could be used for him to meet face-to-face with his collaborators, and because the grant was awarded for five years, rather than the usual three years of NHMRC Project grants.
Strategies of Australian Researchers Supported Through General Schemes

Researchers supported through general schemes reported very different experiences to those described by Dean, who was supported through a targeted scheme. Researchers supported by the general scheme were found to adopt strategies to cope with two overarching issues. Firstly, researchers were found to employ strategies to cope with an inflexibility in the funding rules, and secondly, researchers employed strategies to cope with the scarcity of funds available through these general schemes.

Coping with Inflexibility

Bootlegging

One strategy employed by all researchers supported through general schemes to cope with inflexibility was ‘bootlegging’. This strategy of taking funds from one source, awarded for a certain purpose, and using it for another purpose has also been found in other studies (Morris, 2003a:364–365; Laudel, 2006:493). International collaboration was found to be an ongoing activity, and all types reported in this study were found to require face-to-face interactions. The frequency of these interactions differed by type (see Chapter Three); however, the general schemes did not allow funds for travel for either the Australian researchers or any international collaborators. In order to meet face-to-face, several researchers used funds from their general scheme for this purpose, even though this was not an allowable use of funds.

Robin had been bootlegging funds from an NHMRC general scheme for about 10 years, so that she could work with her international collaborator. Robin and her colleague, Arthur, from a developed country, were undertaking an in-depth collaboration. They were working in the area of population health, running a range of health intervention studies in Australia. Robin was a well-established researcher who had received long-term support through NHMRC general schemes: ‘I’ve been working in this field for over 30 years and I’ve had NHMRC grants over that period’.
Robin had met Arthur 10 years earlier when he had come over to her institute and undertaken his post-doctoral work with her: ‘Somewhere about the mid-90s he came and did his post-doctoral work with me after he’d finished his PhD. He stayed only for 18 months and then he got a job in [Arthur’s home country]’.

Robin and Arthur had then maintained a collaboration over those 10 years: ‘Ever since then he’s come out at least once, often twice, a year’. During those 10 years, Robin had either wholly or partly funded Arthur’s visits to Australia, using funds from her NHMRC general scheme. As Robin explained, ‘I’ve funded him over most of that time to visit, but sometimes he’s able to raise funds himself for, say, an airfare, and then I’ll support the accommodation, or something like that … I fund that from the NHMRC grant’. Arthur had been able to raise funds in his home country or could use his current funding to co-fund the visits when required.

Robin and Arthur had met face-to-face to develop the project proposal and discuss the assessment tools that Arthur had developed that were being used in the project of investigation. They had also met to undertake joint analyses of the results. Robin spoke about how critical Arthur’s specific contribution was to the project:

It’s a very systematic framework to health promotion. Nobody in Australia works like that, and it would be great to have him out here … We’re … working to see if we can get them to Australia because … they have a very systematic thorough, rigorous approach to health promotion and a really rigorous approach to measuring impact.

Robin and Arthur had been trying to enable Arthur to work in Australia for many years, so that they could work together on a long-term basis. However, Robin said that ‘finding the right position and getting it funded’ was a difficult procedure and was the reason that Arthur had been unable to move to Australia.

Robin bootlegged funds to enable her to meet face-to-face with her international collaborator to develop the project proposal and a key assessment tool and to analyse results jointly. Other researchers had bootlegged funds to buy objects or engage in patient trials. The general schemes do not permit funds to be used to purchase objects overseas, unless specifically approved in the budget, and most of the researchers interviewed had not done this. For example, Ned and Leonard were undertaking service collaborations and had used funds from the NHMRC general scheme to pay their international collaborators for patients in a number of
other countries to be part of their clinical trials. Drew, also undertaking a service collaboration, but undertaking experimental work, had purchased a range of unique mouse models from his international collaborator, but had not put this in his NHMRC project budget for fear it would get cut. This fear appears to have been valid, given comments made by the NHMRC managers when asked about how panels made decisions regarding approved budgets. As one manager commented:

Generally project budgets are cut by around 20 per cent, as it is assumed that there is some fat built in ... Then, if there are any overseas items or activities listed, these are often the next thing to be looked at and often cut.

**Target ‘Easy’ Collaborators**

Another strategy employed by most of the Australian researchers funded through general schemes was to work with ‘easy’ collaborators on the project of investigation. These collaborators were considered easy because they had been worked with before when undertaking the same type of collaboration as they were conducting under the project of investigation. Therefore, these researchers had a track record of working together during a particular type of collaboration. This study classified the relationships between Australian researchers and international collaborators in the project of investigation into three categories:

1. New—had not worked together previously
2. Enhancing—had worked together previously, but collaboration moved to intensity level under the project of investigation
3. Business as usual—had worked together previously and the project of investigation was a continuation of their current type of collaboration.

The ‘business as usual’ collaborations were termed as ‘easy’ collaborations.

There were major differences in the types of relationships between researchers funded through general and targeted schemes. Only one researcher engaged in a new collaboration through a general scheme, and even this Australian researcher was only able to do so because the international collaborator had funded him. Eugene’s collaborator had successfully applied for a scheme in his own institute that funded international researchers to visit their institute. It was through this
scheme that Eugene was able to undertake a transmission of know-how collaboration and learn a new method from Peterson.

No other researchers supported through the general schemes engaged in any new collaborations as part of the project of investigation. In contrast, all of the 11 researchers funded through the targeted schemes engaged in at least one new international research collaboration as part of their project of investigation. Ben’s explanation regarding why he had not undertaken any new international collaborations was echoed by most (seven of the nine) general schemes researchers:

When we applied, you had to have a history of collaboration, I think, or it was more helpful if you did. The people I’d wanted to apply with ... we’d only just discovered this relationship ... so we’d only come together in the last 12 months before we considered applying, so we found it pretty difficult to compete in order to explain that we were good collaborators.

Under the NHMRC general schemes, researchers have to have a proven record of working together. Ben believed that 12 months was not long enough to prove to the NHMRC that he could work well with his collaborator; therefore, they did not collaborate.

‘Business as usual’ international collaborative relationships were characterised by the collaboration having lasted for some time, and the researchers having worked together in the same way (such as undertaking service collaboration) over that period. The projects of investigation supported by the general schemes were dominated by this type of relationship, with eight of the nine cases entailing this type of relationship (see Table 19). Ben’s description of his relationship with his international collaborator was typical: ‘We had known each other for years, so this was just an ongoing collaboration. We had been working like this for many years and it works well ... we just had this ongoing collaboration’. Ben’s strategy to engage in business as usual relationships, rather than embark on new relationships, was common in researchers funded through general schemes.

‘Enhanced’ international collaborative relationships occurred when the project of investigation involved the collaboration moving to an intensity level. This did not occur for any of the projects supported through the general schemes, but did occur for five of the projects supported through the targeted schemes.
Table 19: Collaboration History by NHMRC Scheme

<table>
<thead>
<tr>
<th>Scheme</th>
<th>New</th>
<th>Business As Usual</th>
<th>Enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>1</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Targeted</td>
<td>10</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Targeting Low to Mid-Intensity Collaborations

A further strategy employed by general scheme researchers was to target low to mid-intensity collaborations. Only one researcher supported through a general scheme was undertaking an in-depth collaboration—Robin, whose experiences were described earlier in this chapter. Eight of the nine general scheme researchers reported being frustrated about being unable to work in an in-depth collaboration with international collaborators. They spoke about wanting to submit joint research proposals and work more closely with international research collaborators.

Table 20 demonstrates that most researchers were conducting service collaborations only under general schemes. The two researchers who were not were Robin, who bootlegged funds, and Edward, who undertook a transmission of know-how collaboration because his international collaborator funded him to do so. Peterson was also able to support Edward to obtain a short-term grant through his UK employing research institute. This enabled Edward to spend three intensive months in Peterson’s laboratory in the UK to learn the method. This opportunity was important to Edward because it gave him sufficient time to learn the method in enough detail to replicate it in his laboratory in Australia. The funding program of the research institute in the UK was therefore very important in ensuring Edward could conduct his research and learn the unique method that had been developed by Peterson (this is further discussed below in ‘Targeting Well-Funded Collaborators’).

It is a significant finding that researchers funded through general schemes could only engage in service collaborations. Researchers supported through general schemes— which are the main tools that Australian researchers have to conduct
international research collaborations (representing about 75 per cent of NHMRC funding and being the two main funding instruments)—were found to only be able to engage in service collaborations. Even these types of collaborations involved bootlegging funds to exchange objects and meet face-to-face. NHMRC policy managers confirmed the reports of researchers that when these items were included in their budgets, they were usually cut by NHMRC panel members. Therefore, researchers were not permitted to use funds for these purposes, even though this study found that all general researchers did.

Table 20: Collaboration Types Reported by Funding Scheme

<table>
<thead>
<tr>
<th>Primary Collaboration Type</th>
<th>Targeted Funding Schemes</th>
<th>General Funding Schemes</th>
<th>TOTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NHMRC- EU</td>
<td>HFSP</td>
<td>ICRG</td>
</tr>
<tr>
<td>In-Depth</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Service</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Access to Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of Know-How</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Mutual Inspiration</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TOTAL CASES</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

*Orange shading refers to the main type of collaboration

**Dark grey shading refers to the secondary type of collaboration

Coping with Scarcity

Researchers supported through general schemes were also found to employ a range of strategies to cope with scarcity of funds. These are now described.

Targeting Well-Funded Collaborators

Another strategy employed by researchers through general schemes was to target well-funded collaborators. No researchers funded through the general NHMRC schemes were collaborating with researchers from developing countries. This was despite many expressing a desire to do so, and identifying the important contributions these developing country researchers could make in terms of the methods, objects or overall research problem. However, researchers reported it
was not possible to collaborate with researchers in developing countries due to the lack of funding in Australia and in developing countries.

Devon’s story was typical of this dilemma: ‘There is work that could be expanded, as there are large cohorts of patients in India and China that we would like to study, but they don’t have the funding there for that type of work we are interested in’. Devon also commented that:

I want to do some research with an Indian and Chinese group but we don’t think we would have funding to actually start a major project like that in one of those countries. We would have to look for some special fund ... other than the NHMRC, but I don’t really know of one.

Researchers, through general schemes, reported being unable to work with researchers in developing countries. They also stated that because of the lack of external funds in Australia, they were only able to have continued collaborations when their collaborator in the developed country was able to provide support.

Australian researchers spoke about the importance of international collaborators having their own generous funding. For example, Drew had a long-term collaboration with William, from a developed country. Drew spoke about how valuable the unique animal model that William had developed was for his own work, but he also spoke of how critical William’s funding had been over the years to ensure the collaboration had been maintained. William had continued recurrent and external funding for many years, which had enabled them to maintain their collaboration as a mutual stimulation collaboration. However, when Drew did not have NHMRC funding, they were unable to collaborate on a specific project together.

Drew’s story reflects many of the researchers’ reasoning for working with researchers from developed countries. They stated that it was extremely difficult to maintain international collaborations with intermittent funding, and that they often had to rely on support from their international colleagues to ensure the collaboration was maintained—even at a low intensity level—when they did not receive project funding from the NHMRC. Table 21 demonstrates that no researchers funded through general schemes were collaborating with researchers in developing countries, even though several researchers (such as Devon)
identified benefits (such as increased scale and costs) and specific projects in which they desired to do so. Edward’s story, as discussed earlier, was a further demonstration of this strategy.

Table 21: Scheme by Developed and Developing Country*

<table>
<thead>
<tr>
<th>Developed Country</th>
<th>EU</th>
<th>NHMRC-ICRG</th>
<th>HFSP</th>
<th>Program</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing Country</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Orange shading refers to the occurrence of the condition

**Targeting Overseas Sources of Funding**

Another strategy reported by a number of researchers was to seek funds from outside Australia. For example, Stuart was undertaking a range of clinical trials, as well as undertaking experimental research, in collaboration with a developing country on a communicable disease. The experimental work was completed in Australia and the developing country, but the clinical trials were undertaken in the developing country. This was because there was a much larger population who had the disease.

Stuart was undertaking an in-depth collaboration with his developing country colleague. He had applied to have the work supported through the NHMRC general grants scheme on many occasions and had been unsuccessful. As a result, he had applied to an overseas funding agency and had been successful. As he explained:

[The overseas funding organisation] funded us, and the NHMRC Project grants didn’t, which is interesting and it reinforces the perception that nothing offshore gets funded by NHMRC … The science was good enough, but it didn’t get … a project grant. In fact, the reviewer’s comment was, ‘Why should we fund stuff in [the developing country]?’.

Through this overseas funding agency, Stuart and his international collaborator obtained funds for the laboratory work in Australia and the developing country, and the fieldwork in the developing country. When Stuart’s funding through the overseas agency was about to cease, he was able to receive funding from the new NHMRC targeted scheme.

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Henry was another Australian researcher who had felt he had no option other than to seek funds from an overseas funding agency to support his work. He was an epidemiologist undertaking a clinical trial of a non-communicable disease. He had been undertaking a large clinical trial in Australia, with many Australian collaborators, but said the work needed to expand to international cohorts. Henry had been trying for many years to receive funding from the NHMRC for a large clinical trial. While parts of this had been funded by NHMRC and various pharmaceutical companies, Henry stated that the work needed to progress to phase four trials. In order to do this, he required a large cohort, which meant a large sum of money. While Henry had been successful in obtaining some funding from NHMRC, it wasn’t enough to support the phase four trials.

Henry had also been unable to obtain sufficient funding from the pharmaceutical companies because they were only interested in sponsoring certain drugs. His trial involved a very low-cost drug and while he argued that there were great health benefits, the costs of the drugs associated with the trial were relatively low. Henry argued that the research was important because it had such a low-cost treatment for a great health benefit. However, the pharmaceutical companies appeared to have the view that they could profit more if people with this disease continued to use the inefficient, high-cost alternatives. As a result, Henry sought funding from an overseas agency:

We’d scanned [the developed country] for suitable collaborators ... [The overseas funding agency], recommended us and they actually rang up and sorted out this chap, Bert ... We’d sort of been working out who to collaborate with and writing to a number of people, but [the overseas funding agency] actually selected the collaborator. They are very keen on the program ... Personally, I think it’s a massive disappointment for Australia, in a way, because Australia’s future ... the future of those phase four trials is massively important. They’re the ones which really change practice. They might be expensive. They might be 20, 30 million dollars, but they’re all things which are focused on the really important questions of medicine. And when they’re done, doctors pick up their results straight away—and this is a particularly important question for doctors.

The consequence of obtaining this funding from overseas was that the study then took place in the developed country, as well as Australia. Henry stated:

We’d really like to have done it all in Australia, to be honest. We’re only going overseas because we found funding easier. Ideally, we
would have liked to work with Australian researchers. We’d have liked to have got the funding distributed here, in this country, and, I mean, we’ve already got the network set up here in Australia of investigators. It’s just that big studies like this need a consortium to fund it … and there’s not really a mechanism to do that in Australia. It’s not only our study—it’s all phase four studies, any big epidemiological study.

Henry also discussed how frustrating it was to have breaks and delays in NHMRC funding, and how this meant that international researchers were able to progress more quickly with the research. As Henry explained:

You pick up these ideas often at international meetings and you recognise you have an opportunity ... And then you already have a delay because you probably have to wait until January to put in a grant, and then the following January to start ... Therefore, the international people who ... hear of the same things at these international meetings and can get going straight away [have] a big advantage ... We’ve been knocked back [by NHMRC] on several occasions before we got funding [from the overseas funding agency] and ... it’s that sort of delay that stops [research] being internationally competitive.

He spoke about the fact that the overseas funding agency had ‘made noises a few years ago about keeping intellectual property’ of their research and how disappointing it would be if this did occur. Seeking funding from an overseas agency was not Henry’s ideal option.

*Narrowing Research Area*

Drew is an example of a researcher who narrowed his line of research to try to improve his chances of funding by the NHMRC. Drew’s project of investigation had been rejected under a previous round of project grants. He discussed how the rejected application had identified new lines of research that he was aiming to undertake with William, one of his international collaborators. Drew had been successful during the second round, but had modified his application in response to comments from the chairperson of the panel who had reviewed his last application. He explained:

I think when the project was reviewed and rejected in the previous round, the chairperson said we needed to keep to our strengths, so we wanted to convince him that we weren’t moving away from our strengths. I guess we were more specific about using our strengths and not being quite as broad—a little bit less risky, I guess.
Drew had wanted to move into studying new areas regarding pain—areas in which William was working. However, he had stayed in his current research area following the comments from the NHMRC panellist regarding his application. He was working with William in terms of exchanging objects, rather than collaborating in the new area: ‘I guess we moved away from [the new research area] because we knew specifically that that was where one of the reviewers had concerns’. Drew went on to state that by the next round they ‘had more supportive evidence that we had the animal behaviour work working [in his usual research area] and so they [the NHMRC] were happy to give it [the grant] to us then’. However, this also meant that Drew could only work with William by undertaking a service collaboration, rather than an in-depth collaboration, as Drew had hoped.

Other researchers reported similar experiences. For example, Ben had significant sections of his project of investigation cut by the NHMRC in the previous round. He explained that the project that was funded after he had made modifications to his application based on feedback from the NHMRC panel was more similar to projects for which he had previously received funds from the NHMRC. He stated that, disappointingly, ‘it was the more interesting bit that the NHMRC did not want to fund’. The part that was not funded represented a new research area in which Ben had wanted to work with his international collaborator, Andrew. As Ben explained:

It was exploring the regulation of some of these genes, and how genetics can vary that regulation ... If every gene was working all of the time, the whole system would fold up, so all the genes have got to be switched on at the right time and switched off. Gene regulation is critical to how our cells work, and there can be genetic variations between individuals as to how genes are controlled. That’s an area [that] there is not a lot known about and that was an area I wanted to pursue in relation to these particular genes ... but that wasn’t funded so we [he and Andrew] can’t pursue that as we’d liked.

Rather than working with Andrew in this new research area, Ben was working with him in a lower form of collaboration—mutual inspiration—in which they exchanged ideas, rather than undertaking laboratory-based work.

*Downsizing*

Another common adaptation made by researchers funded through the general schemes was to reduce the size of studies they were undertaking with international
collaborators. Downsizing was also reported by Gläser and Laudel (2007:145). Downsizing occurs when researchers have to match the project with the funding they receive. For example, Devon spoke about the effects of the NHMRC budget on his study: ‘We were working on a shoestring Project grant. Because they [the international collaborator] had funding of a million dollars per year and we were working on 120,000 dollars per year, the scale of ours had to be very different’.

All the researchers conducting clinical trials through general schemes reported having to do this. This is a significant finding. The fact that they had to reduce the size of their studies became more and more critical as they wanted to progress to later phase clinical trial studies. As a result, some researchers had to obtain funds from outside Australia in order to undertake later phase, larger clinical trials. An example of this—Henry’s story—is discussed under ‘Targeting Funding From Overseas’.

**Stretching**

Researchers also responded to budget cuts by stretching their projects. Again, this was a strategy also found by Gläser and Laudel (2007:145) Stretching a project ‘is not linked to any strategic design of the project but is rather passive. It occurs when academics do as much as is possible at the time and do less if there is less funding’ (Gläser & Laudel, 2007:145). Leonard discussed how he had to stretch his project because the budget was cut on his project of investigation. As he explained:

> The clinical trial was frustrating ... We asked for two million to do a five-year study. I knew it was going to be challenging, and we got 1.2 [million] and they [the NHMRC] said, ‘We’ll give you 1.2 million for three years’ funding, and come back for a second application when you want more money’. Now that’s just silly. I mean, they’d obviously decided that it was good enough to be funded, which it clearly was. We were clearly going to be able to do it, and we are, but I’m now going to have to worry about getting a couple more years in funding ... But, again, it wastes a lot of my time just to do all that paperwork and justify and prepare it, rather than just doing the study.

Leonard stated that he was going to do as much of the study as possible during the three years of funding he had been granted, rather than taking the five years he had requested.
Devon discussed places in which he had made cuts to his research, and how this had affected the data that was produced during the clinical studies in mental health that he was undertaking:

The money we had was small. We had to make some compromises as a consequence. I think that sometimes the data quality suffers if you’re working on a shoestring budget because you don’t have a data manager who can scrutinise the data very closely. So we had difficulties like that ... with this project.

Level of Adaptation

One researcher who was supported through an NHMRC general scheme reported that he did not change whom he wanted to work with internationally, nor did he change the ways in which he wanted to work with them. He was able to match his research needs with those of an NHMRC general scheme.

Effects of Project and Program Grants on Conduct and Content

The strategies employed by general schemes researchers had a number of effects on the conduct and content of international research collaboration.

In terms of conduct, these researchers had to limit their international collaborations to service collaborations, to limit their work with researchers in developing countries, and to collaborate only with researchers with whom they were already working.

In regard to content, the general schemes meant researchers could only access state of the art objects or larger populations. The general schemes have a focus on track record and extensive supporting data, which means they favour the mainstream perspective. This causes researchers to cease lines of research that are too basic or unfashionable, and advance lines of research towards more applied and fashionable topics. This causes research trials to narrow. This is particularly relevant for international research collaboration because, as a result of research trials narrowing, there are fewer ‘docking points’ for researchers from other fields (Gläser & Laudel, 2007:146). Therefore, the research is reduced in scope and
validity because researchers alter their projects in order to increase their chances of obtaining funding. As a result, fewer and poorer empirical objects were used, fewer experiments were conducted and smaller populations were investigated. In addition, researchers were limited to accessing the state of the art objects only. That is they were not able to learn world leading methods and work on the most exciting, state of the art research problems. ‘Fewer empirical objects, less suitable empirical objects, fewer experiments, measurements, or methods all mean that the knowledge claims offered to the scientific community in publications are less well grounded than they could be. Since these features are directly linked to the quality standards of scientific communities, we can say that reduced scope and reliability also mean reduced quality of research’ (Gläser & Laudel, 2007:146).

The links between the conditions, schemes, strategies and effects are illustrated by scheme in Figures 4 and 5. The strategies have not been reported by scheme in the previous discussion to protect interviewees’ confidentiality, and because the strategies were common to both schemes.
Figure 4: Effects of Project Grants on International Project of Investigation

### Conditions for All Types of Research Collaboration
- Epistemic link through research problem
- Shared language
- Strong trust and personal relationships
- Frequent face-to-face and other interactions
- Strong government links (developing countries)
- External funds
- High levels of funding
- Flexibility in funds
- Duration of funding

### Properties of Project Grants
- High financial importance—accounts for approximately 50% of NHMRC annual budget
- Supports investigator initiated research with supporting evidence
- Normally three years
- International investigators cannot be full partners
- Funds cannot be used outside Australia
- Around 300–500 AUD

### Strategies
- **Coping with Inflexibility**
  - Bootlegging
  - Target easy collaborators
  - Target low to mid-intensity collaborations

- **Coping with Scarcity**
  - Target well-funded collaborators
  - Target funds outside Australia
  - Downsize
  - Stretch
  - Reduce research area—develop projects with low strategic and technical risk

### Effects on Conduct
- Limit collaboration to service collaborations only
- Work with researches in developed countries
- Work with existing collaborators
- Conduct research outside Australia
- Risk losing IP

### Effects on International Content
- Access to state-of-the-art objects only
- Narrow research trail
- Quality reduced
Figure 5: Effects of Program Scheme on International Project of Investigation

**Conditions for All Types of Research Collaboration**
- Epistemic link through research problem
- Shared language
- Strong trust and personal relationships
- Frequent face-to-face and other interactions
- Strong government links (developing countries)
- External funds
- High levels of funding
- Flexibility in funds
- Duration of funding

**Properties of Program Grants**
- Mid financial importance—accounts for 10% of NHMRC annual budget
- International investigators cannot be full partners
- Five years of funding
- Funds cannot be used outside Australia
- 5-10 million AUD

**Strategies**

**Coping with Inflexibility**
- Bootlegging
- Target easy collaborators
- Target low to mid-intensity collaborations

**Coping with Scarcity**
- Target well-funded collaborators
- Target funds outside Australia
- Downsize
- Stretch
- Reduce research area: develop projects with low strategic and technical risk

**Effects on Conduct**
- Limit collaborations to service collaborations only
- Work with researches in developed countries
- Work with existing collaborators
- Conduct research outside Australia

**Effects on Content**
- Access to state-of-the-art objects only
- Narrow research trail
- Quality reduced
- Risk losing IP
A Comparison: Strategies of Australian Researchers Supported Through Targeted Schemes

Researchers supported through the targeted schemes provided a comparison for researchers conducting international research collaborations under different conditions (see Chapter Five). The targeted schemes supported more of the nine necessary conditions (eight when collaborating with developed countries) for all types of international research collaboration than the general schemes. The Project grants supported one condition, the Program grants supported three conditions, the HFSP grants supported three conditions, the ICRG grants supported nine conditions, the EU grants supported eight conditions.

This section discusses the strategies that researchers employed and the effects these strategies had on the conduct and content of the project of investigation. Many of the strategies that were found to be triggered by the NHMRC targeted schemes (such as increasing riskiness of methods used) were also found to be effects. This study argues that NHMRC schemes have these effects because they support the necessary conditions, and they also have specific selection criteria that supports risky research. The NHMRC scheme applications do not require extensive supporting data, and these schemes enable collaboration with international researchers. The properties of the schemes triggered the strategies described below.

No Need to Bootleg

As reflected in Dean’s story, researchers supported through general schemes did not have to bootleg funds because the targeted schemes provided flexibility in the use of funds. Unlike Robin—who extensively bootlegged her funding to support interactions with her collaborator—Dean could use funds to meet with collaborators face-to-face and conduct studies outside Australia.
Work with New Collaborators and Researchers in Developed and Developing Countries

In contrast to the general schemes, as shown in Table 19, 10 of the 11 projects of investigation under the targeted schemes involved at least one new collaborator. For the HFSP, this was a requirement, and for the other two targeted schemes it was a desirable selection criteria. Dean’s story, discussed at the beginning of this chapter, is an example of a new collaborative relationship that researchers under targeted schemes were able to undertake. Table 19 shows that researchers funded through the targeted schemes were able to engage in more dynamic collaborations that involved new or enhanced working relationships, rather than working with researchers from previous collaborations, as was the case with all except one of the researchers supported through general schemes.

Increase Perceived Risk

As opposed to general schemes, the main adaptation that researchers working under targeted schemes made in regard to content was to increase the riskiness, as perceived by researchers, of their research in terms of the problems and/or, methods and/or objects. This occurred with 10 of the 11 targeted schemes. As part of two projects, the researchers were able to increase significantly the scale of their research.

Researchers were able to implement riskier methodologies, explore riskier research problems, and use more unusual objects. All of the targeted scheme projects of investigation had previously been rejected—in part or in entirety—under the general NHMRC schemes. Australian researchers stated that the main reason for their projects not being funded, based on the feedback from the NHMRC panels, was that the research was too risky. Through analysing the structural properties of their research, this study was able to ascertain in more detail what this meant—whether it was in reference to the objects, methods or research problems.
Dean for example, discussed at the beginning of this chapter increased riskiness in terms of the methods he used. He described how the methodology he was using was being developed during the project.

Nancy’s project of investigation represented a new approach to her research problem, and the use of new methods and objects. She highlighted that the study was ‘a project that, in scientific terms, is very risky’ and explained that:

The key I found was that each of us had the chance to do better research than we would normally have been given funding for. We all had the chance to be involved in research that a research council would probably have deemed too risky. We all made significant inroads in our field. It [the NHMRC targeted scheme] gives you the forum for trying out something new. To have a free spirit, which maybe sometimes is lacking, and I think this is amazing ... We made a huge step forward. We moved from a negative definition to understanding how it is actually working. It is a huge leap.

This was particularly the case with the HFSP scheme. Many researchers, including those who were not currently funded under this scheme, reported that the HFSP was a very unusual type of scheme for Australians to access. Not requiring preliminary data in the application or an extensive track record in the area of the proposal was reported as being very rare. All the researchers funded under the HFSP made similar comments to Walsh’s who was supported under this scheme—that ‘HFSP supports innovative and more risk-oriented science’ (Walsh). All HFSP funded researchers contended that their projects would never have been funded by NHMRC or ARC’.

Increase Scale and Empirical Basis for Clinical Trials and Public Health Research

All researchers funded through the NHMRC, EU and ICRG schemes stated that the scheme had meant they were able to increase the scale of their research under the project of investigation. Researchers stated they could do this because they had funding that was larger than usual, and because both collaborators could travel and use funds for the research outside Australia. During the interviews, researchers were often excited when discussing how the targeted scheme enabled them to study on a scale that they had previously been unable to achieve.
Dean and his international collaborator, Nigel, were undertaking public health studies across four countries. They stated that their research was 'the biggest thing on the planet' because it was 'the biggest thing to ever happen in the South Pacific'.

Another example is that of Delia, who was able to participate in a clinical trial of cancer with more than 10 countries because she obtained funding through the NHMRC targeted scheme. She discussed her successes with small studies, but stated that this funding provided a very important opportunity to be part of a study far bigger than she could when only collaborating with national colleagues. As she explained, 'This grant has got a huge consortium and so there are at least a dozen groups from various places. We just wouldn’t have been able to do a study this big here'. Delia had enjoyed a long-term association with her international colleague, but had not been able to work with him for many years because there was no funding to do so. Delia was keen to be involved in this research because it:

> Opens up horizons which are enormously valuable, and brings technology and ideas, and enlarges the critical mass so that the whole standard of the work goes up a huge amount ... It just leads to better quality research and much more highly competitive research.

Mal was also able to increase the scale of his research because he received support through an NHMRC targeted scheme. He was able to work with genes that he sourced through his international collaborators. He spoke about how these genes were not available in Australia, as they were patented by some of his international collaborators. Particularly for those undertaking clinical trials, being able to undertake research in countries with much larger population bases than Australia was spoken about as being such a rare opportunity. It meant that the ability to translate these results into practice was much quicker. One project, in particular, had already changed clinical guidelines and policy regarding treatment poisoning from a particular household chemical. The researchers said that achieving this through a study based only in Australia would have been impossible due to the small number of Australian patients who suffered from this type of poisoning.
Broaden Research Trail

Ten of the 11 researchers funded through targeted schemes stated that the scheme had enabled them to broaden their research area. Delia and Mal were examples of this. For Delia, the EU grant meant that she was able to access genetic and epidemiological information on more types of the disease he investigated. For Mal, it meant that he could broaden his research area: ‘I thought it was a very good idea to be part of a larger group of people with ... a concrete goal of trying to cure [non-communicable disease]. It definitely expanded my research program by getting the additional funding’. Mal discussed how he had applied under the Project grants scheme for elements of the work that were funded under the NHMRC-EU scheme that had been rejected. He stated that he ‘had previously applied for Project grants on some of this work, which weren’t successful’. Delia, too, had her project of investigation rejected under general NHMRC funding schemes. Mal discussed how the NHMRC-EU grant meant that the team could have a broad research aim, rather than a narrow hypothesis:

Because the Project grant is just so focused and you have to have a certain, very small, hypothesis ... they’re ... completely different kettles of fish. I mean, if I’d said in the Project grant that I wanted to cure autoimmunity over a five-year period working with a group of 25 other scientific groups and with five biotech companies, it [the application] just wouldn’t be successful.

Access and Provide Unique Objects and Expand Application of Unique Methods

Some researchers, through their international collaborators, could access unique objects. For example, Peter could apply his unique methodology of cell tracking by using cells provided by his international collaborators. Each of his international collaborators had used techniques specific to their individual laboratories to derive the cell lines that Peter was tracking. Another example was of Mal, who was able to use specific genes that were under patent by his international collaborators.

Paul, a public health researcher, discussed the targeted scheme that had enabled him to develop a new methodology. As he explained:

This was an ideal opportunity to run out something that was cutting edge. No one had heard of it. We’d been collaborating very steadily since the early 1990s, which laid out a framework so that you could compare the impact of a certain disease from one risk factor ... with
another, which had never been done before. And then we systematically set about applying this framework and produced what's called a [specific type of framework] ... This grant was an ideal opportunity to run out something that was cutting edge. No one had heard of it. No-one had seen it. And so here was an opportunity to expand—to do a risk factor and an economic effectiveness study.

Peter was also able to apply his unique method of cell tracking because the NHMRC scheme enabled funds and people to cross borders. Dean’s story, presented at the beginning of this chapter as a vignette, also describes how he was able to use a ‘risky’ methodology that was developed during the project of investigation.

**Effects of Targeted Schemes on Conduct and Content**

Researchers could conduct projects entailing strategic and technical risk because targeted schemes had selection criteria that required working with international collaborators, and the ICRG and HFSP schemes had specific criteria that stated projects did not require extensive supporting data. In contrast, general scheme collaborators could only undertake service collaborations based on exchange of objects, and only after overcoming the obstacles of funding scarcity and inflexibility.

Most of the strategies identified above were also effects. All projects funded through targeted schemes were, as perceived by researchers, to be more risky in terms of objects and methods used, of problems addressed or in terms of the increased scale. Access to the world’s best objects, methods and addressing the most exciting research problems is likely to lead to the knowledge claims offered to the scientific community in publications being particularly well grounded. Therefore, an increase in scale and using the world’s best objects and methods and addressing the state of the art research problems is likely to lead to an increase in the quality of research.

This study discovered one scheme-specific finding in relation to the HFSP. Researchers supported through this study provided empirical evidence to confirm the finding of many laboratory studies that all decisions relating to conduct and content must be self-identified by researchers, rather than imposed (Knorr Cetina,
1981). This was found to be the case in the experiences of HFSP-funded researchers. The HFSP scheme had a requirement that there must be at least one new collaborator, and that the team must be interdisciplinary. For three out of the four HFSP projects investigated in this study, the contributions of the collaborators were not combined because of a lack of personal relationships and an inability to develop a shared language due to having weak epistemic links.

This finding confirms that these strategic decisions relating to research (decisions about problems, methods, objects and collaborators) are only able to be made by researchers, themselves. Therefore, if there are too many requirements for researchers, collaborative contributions cannot be combined and the collaboration is unsuccessful. This occurred with the HFSP scheme. This study argues that these researchers required more time to develop a common language based on shared knowledge and epistemic links, such as trust and strong personal relationships with their collaborators. The three years of a HFSP grant did not allow this to occur.

The three figures below illustrate the strategies and effects by scheme. As noted earlier, strategies and thus quotes were not identified by scheme to protect interviewees’ confidentiality.
Figure 6: Effects of NHMRC-EU Scheme on International Project of Investigation

**Conditions Supported by Scheme**
- Epistemic link through research problem
- Shared language
- Strong trust and personal relationships
- Frequent face-to-face and other interactions
- Strong government links (developing countries)
- External funds
- High levels of funding
- Flexibility in funds
- Duration of funding

**Properties of HFSP**
- Supports EU Framework Health priority research
- Teams must be international
- Five years of funding
- 1 million AUD
- Funds for Australian researchers to conduct research in Australia on EU framework project

**Strategies**
- Target new and existing collaborators
- Target high-intensity collaborators
- Expand scale of project
- Broaden research area

**Effects on Conduct**
- Work with collaborators in developed countries
- Work with new and existing collaborators
- Expand network of international collaborators
- Conduct in-depth collaborations
- Conduct service collaborations

**Effects on Content**
- Access state-of-the-art objects and problems
- Increased validity and scale
- Increase quality
- Conduct risky research
- Widen research trail
Figure 7: Effects of ICRG Scheme on International Project of Investigation

**Conditions for All Types of Research Collaboration**
- Epistemic link through research problem
- Shared language
- Strong trust and personal relationships
- Frequent face-to-face and other interactions
- Strong government links
- External funds
- High levels of funding
- Flexibility in funds
- Duration of funding

**Properties of HFSP**
- Supports innovative investigations—limited supporting data required
- Teams must be international
- Five years of funding
- 250,000 USD for team of two; 350,000 USD for team of four
- Flexible use of funds

**Strategies**
- Target new and existing collaborators
- Target high-intensity collaborations
- Develop risky projects
- Expand scale of project
- Broaden research area

**Effect on Conduct**
- Work with collaborators in developed and developing countries
- Work with new and existing collaborators
- Expand network of international collaborators
- Conduct in-depth collaboration

**Effect on Content**
- Access state-of-the-art objects, problems and methods
- Conduct risky research
- Increased validity and scale
- Increase quality
- Widen research trail
Figure 8: Effects of HFSP Scheme on International Project of Investigation

**Conditions for Successful International Collaboration**
- Epistemic link
- Shared language
- Strong trust and personal relationships
- Frequent face-to-face and other interactions
- Strong government links (developing countries)
- External funds
- High levels of funding
- Flexibility in use of funds
- Duration of funding

**Properties of HFSP Grants**
- Supports innovative interdisciplinary research
- Teams must be international
- Three years of funding
- 250,000 USD for team of two; 350,000 USD for team of four
- Flexible use of funds

**Strategies**
- Target new collaborators
- Target collaborators outside field
- Target high-intensity collaboration
- Develop risky projects
- Broaden research area

**Effects on Conduct**
- Work with new and existing collaborators
- Work with collaborators in developed and developing countries
- Conduct in-depth collaborations
- Expand network of international collaborators

**Effects on Content**
- Access state-of-the-art objects, problems and methods
- Conduct risky research
- High probability of collaborative contributions not being combined
- Widen research trail
Summary

This chapter has attributed changes in international research collaboration conduct and content to NHMRC funding schemes. This study argues that the NHMRC schemes have the effects described because the NHMRC schemes changed the ‘self-identification mechanism’ of researchers. This occurred when researchers developed their research proposals in terms of the problem addressed, the methods used, the objects or populations explored, and decisions regarding with whom to collaborate and how to do so.

For example, all of the researchers supported through the HFSP schemes converted ideas they had been developing for some time into project proposals because the HFSP offered them their first opportunity to obtain funding. In addition, all of the other researchers funded through targeted schemes had failed—some multiple times—to have their projects of investigation funded through the NHMRC general schemes. All researchers (except one) who were funded through the targeted schemes worked with new collaborators with whom they had been wanting to work for some time, but had not had the opportunity. The targeted scheme provided them with this opportunity.

The NHMRC targeted schemes offered a match for almost all the necessary conditions for international collaborations. As a result, collaborators were able to work with international collaborators and undertake projects that included a high level of perceived risk, a relatively long duration and significant unusual expenses. This study’s argument is that researchers are dependent on the NHMRC to provide the conditions for international research collaboration. If these are provided, the benefits of working with international collaborators can more readily be grasped, and researchers will have access to world-leading knowledge in all its forms.

However, most researchers had to conduct international research collaborations through NHMRC general schemes, which provided few of the necessary conditions for international research collaboration. This study demonstrates that if researchers
have to conduct these collaborations through unsuitable schemes, they have to limit with whom they work and how they work with them. These researchers were found only to be able to access these opportunities that international collaboration can offer in a limited manner. They were only able to undertake service collaborations and only access world-leading objects; they were not able to access world-leading methods and problems. The following chapter considers the implications of these findings for contributing to a middle-range theory linking the effects of institutions to changes in international research collaboration conduct and content.
Chapter Seven: Contributions to a Middle-Range Theory of the Effects of Institutions on International Research Collaboration

This chapter presents this study's contributions to a middle-range theory that explains how variations in institutions link to changes in international research collaboration conduct and content. This study endeavours to identify the effects of these institutions and explain how these institutions have these effects. As demonstrated in Chapter One, there is no theory that explains these links. This section will discuss the ways in which this study confirms, extends and adds to the limited research regarding the effects of institutions on international research collaboration. This study's contributions link the conduct and content of international research collaboration with sets of conditions, social mechanisms that are triggered under specific conditions, and the outcomes of these mechanisms.

A key aim of government-funded research is to alter the research it funds. For example, a strategic aim of the NHMRC is, 'To support the best and most relevant research' (NHMRC, 2011). However, how do researchers achieve this aim, and what is the role of institutions, such as funding schemes, in these decisions? If this objective is closely examined, it can be seen that this research council seeks to support excellent research that best supports the country's economic and social prosperity. The NHMRC also aims to support not only investigator-initiated research, but research on specific topics—for example, topics that align with the national research priority areas.

This major strategic aim can only be achieved when the content and conduct of research is changed. The best and most relevant research requires more challenging problems to be solved and researchers to work in particular areas. For example, having a national research priority of environmental research means some researchers changing their current research trails. 'At the same time, science policy measures are suspected to have inadvertent consequences for the content of research with changes towards mainstream, applied, short-term and safe research being the most frequently
identified side effects’ (Gläser, 2011:3). This study argues that a key way in which to support the best research, though not necessarily superior to national collaboration, is through the support of international research collaborations. This enables researchers to access the world’s best methods and objects and address the most exciting problems. It also increases the validity of work by enabling access to, for example, larger study populations.

However, how does the NHMRC know what is required to fund the best research? This study argues that science policy organisations do not have access to systematic knowledge about causal relationships between institutions and changes in research content. Knowledge about relationships between funding instruments and knowledge is based on ad hoc information provided by researchers—either from within the NHMRC advisory committees or from NHMRC staff. However, these researchers have no systematic knowledge regarding the causal links between institutions and research. Their views on the effects of funding instruments are based only on their personal experience and implicit knowledge.

In terms of where to look for empirical evidence, rather than relying on anecdotal evidence, as discussed in Chapter One, the link between institutions and research content and conduct falls in the gap between the analysis of science policy studies and the sociology of science. Without such a link, science policy studies can learn little about one of the central effects of institutions—that on research—while the sociology of science will remain ignorant of the role that institutional conditions of research play in the social construction of scientific knowledge.

The main way in which institutions affect the self-identification mechanism of researchers (see Chapter One) is through the allocation of resources and the rules related to receiving these resources. In order to arrive at a problem that is technically achievable, the researcher must align technical and other concerns, such as funding (Fujimura, 1987). However, before these effects are discussed, it is worthy to note the contributions that this study makes to theory, in regard to the specific activity of international collaboration.
Chapter One revealed that surprisingly little attention has been given to the concept and detailed activities of research collaboration (Knights & Wilmott, 1997; Katz & Martin, 1999; Newell & Swan, 2000:1289; Laudel, 2002; Shrum et al., 2007:7), with international research collaboration having been virtually unexplored. The first contribution this study makes to a middle-range theory about the effects of institutions on international research collaboration is to describe the research actions that are entailed in international research collaboration. This study found that international research collaboration is an ongoing activity, and it extended the research collaboration types developed by Laudel (2001) in three ways: from national to international, from bilateral to multilateral, and from only including experimental research to including public health and clinical trial research.

This study found that NHMRC schemes support four types of international research collaborations: in-depth, transmission of know-how, service, and mutual inspiration. These types occurred in bilateral and multilateral collaborations. In multilateral collaborations, they also occurred in combinations of homogenous collaborations, in which all partners were engaging in the same type of research collaboration; and heterogeneous collaborations, in which some collaborators were working together in an in-depth way, while others were undertaking service collaborations.

This study provides evidence that some types of collaboration are more likely to occur in national, rather than international, research collaboration. In this study, provision of access to research equipment was not found as a type of research collaboration, though it was one of the types identified by Laudel (2001). In addition, this study found that, transmission of know-how collaboration was only found to occur once as the strongest form of collaboration.

Therefore, this study confirmed the research collaboration types identified by Laudel (2001), but extended the scope of their applicability to international research and multilateral collaborations, and extended the scope of activities in regard to public health and clinical trial research.
Table 22: Contributions of This Study to Theory on International Collaboration

<table>
<thead>
<tr>
<th>National Types</th>
<th>International Types</th>
<th>Contributions of This Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-depth, service, transmission of know-how, mutual</td>
<td>In-depth, service, transmission of know-how and mutual inspiration</td>
<td>Expands the descriptions of activities to clinical trial research and population health research; Highlights that some types are less likely in international collaborations (transmission of know-how and access to research equipment)</td>
</tr>
<tr>
<td>inspiration and access to research equipment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The second major contribution that this study makes to a middle-range theory is to extend the scope of the conditions for national collaboration to international collaboration. The conditions identified by Laudel (2001) for national research collaboration were extended in four ways:

- Firstly, in regard to international collaboration
- Secondly, this study made a distinction between the different conditions required when collaborating with developed and developing countries
- Thirdly, this study extended the scope to examine multilateral and bilateral collaboration
- Fourthly, this study extends the scope of the conditions from only being based on activities in collaborations for experimental science, to look at collaborations required for public health, clinical trials and experimental research.

International in-depth collaborations were found to have the following suite of necessary conditions: shared research goal, shared knowledge base and language, frequent face-to-face interactions, trust, high amounts of funding, flexible use of funding, and long durations of funding. There were additional conditions required for multilateral collaborations and for those working with developing countries. Multilateral collaborations had the additional facilitating condition of mid-levels of bureaucracy. Collaborations with developing countries were found to require support for the research project from the government in the developing country. They also required mid-levels of bureaucracy and an understanding of institutional and national cultures. Transmission of know-how collaborations were found to have the following necessary conditions: shared epistemic links through objects or methods, shared
knowledge base and language, an intense face-to-face period of interaction, companion and competence trust, high levels of funding, flexible use of funding, and long durations of funding. Service was found to have the same necessary conditions as transmission of know-how, except the intense face-to-face periods of interaction were not required. Mutual inspiration was found to require epistemic links through research interests, shared knowledge as a communication base, companion and competence trust, and face-to-face communication. International research collaboration was found to have different suites of conditions to national research collaboration (Chapter Four).

This study also extends the scope of the social conditions required for international collaborations. Laudel (2001) and many others have reported the importance of trust in collaborations (Newell & Swann, 2000; Laudel, 2004). However Shrum et al. (2007) argued that trust was less important than had previously been found, and that its importance was reduced with the introduction of bureaucracy to the collaboration. This study found that trust was a necessary condition, but that mid-levels of bureaucracy were also important. Therefore this study’s findings, unlike Shrum et al.’s (2007), did not reflect that trust and bureaucracy were either/or conditions, but that both conditions were necessary to facilitate international research collaboration. Mid-levels of bureaucracy were particularly important when collaborating with developing countries and in multilateral collaborations.

When collaborating with developing countries, this study found that levels of bureaucracy were important to resolve issues relating to different national research cultures. Bureaucracy was important to ensure these issues were addressed and all parties had an agreed approach to addressing these issues. These issues included valuing different research outputs (local collaborators preferring local journals, instead of international high-impact journals), the need to have large projects supported by the government in the developing country, and different institutional conditions (for example, that developing countries usually need to source all costs externally, rather than only direct costs, as is the case in Australia). Therefore, this study also added to the literature relating to the role of cultural conditions and international research collaboration.
This study also found that levels of bureaucracy were important when working in large collaborations. For example, establishing publishing protocols ensured that issues relating to acknowledging collaborators’ contributions were addressed early, so that these were not issues later in the project.

Further, this study contributes to the research regarding the importance of time in international research collaborations, and identifies why more time is required. More time is required in order to develop epistemic links and to develop and maintain competence and companion trust. International collaborations require face-to-face interactions for the same reasons. Collaborators need to make deliberate measures to meet face-to-face because, given they are often working in different countries, these meetings do not occur as casually or as frequently as they do for national collaborations. This study also established why these conditions were important and how they related to each other.

Table 23: Contributions of This Study to Conditions for International Research Collaboration

<table>
<thead>
<tr>
<th>Condition</th>
<th>Previous Research</th>
<th>Contributions to a Middle-Range Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Cultures</td>
<td>Made general statements that researchers from similar national cultures find it easier to collaborate.</td>
<td>When collaborating with developing countries-Identified the specific cultural conditions, such as valuing different research outputs, Westernised approaches to track record, and the importance of having government links to conduct research.</td>
</tr>
<tr>
<td>Trust</td>
<td>Had not explored the role of trust in international research collaborations, although the importance of trust was highly cited.</td>
<td>Companion trust appears almost more important than compliant trust.</td>
</tr>
<tr>
<td>Time</td>
<td>Had not been explored in regard to international research collaborations.</td>
<td>More time required to address additional issues in international collaboration (such as understanding different institutional conditions—for example, having to obtain funding for all research—and understanding different national cultures, as described in first box of this table).</td>
</tr>
</tbody>
</table>
The third contribution to a middle-range theory that this study makes is to assess the opportunities for international collaboration that five of the NHMRC schemes provide, by assessing these schemes against the suites of conditions for the four collaboration types. This assessment found that there was a sliding scale of opportunities provided by the five funding schemes with the Project grants scheme providing the least support for the necessary conditions, followed by the Program grants, HFSP, EU and ICRG schemes.
Table 24: Schemes and Provision of Opportunities to Conduct Each Collaboration Type*

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Targeted</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HFSP</td>
<td>EU</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epistemic link</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>through research problem</td>
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<tr>
<td>Shared language</td>
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<td>Yes</td>
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<tr>
<td>Strong trust and personal relationships</td>
<td>Yes</td>
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<tr>
<td>Frequent face-to-face and other interactions</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Strong government links</td>
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<td>Yes</td>
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<td>External funds</td>
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<td>High levels of funding</td>
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<td>Flexibility in funds</td>
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<td>Time</td>
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*Orange shading refers to the occurrence of the condition
This analysis reveals that there is a mismatch in the way that researchers conduct their international research collaborations and the way that organisations provide funding. Researchers engage in international research collaboration to provide or receive knowledge or objects, or to work in a creative collaboration on a specific project or in regard to general ideas. However, the NHMRC does not provide the conditions for this normal manner of working. As a result, researchers have to employ a number of strategies to manage this mismatch.

The fourth contribution of this study was to confirm the finding of many previous laboratory studies that it is researchers, themselves, who must make the decisions regarding how to conduct research (Knorr Cetina, 1981; Latour & Woolgar, 1986 [1979]; Lynch, 1986; Fujimura, 1987). This study confirms that researchers have to self-identify tasks because they are in the best position to identify problems that they are able to solve, and the way in which to solve them.

This finding was confirmed through the results of researchers funded through the HFSP scheme. Under this scheme, projects have to be interdisciplinary and collaborations have to include at least one new collaborator. Therefore, researchers had specific requirements that restricted with whom they could work—they had to work with at least one collaborator and they had to work in an interdisciplinary field. In this study, in three of the four collaborations supported through the HFSP scheme, the collaborative contributions were not combined. Therefore, this finding appears to confirm the previous finding that it is the researchers, themselves, who must decide with whom they will work and in what area.

The fifth and most important contribution this study makes is to identify the social mechanisms that explain how the schemes affect international research collaboration conduct and conduct. Researchers were found to implement strategies in response to the funding schemes in order to conduct international research collaborations. There were different research strategies implemented by researchers supported through the two NHMRC general schemes and the three targeted schemes. There were also different strategies within the three targeted schemes, based on the opportunities provided to conduct international research collaboration. These were outlined in
Chapter Six. In summary researchers funded through general schemes had to limit who they worked with internationally and how they worked with international collaborators while researchers funded through targeted schemes did not.

Therefore, this study has quite different findings to other studies, such as those of Morris (2004) and Leisyte et al. (2010). These two studies found that most researchers were able to develop compromise packages between the funding provided by research agencies and their desired research. Leiste et al. (2010) stated, 'Thus, we observe symbolic compliance at work in many cases, and self adaptations and enforced adaptations in some others'. It is important to note that these studies appeared to focus on problem choice, while this study examined a broader range of the structural elements of research. This study only found one researcher, of the 11 Australian researchers supported through general schemes, who did not have to make changes to their research. All the other researchers had to make some changes to their research to increase their chances of funding through the NHMRC schemes. Therefore, this study did not find that the 'symbolic compliance' of Leisyte et al. (2010) or the 'compromise packages' of Morris's (2004) study were the dominant ways that researchers adapted to their funding conditions. Also, these previous studies did not examine the consequences of these conditions on the structural properties of research. Other studies of Australian researchers have also found strong adaptations (Gläser & Laudel, 2007).

This study adds to the literature on research strategies by identifying the strategies specifically in regard to international research collaboration. Previous studies have examined the effects of research evaluation systems (Gläser & Laudel, 2007) and general science policies (Morris 2004; Leiste et al., 2010). This study found that researchers do change whom they work with and how they undertake work because of NHMRC schemes. This led to reduced validity, reduced use of world-leading methods and objects, and a reduced ability to work on innovative problems. Figure 1 illustrates the findings of researchers supported through targeted schemes.
NHMRC targeted funding schemes to support international collaborative research

**Individual Traits**
Collaborating researchers' goals and interests

**Actions of Collaborating Researchers:**

**Negotiation Processes**
Considering whether to apply, with whom to collaborate, what type of collaboration is required, type of research problem, method, and so on.

**Adaptation**
Strategies of researchers supported through targeted schemes

**Funded Application**

**Conduct of Research**
Engage in all types of international research collaboration with developing and developed countries

**Content of Research**
Able to access world-leading objects and methods, and address state of the art research problems
Undertake perceived riskier research
Increase quality of research

**Necessary Conditions**

**Epistemic Conditions**
Epistemic link identified and developed by researchers, not imposed by funding agencies
Shared language based on shared knowledge

**Economic**
External funds
Flexible use of funds
Long duration of funds

**Social**
High levels of companion and competence trust
Face-to-face interaction

**Cultural**
Strong government links (when collaborating with developing countries)

**Other Institutional Conditions**
Lack of ongoing funding from university, thus reliant on external funds

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Figure 9: Summary of Findings: Researchers Supported through Targeted Schemes
Summary

This study makes theoretical contributions to a middle-range theory in identifying types of international research collaboration, the conditions required for each type, the level of support that the NHMRC provides for these types, and the strategies this level of support triggers in researchers. This study then assesses how this affects international research collaboration conduct and content. This study argues that researchers need to be able to engage in international research collaborations in order to be able to access the best knowledge.
Chapter Eight: Policy Recommendations to Improve NHMRC Support of International Research Collaboration

This chapter makes recommendations regarding how policy to support international research collaboration might be improved. These recommendations are based on researchers' experience of international research collaboration; NHMRC managers' accounts of developing, implementing and managing general and targeted NHMRC schemes; and a review of the literature. The overarching policy recommendation is to implement specific measures to support international research collaboration because it has additional conditions compared to national collaborations. The goal of these recommendations is to improve support for the necessary conditions for international research collaboration, and to remove or reduce the hindering conditions that have been identified throughout this study. This section will first make policy recommendations at the organisation level of the NHMRC, then at the program level of a suite of international collaboration-specific schemes.

Before discussing these recommendations, it is worth highlighting that these findings were presented to the NHMRC in 2008. As a result of these findings, a number of the policy recommendations in this chapter were implemented the following year. The changes implemented were aimed at improving support for collaborating with developing countries. In 2009, the NHMRC introduced grants for collaborating with developing countries that addressed the specific conditions that were found in this study. These grants maintained a sensitive approach to the assessment of track record; had a longer than normal duration of funding; and allowed funding for items not normally permissible under the NHMRC funding rules, such as salaries, given that most developing countries are expected to obtain the full costs of research from external funding sources. The following discussion will now address the full range of policy recommendations, based on the findings of this study.
NHMRC Organisation

Recognise the Different Types of Collaborations' Conditions and Effects on Knowledge Production

A key driver for undertaking this study was the lack of empirical information about the depth and breadth of the content of collaborative contributions that occurred between international research collaborators. In addition, there was no empirical evidence about what was needed for different types of international collaboration, and the effects of schemes. This study provides an initial empirical base to answer these questions. Therefore, a first general recommendation is to encourage staff at NHMRC to recognise the different types of international research collaboration, their conditions and the effects these have on knowledge production, as was found in this study.

This is important for a number of reasons. Firstly, any organisation should be aware of the types of activities it is funding to ensure desired policy aims are being achieved. In regard to international research collaboration, this is important because different types of research collaboration have been found to be rewarded differently. For example, in-depth collaborations are more likely to lead to publications than the other types of collaboration (Laudel, 2001:775). Therefore, the finding of this study that the NHMRC’s two main funding mechanisms of Project and Program grants do not support international in-depth collaboration should be of keen interest to the NHMRC and should act as an indicator that it is important to be aware of this type of information.

This is also important in the context of the new public management ethos that was reflected in the interviews with NHMRC managers. The NHMRC managers spoke about the high administrative costs of targeted schemes, and the needs of the government and the NHMRC, rather than the needs of researchers to conduct international research collaboration. As an NHMRC manager, Laura, described:

In terms of necessary conditions, I think that the first condition is that there is some sort of need that is common to the countries involved—that
it's of strategic interest and priority, particularly to the government of the
day. Because it's really government expenditure ... and there needs to be
a level of engagement between the areas of the organisation to facilitate
that. Once you've got those sorts of conditions in place at the higher
level, at the lower level you need money to back it up, and you need the
resources, and you need to be able to have the schemes geared up in such
a way that it can deliver and that people can interact and have that ability
to do so. So international communication at the agency level is highly
important, having those resources is highly important, having the
common goal between the organisations and a common agenda and
working towards that with some goodwill is another aspect of that.

When pressed further for the conditions required for researchers to undertake
international collaborations, and how these compared to national collaborations,
Laura elaborated by again focusing on the needs of the NHMRC, and the
administrative burden on NHMRC of international schemes, rather than the needs of
researchers:

In terms of national research compared to international research, it's
much easier to say to the minister of the day that you're undertaking x
number of national collaborations in key areas. That's going to help the
minister more than, say, undertaking the same number of research
collaborations, but with international agencies. I think the latter is
somewhat more prestigious in some cases. But in terms of gaining votes,
it's the former that is more important to the domestic political scene and
ultimately NHMRC is responsible to the minister of the day. In terms of
actually running the round, they're immensely different. Program
grants—we have three months to review it, redesign the funding scheme
criteria, advice and instructions to applications—those sorts of
documents—and then go back out and put it open for a few months and
then another three months to get it through the funding recommendation
process, give or take a couple of months. With the targeted scheme, there
was at least three years of lead up. I guess the issue was trying to get
agreement between the countries about what the focus would be, what the
criteria should be, and how to draw up the actual funding documentation.
And that was challenging because everyone had a different opinion and
we were all working on different timelines. You know, it wasn't the usual
going up and having nine a.m. meetings. It was seven a.m. or midnight
teleconferences. And, of course, trying to progress that from different
avenues means it's much harder because you come back with one lot of
comments from one partner, which might not reconcile with the other
partner's comments, and that sort of creates a process on its own. So in
terms of version control of the policy documentation, it's much more
difficult and obviously much more timely in that respect. Whereas with
the [specific NHMRC general scheme], I was able to control it so it was
much, much easier than the [targeted scheme]. So [the general scheme is]
less costly and less administratively burdensome.
Developing an awareness of the different types of international research collaboration could support science policy that better achieves NHMRC's key aim of supporting the best research.

**Undertake Regular Analysis of Effects of Schemes on Content and Conduct**

Any funding agency should regularly assess if its funding is having the desired effect. However, this study appeared to be the first to provide opportunities to assess the effects of NHMRC schemes at the level of the researcher. Therefore, a further policy recommendation is to conduct regular analysis of the effects of schemes on the conduct and content of research in a similar manner to this study. NHMRC regularly commissions bibliometric assessments of its schemes (Butler et al., 1998; Butler & Biglia, 2001, 2005; Butler & Henadeera, 2009), but these cannot reveal whether NHMRC schemes are having any observed effects.

There have also been a number of strategic reviews of the NHMRC over the last 10 years that have made reference to ways in which NHMRC could better support international research collaborations (Commonwealth of Australia, 2000; Bernstein, 2007; Zerhouni, 2008). However, these reviews made recommendations on 'strategic pathways' starting at a high level. They focused on what should be achieved, rather than detailing how NHMRC support could be improved. For example, it was recommended that 'NHMRC should lead an effort to build strategic partnerships with other nations in this region' (Bernstein, 2007). However, it was not discussed how these strategic partnerships could be achieved and the types of research they hoped to support.

In addition, these reviews did not involve interviews with researchers to investigate, in a detailed manner, the conditions associated with different types of international research collaboration. Rather, the scope of these reviews was at the macro level of document analysis with 'international analysis and comparisons of NHMRC strategies, plans for targeted investment, funding mechanisms and schemes and the documents and processes associated with the various funding schemes' (Zerhouini, 2008:2). Therefore, although bibliometric studies and strategic reviews are valuable,
they should be complemented by studies that assess the effects of NHMRC schemes at the researcher level.

This study suggests that a component of undertaking regular analyses of these effects of NHMRC schemes would be that researchers have regular opportunities to provide feedback regarding how the schemes meet their needs for international research collaboration. An important finding of this PhD was that this investigation appeared to offer a unique opportunity to gather this information on the conditions that facilitate, hinder or are necessary for international research collaboration. There is currently no structure in place that gathers feedback on these grants. This information could be gathered through formal analysis exercises, as described earlier, or through the annual report that is required under the NHMRC Deeds of Agreement. The fundamental finding is that most researchers interviewed in this study reported that they believed that firstly, the NHMRC provided little or no support for international research collaboration, and secondly, that there was no formal mechanism through which they could raise their concerns about this with the NHMRC.

**Develop an Internal Engagement Strategy and Establish an International Collaboration Office**

*Facilitate Information to Researchers*

A hindering condition (see Chapter Four) was a lack of understanding of the opportunities within NHMRC schemes to support international research collaborations. An international engagement strategy and international office could better highlight these opportunities. Many researchers who were supported through the general schemes had a limited or incorrect understanding or were unaware of the targeted schemes of the NHMRC-EU Framework, the ICRG and the HFSP scheme.

For example, Ben had been working with Andrew, his collaborator in the US for many years, undertaking a mutual inspiration collaboration. They were doing this after previously collaborating, with great difficulty, on an in-depth basis. Ben spoke about how Andrew had been able to use funds from his National Institute of Health
(NIH) funding for them to collaborate in this way, but because Andrew was no longer receiving NIH funding, they had been forced to scale back their collaboration. Ben spoke about how he had sought funding opportunities to collaborate again in this intense way, and that he would have liked to apply under the HFSP scheme. However, Ben stated, ‘I would have liked to apply to the HFSP, but because Australians are not eligible, we haven’t been able to that’. Ben’s understanding of the HFSP scheme was incorrect. Australian researchers have always been eligible to apply under the HFSP as co-applicants, but were only able to apply as principal applicants from 2005, when Australia became a member of the HFSP through the NHMRC. Interviews for this study were conducted in 2006 and 2007—after Australia had become a member of the HFSP.

Even those funded through the targeted schemes often reported difficulty in understanding how the scheme worked. One researcher was made aware of the NHMRC-EU scheme by their collaborator in Europe. Peter received funding under the NHMRC-EU Framework scheme to work with his European colleague, Bill. They had known each other for a number of years, but had to limit their collaboration to mutual inspiration due to lack of funding. Peter said that he had not been aware that the NHMRC provided any support for Australian researchers to work with collaborators under the EU Framework Programme. He said that he had actually heard of the NHMRC scheme from his EU collaborator. When I asked Peter why he had applied under the NHMRC-EU Framework scheme, I was initially confused by his response:

SM: Why did you apply under the NHMRC-EU collaborative grants scheme?
Peter: Ah, yes, because the EU Commission told Andrew that Australians could get funding from the NHMRC.
SM: Sorry, what do you mean?
Peter: Yes, the EU Commission told Andrew that they’d had someone from Australia come to the Commission who said that there was funding.
SM: Right, so the EU Commission told Andrew who told you about the NHMRC scheme.
Peter: Correct. I hadn’t heard of it before. I didn’t know the NHMRC funded that type of work.
Not only did Peter not know about the NHMRC scheme, but he then went on to speak about how information about how the NHMRC scheme worked was very unclear, and how this had caused him a great deal of anxiety.

Peter’s confusion was echoed by Ted. Ted’s project of investigation was funded through the HFSP, but, at the time of the interview, he also had an application being considered under the NHMRC-EU Framework scheme. He spoke about how frustrating he had found the whole NHMRC application process.

Therefore, another suggested policy recommendation to improve NHMRC support for international research collaboration is the development of a document along the lines of an International Engagement Strategy to highlight the support for international research collaboration available through the NHMRC. At the time this thesis was printed, there was no such a document and no easily identifiable way for researchers to learn if and how the NHMRC supports international research collaboration.

NHMRC is behind its counterparts in not having already developed such a document. Most other international research funding agencies have a framework to this effect—such as the Canadian Institutes of Health and the Medical Research Council in the UK. The only other national research funding council in Australia—the ARC—has also developed an International Strategy. This study proposes that the NHMRC International Engagement Strategy should include a multi-pronged approach. The discussion below details the suggested key elements that this strategy could include. Rather than specifying a particular direction or providing prescriptive guidelines on how to collaborate, the elements below aim to ‘encourage and facilitate international collaboration’ (Parliament of the Commonwealth of Australia, 2010:viii).

The need and potential for this document was also reported by NHMRC policy managers; however, again, the needs of the government, rather than researchers, appeared to be paramount:

I’d like to see NHMRC have an explicit investment strategy, not the passive current one, however. They have any existing array of funding
schemes, but I’d like NHMRC to say, ‘We’ve got x million dollars this year’, and have a transparent budget process that says, ‘These are the funding schemes that we’re going to run over the next period of time, these are the budgets allocated to that, and these are the reasons we’re making this investment’ … But it would be good to have an open dialogue around how the funding should be allocated, for what future issues, and what collaborations should be entered into. The government of the day needs to be brought into that because, at the end of the day, it’s the minister that signs off on funding recommendations … and, through the minister, the people of the day … If you increase the funding to international research collaboration and the overall budget is not being increased, then you need to commensurately decrease in some other area. So there has to be a rationale for that because someone is affected somewhere along that process … so it has to be an open, honest and transparent investment strategy.

When I asked an NHMRC manager why there was not an international engagement strategy, they explained:

I think it comes down to resources. It’s also often contingent upon personalities of those in charge. So if you’ve got someone in charge who finds it important to set up and develop these initiatives to leverage off the resources that others can bring to the game—that is, leverage off their IP and leverage their financial base—then that would be a condition which is highly important … I think there is certainly recognition that international collaborations are important, but, like any policy, it really is somewhat determined by the importance given to the powers that be in the organisations … The impetus must come from the head of the NHMRC because you need the resources internally to carry that out. The strategic plan is also important and you could canvass with people whether they see it as important for NHMRC. But, obviously, the minister of the day is probably the key. So it’s important to get sponsorship from senior, levels of management, as it’s the program areas that will go out and do what they need to within the resources they’re given to undertake that. There are many hurdles to overcome at a program level. Not the least of which are time differences; currency; having an understanding of what is meant by certain words and the intent of policies; trying to get everyone onto the same page around what we’re trying to achieve, how we’re to achieve it., who should run it—those sorts of issues. And so, the program level is tricky … it can be a very tricky issue.

A strategy would enable an explicit statement on NHMRC international collaboration priorities so that researchers would be able to identify the support NHMRC provides for international research collaboration.
Support Relationships Between NHMRC and Overseas Research Agencies

From the interviews conducted with policy managers and from my own experience working as a policy manager for 10 years at NHMRC, I am aware that there were a number of visits from overseas research council agencies to Australia. These visits occurred on a regular basis, but the full benefits of these visits were not realised. A key issue was the fact that there was no international office that could act as the central liaison for such visits. Having a central international office would ensure consistency of information and a clear overriding strategic vision to guide such visits. This would also enable personal relationships to develop and be maintained between the NHMRC and overseas agencies at the NHMRC officer level, rather than only at the CEO and senior management levels.

Through the interviews with policy managers, personal relationships at the officer level were found to be important in developing collaborative targeted schemes agency-to-agency, such as the ICRG scheme. This scheme was developed in collaboration with the NHMRC, the Wellcome Trust and the New Zealand Health Research Council. Laura, an NHMRC policy manager, spoke about the difficulties in developing the ICRG scheme. She explained how these targeted schemes were often initiated at the senior levels of CEOs, but development was often delayed because of either a lack of relationships at the policy officer level, or a lack of in-depth understanding of the international agencies’ priorities and institutional environments. Having a central internal office would enable these relationships at the policy level to be developed and maintained. This would allow joint-agency targeted funding schemes to be more readily developed in a timely and effective manner. In addition, an international office within the NHMRC could draw attention to the fact that NHMRC schemes support international collaboration.

Develop an International Research Collaboration Program of Targeted Schemes

In order to more effectively support the necessary conditions for international research collaboration, it is recommended that the NHMRC develop an International Research Collaboration Program of targeted schemes. A key recommendation of a
recent Australian House of Representatives inquiry on international research collaboration (2010:xvii) was that:

The Australian Research Council and the National Health and Medical Research Council relax the restrictions on researchers spending funding overseas on a trial basis for the next two funding rounds, and that the organisations review the impacts of this policy to determine whether it should be a permanent feature of research funding.

This study provides further empirical evidence for the importance of this recommendation, and further elaborates on schemes through which funding should be allowed to be used overseas. Three schemes are suggested under an International Research Collaboration Program of targeted schemes: a Visiting International Scheme/Short-Term International Fellowship; a Joint-Project International Scheme; and an International Clinical Trial Scheme. Each of these are detailed in the below section.

**Visiting/Short-Term International Fellowships**

This study recommends the implementation of a scheme that provides funding for Australian researchers to have short-term visits at international colleagues’ institutes, and for international researchers to have short-term visits at Australian institutes. This would support some of the social conditions, particularly those of companion and compliance trust. Given the lack of funding opportunities for researchers from developing countries, compared to developed countries, these researchers could be given priority.

This scheme would provide support for the necessary conditions of service, transmission of know-how, and mutual inspiration collaborations. It would also support the development of epistemic links that could later develop to in-depth collaborations. In addition, this scheme would support the development of personal and epistemic links, which this study found often occur outside of project-specific funding. Other agencies, such as the HFSP and a number of universities in the UK and Europe, have a similar scheme. The NHMRC currently provides general schemes, but the funds offer little support for these types of research collaborations.
For example, Eugene discussed how he had wanted to learn a unique method from an international colleague and had spent some time in their laboratory to achieve this (see Chapter Three). He had received a Project grant, but could not undertake this particular activity as part of this grant, and there were no other funding vehicles to do this. He was only able to spend three months at his international colleague’s institute in Europe in order to learn the method. This was made possible because his colleague’s institute had a scheme that provided for international colleagues to visit. The recent Australian House of Representatives Report (2010) also noted this hindering condition, stating that there was a worrying trend of Australian researchers being unable to take opportunities to visit international research organisations. As a result, these researchers were missing opportunities to use rare and expensive equipment not available in Australia. The NHMRC should consider developing a scheme to address this issue, as there are relatively few associated costs, and immense scientific benefits.

For this scheme, researchers would need to demonstrate the service or transmission of know-how type of collaboration that they planned to undertake. Eugene spoke about his desire to bring a colleague to Australia from a developing country in order to learn a specific, unique method. However, he spoke about the lack of funding opportunities, stating, ‘I would be quite keen on the NHMRC having maybe a second level of the Australian Fellowship, where you could bring international people over here’.

These fellowships could also be used to support the development of in-depth collaborations. Key conditions for in-depth collaborations are the development of epistemic links based on problems, as well as strong personal links. Many researchers commented about how difficult it was to develop these conditions because there were limited opportunities to have face-to-face interactions with international colleagues. Most researchers had to rely on attendance at conferences to build international networks, if these had not already been built. This is usually the case during researchers’ post-doctorate years. These short-term visits would support these
important personal connections and would help develop joint projects through enabling researchers to develop epistemic links.

A common theme in interviews was that there was often a lack of seed funding available to enable researchers to travel and build links with colleagues overseas. Much of international research collaboration, particularly in regard to developing strong personal relationships, occurs outside of project funding. This has also been found in other reviews (Parliament of the Commonwealth of Australia, 2010:11). The importance of personal links based on trust were also reported by researchers who made submissions to a recent Australian parliament inquiry: ‘I still feel that it boils down to personal linkages; skills, expertise that we need to have on the ground that can link us with the people overseas. To me, that is really the starting point’ (Parliament of the Commonwealth of Australia, 2010:12). These are of particular importance for early-career researchers.

This could be a stand-alone scheme or, in order to facilitate lower administrative costs, researchers could apply for a travel grant of approximately 50,000 AUD as part of the Project or Program grants schemes.

**Joint-Project International Scheme**

As well as short-term fellowships, a Joint-Project International Scheme is suggested so that Australian researchers can work with international colleagues on in-depth collaborations, as well as service, transmission of know-how and mutual inspiration collaborations. Nearly all Australian researchers interviewed (19 out of 20) spoke about their desire to work in an in-depth manner with international collaborators, but they were unable to do so because of the lack of funding opportunities.

For example, Robin spoke about the value of a joint scheme. She described how frustrating it was that her collaborator, Arthur, could not be a chief investigator on the NHMRC general scheme grant that supported her project of investigation. As she explained:
Certainly, he contributed intellectually to it [the project proposal]. He’s called an associate investigator on the application, but he’s not a chief investigator because he’s international. He should be a chief investigator because intellectually he’s put as much into it as anybody else. We write papers together, we have complementary skills and we do a lot together.

She elaborated by stating:

I’d like him to be a chief investigator on the grant. Arthur has a good enough track record to be a chief investigator and I can’t see why [he’s] not. If they’re making a major intellectual contribution then it would be great to be able to put it in the NHMRC grant.

Robin also reported her frustration about the lack of support for international research collaboration because she was very keen to run the same health interventions she was conducting in Australia in other countries to serve as comparisons. This international collaboration meant that she could increase the validity of her work. As she explains:

There is so much huge potential for international collaborations. For us, we’d like to run our interventions in other countries to see … the comparisons. And … you could have an international chief investigator, with 50,000 dollars, who could do all of that.

Devon also reflected the sentiment of several researchers when he spoke about how a scheme that supported international research collaborations would result in larger sample sizes, and thus an increase in the quality of his research:

I think international collaborative grants that were substantial amounts of money—not just 20,000 to 50,000 for visit—larger project grants that could be, say, 200,000 dollars, or something like that … One could do a substantive project in a developing country. You could ask some different questions and have a larger sample size. Certainly, we would like to set up studies with the Chinese investigators and some Indian investigators if we had good funding for those.

This was a common theme in interviews—that researchers had specific projects and ways in which their research could be improved if they were able to work on joint projects in international collaborations.

The suggested scheme could be in all research areas and could fund the international collaborators as well (in a similar way to NIH), but would give priority to developing countries. A flexible approach to budget could be adopted, noting that international researchers from developing countries may require funds for infrastructure and
salaries. Funds would be able to be spent overseas. In addition, a flexible approach to track record would be taken for researchers in developing countries to reflect the fact that they may not publish in high-impact journals. This study found that there was an unintentional bias against assessing the track records of researchers from developing countries. This was because the NHMRC uses largely bibliometric indicators to assess track record—namely, publications in high-impact journals. However, researchers in developing countries were found in this study to place more importance on publishing in their local journals in order to maximise the impact of their research in their local community. For this suggested scheme, the impact of researchers at the local level would be viewed as important and a sign of scientific quality.

For this suggested scheme, grants would be for a minimum of five years because providing sufficient time was a necessary condition of international research collaboration. Schemes such as the ICRG and the NHMRC-EU collaborative grants were found to be advantageous because of their five-year period. The three years of the HFSP grant were found to be insufficient, and in three out of four cases, this affected the international collaboration. This suggested scheme supports the necessary conditions found in this study for in-depth collaborations (see Chapter Four).

This scheme could be developed through three administrative mechanisms. Firstly, it could be undertaken solely by the NHMRC. This could be a scheme in which researchers could apply for international research collaborations.

A second mechanism could be with other agencies in Australia, such as other charitable organisations. The NHMRC already undertakes work with project grants with agencies such as the National Heart Foundation. There are efficiencies in operating grant rounds in this manner. For researchers, this would prevent them having to apply to multiple sources. It would also reduce administrative costs for the agencies involved. Through using the pre-existing NHMRC Project grant process, the Heart Foundation does not have to run grant rounds, and the NHMRC charges the Heart Foundation to use the NHMRC peer-review system.
A third mechanism could be developing partnerships with other research funding agencies overseas, in the same way that the ICRGs were developed. However, this study found some challenges with the administration of these grants, thus these issues would need to be addressed if this option was pursued. For example, it would be important to be clear in which currency the grant would be paid, and when, how and to whom payments would be made. It would also be important to identify who would be responsible for administering the grant, in terms of annual reports.

*International Clinical Trials Scheme*

All the researchers undertaking clinical trials spoke about the opportunities that international research collaboration provided to enable researchers to have a larger pool of patients. Some researchers had managed to access these patients by bootlegging funds (see Chapter Six). Others, due to a lack of NHMRC funding, had obtained funding from overseas agencies. NHMRC was found to fund a number of clinical trials, but there was insufficient funding for phase four trials.

Andrew spoke about how he had been looking to the EU for funding. He was concerned that he would no longer have intellectual property rights ownership of the research he had driven over many years. This was found in a number of reviews of clinical trial research in Australia (NHMRC Clinical Research Working Group, 2001). As John—who had to move his phase four clinical trial study offshore in order to obtain funding—stated, ‘NHMRC should have a system where they provide one study of major national significance every five years ... It should be funded at about five million per year’. John explained that he would have preferred to conduct his study in Australia, particularly given that NHMRC had supported all the earlier trials. However, due to lack of funding, he had to move the research overseas. This suggested scheme would support Australia to obtain the full benefits of its research, particularly for research funded by the NHMRC up to the phase four trials.
Lower Administrative-Cost Option: Mainstreaming International Projects in General Schemes

Another approach could be to implement all or part of the recommendations above through the general schemes. That is, to mainstream international programmes in the general schemes. However, this is likely to result in fewer types of collaboration being supported and very low numbers of international projects being funded. This is because international projects would be in competition for funds with national projects. Policy managers interviewed in this study commented on issues such as national projects being viewed as lower risk (in terms of possible lack of control over an international institute and also abiding to Australian ethical standards) as one of the reasons why national projects are often preferred to international projects when considered under NHMRC general schemes. There is also the major finding of this study that general schemes, because of their lack of support of the conditions for international collaboration, make in depth collaboration almost impossible. Therefore, although this option would have lower administrative costs, it would also likely have reduced scientific benefits.

Possible Challenges to Implementing Targeted Schemes

It is worth noting that based on this study, the NHMRC, as discussed earlier, appears to have embraced the New Public Management ethos. In recent years, it has seen a reduction in its number of targeted schemes. The needs of the NHMRC organisation appeared to be paramount in these policy managers’ minds, rather than the needs of the researchers.

The policy managers discussed the importance of ensuring that the government of the day supported any international collaborative agreements between funding agencies. They discussed the difficulty of ensuring that the strategic interests of two agencies and the Australian Government were synchronised.
The policy managers also discussed how resource intensive it was, at the agency level, to implement and manage joint schemes. One policy manager stated that the Program grants had one round each year, but for one of the international schemes, the second round had taken three years for the agencies to agree upon and advertise.

Managers discussed how the NHMRC had finite funds, which meant that funding for international research collaborations was very limited. Another theme was the view that the government was not as supportive of international collaborations as they were of national collaborations. An NHMRC policy manager explained this process and reflected the value placed on efficiency, rather than effectiveness, which is what is needed to support the best research:

There was probably quite a few drivers for that. One was that the cost of running individual schemes is large, and there’s some economies in those schemes ... So regardless of your discipline, you’d like there to be multiple schemes you could apply to. And the problem with that is administering them. And what’s happened is that ... NHMRC has deliberately wound back the number that it administers from what was a phenomenally large number that had really become unsustainable, to a number that hopefully the agency can manage. Certainly, the agency has been doing many, many fewer targeted calls on anything and that trend is likely to continue.

However, that is why further studies that assess the effects of funding schemes on researchers are valuable for informing science policy. These studies would better support ‘efficiency decisions’ being made in the context of empirical evidence about their possible effects on collaborations’ effectiveness. In NHMRC’s case, it would be valuable to establish how efficiency (reducing targeted schemes) would affect the research produced.

Summary

To conclude, the policy recommendations made in this chapter reflect the necessary conditions for international collaboration that were found in this study. Unlike similar agencies within Australia and around the world, the NHMRC does not have a strategic approach to support international research collaboration. The overarching recommendation is that the NHMRC develops this approach, as well as a recognition
of the different types of international research collaboration, and the content they produce. Recommendations are suggested for NHMRC as an organisation and in regard to a specific suite of targeted schemes to support international research collaboration. Implementing these recommendations may be challenging, given the value placed on the New Public Management ethos, but this study highlights the importance of empirical information about the effectiveness of the NHMRC’s schemes. It is also worth noting that following my presentation to the NHMRC regarding the findings of this study, a number of these recommendations were implemented into NHMRC policy in 2009. These recommendations were in regard to improving support to better enable collaboration with researchers in developing countries.
Conclusion

This thesis examined the effects of variations of NHMRC schemes on changes in international research collaboration conduct and content. It argued that NHMRC schemes affect international research collaboration through their provision (or otherwise) of the necessary conditions for international research collaboration.

This study established that there are different types of international research collaboration. In-depth collaborations involve Australian and international researchers jointly developing research problems and collaborating throughout the entire research process. Transmission of know-how collaborations involve transferring specialist knowledge, while service collaborations involve providing a service, such as providing animal models or access to patients for a clinical trial. The latter two involve shared research interest, rather than a shared research goal, as is the case with in-depth research collaborations. Mutual inspiration collaboration involves sharing ideas and is not necessarily linked to a specific project.

Different types of international research collaboration were found in this study to have different suites of conditions. Australian publicly-funded health and medical researchers were particularly reliant on the NHMRC to provide these conditions because of the reduction in recurrent university funding, and the fact that the NHMRC is the only major source of external funds in Australia. Despite international research playing a key role in a country's economic and social prosperity, the NHMRC's two main funding schemes—Project and Program grants, termed in this study as general schemes—provide only one and three, respectively, of the necessary conditions for international research collaboration. These grants were the tools used by most researchers to engage in international research collaboration—they represent about 75 per cent of NHMRC funding. These general schemes subsequently triggered a number of strategies in researchers so that they could engage in international research collaborations. Researchers funded through general schemes only engaged in service collaborations, only collaborated in terms of objects or access to larger populations and only worked with researchers in developed countries. These
researchers had to limit the international collaborators they worked with and how they worked with them and as a result the benefits that international collaboration could provide were not fully realised.

The experiences of researchers conducting international research collaborations under these general schemes were compared with researchers funded through the few NHMRC schemes aimed at supporting international research collaboration—termed in this study as targeted schemes. These three schemes provided all or most of the necessary conditions for international research collaborations. As a result, these researchers engaged in a broad range of research collaboration and were able to access the world’s best objects and methods and work on the most exciting research problems. They were also able to work with collaborators in developed and developing countries and expand their networks of collaborators. As a result researchers funded through targeted schemes were able to better realise the benefits of collaborating with international researchers.

This study explained these changes in research conduct and content by linking sets of conditions for different types of international research collaboration to strategies that were triggered by different NHMRC schemes, and the different outcomes that these strategies had on international research collaboration conduct and content. Therefore, this study has not only demonstrated that NHMRC funding schemes do affect research, but has also explained how these schemes have these effects.

This thesis began by positioning the study in the relevant literature. The review of the literature exposed a gap between the analysis of science policy studies—which focused on the organisation level of research councils, including funding policies, but gave little attention to how these affected the conduct or content of research—and the analysis of the sociology of science. Although the sociology of science acknowledged the influence of such tools as funding policies, it did not explore how these influence research content at the level of the researcher. In addition, neither of these approaches had concentrated on international research collaboration.
The gaps highlighted in the literature informed the four areas of focus in this thesis, and offered the central research question: **How do research council funding schemes affect international research collaboration conduct and content?** The first area of enquiry was the activities that occur during international research collaborations. Previous research had largely either been bibliometric studies, which could not reveal how researchers were collaborating, or had argued that the term 'research collaboration' was so multifaceted that it was near impossible to define. Thus, this study asked: What are the different types of international research collaboration that occur between Australian and international researchers?

Secondly, this study analysed the conditions associated with the different types of international research collaboration identified in the previous chapter. No studies had systematically assessed the conditions associated with international research collaboration. Therefore, this study asked: What conditions affect international research collaboration? Given the conditions for international research collaboration had not been identified, there had not been an assessment of these conditions against the funding tools available. This led to the third area of investigation: How do different NHMRC funding schemes address the conditions for each of the different types of international research collaboration?

Fourthly, this study examined how the NHMRC schemes affect international research collaboration conduct and content. That is, how do researchers respond to their situation in order to undertake international research collaboration, and how do these responses affect the content of these international research collaborations? These results were then discussed in terms of their implications for contributing to a middle-range theory of the effects of institutions on international research collaboration. Finally, policy recommendations regarding how the NHMRC could better support international research collaboration were presented.

The above questions informed the data collection and analysis process. In order to bridge the gap between science policy studies and social constructivist sociology of science studies, the aim of this study was to identify the social mechanisms that link changes in international research collaboration conduct and content to different
NHMRC funding schemes. To identify social mechanisms, differences in causes and effects needed to be observed. Therefore, comparative case studies were developed to assess these differences. There were two levels of cases. First-level cases were five NHMRC funding schemes, and second-level cases were 20 projects of investigation funded wholly or partly through one of the five NHMRC funding schemes. Qualitative interviews with researchers and NHMRC policy managers provided the main empirical base for the study. Bibliometric research trails were also used, as were detailed analyses of policy documents, scientific papers, reports and other scientific literature to provide further detail on the cases.

The methodology employed in this investigation proved effective in that changes in international research collaboration conduct and content could be identified and attributed to the NHMRC funding schemes. The findings demonstrate that the applied methodology enables insights into change mechanisms that are not easily obtained by other methods, if at all. The validity of these findings crucially depends on the possibility to draw conclusions about change and its causes from interviewees' statements about their research content, and other supporting documentation.

How can valid conclusions be drawn from a small sample of 20 cases? This study maintains that causal statements based on the interpretation of statistical associations between variables measured for a representative sample of interviewees leaves a big gap in explaining a connection between A and B. By examining the structural elements of research, and identifying the social mechanisms, this study has filled the gap that is exposed in statistical association arguments of causation. Statistical association arguments cannot identify how NHMRC schemes have effects on research. This study's overall argument is that in situations in which the conditions for international research collaboration are supported by NHMRC schemes, these schemes affect international research collaboration conduct and content.

International research collaboration was found to include a broad range of research activities. Laudel’s (2001) collaboration types were used as a framework to categorise how researchers working in a project of investigation were funded through one of the five NHMRC schemes investigated. A wider understanding of research collaboration
was developed through this study, with Laudel's (2001) types being expanded in three ways. These types were expanded firstly, from national to international collaboration types; secondly, from experimental to clinical and public health research; and thirdly, from bilateral to multilateral collaborations.

Researchers were found to be undertaking in-depth collaborations, which were highly intensive and involved the entire research process; transmission of know-how collaborations, which involved either teaching or being taught a method by an international colleague; service collaborations, which entailed either providing or receiving a service, such as providing patients for a clinical trial; and/or mutual inspiration, which occurred when there was a sharing and discussing of ideas not necessarily linked to a specific project. Mutual inspiration is a key way in which all researchers were found to be engaging with international collaborators. However, this type is not project-specific, while NHMRC funding largely is.

This study expanded the range of analytical tools to understand how researchers work together in a broader range of research fields, and to further distinguish the participation of each collaborator. For example, this thesis identified whether the Australian researcher provided or received the service or the transmission of know-how in these types of collaboration. Identifying the direction of collaborations is important in order to ascertain which country is receiving or providing the knowledge or understanding when it is involved in a combination of both, as in the case of in-depth and mutual inspiration collaborations. This study found that Australian researchers did not engage in provision of research equipment or, to a limited degree, transmission of know-how. Thus, this thesis makes a significant contribution to the sociology of international research collaboration by further developing the types of collaboration, identifying the direction of collaborations, and describing how these collaborations occur in bilateral and multilateral collaborations.

After establishing four different collaboration types, this study then analysed each of the types for common conditions that facilitated, hindered or were necessary for each collaboration type. Different collaboration types were found to have different suites of necessary, facilitating and hindering conditions. The greater the intensity of the
collaboration, the more the necessary conditions, with in-depth collaborations having the most necessary conditions. International collaborations were found to have additional conditions compared to national collaborations, requiring high funds, flexibility in use of funds, and more time. Collaborations with developing countries and larger groups also required additional conditions. Additional hindering conditions were also identified in this study. For example, the Western model of assessing track record is largely based on publishing in high-impact journals. However, this does not recognise that many researchers in developing countries believe that publishing in their local public health journal, rather than a high-impact international journal, is more effective in improving health outcomes. The findings in this chapter build significantly on the previous literature, which had not explored conditions for international research collaboration.

By identifying which conditions were required for each collaboration type, this study could then undertake a detailed assessment of how each of the five NHMRC funding schemes supported the conditions for the four different types of international research collaboration. This study argued that researchers in Australia are reliant on research councils to support, directly or indirectly, many of these conditions because of the dependency on external funding to conduct virtually all research. The two general schemes were found to provide one and three of the eight necessary conditions, while the three targeted schemes provided all or most of the necessary conditions.

This study then assessed how the NHMRC funding schemes affect international research collaboration, through identifying the social mechanisms that link institutions to changes in international research collaboration conduct and content. Firstly, NHMRC schemes have an enabling effect. All projects of investigation were perceived by researchers to have no other source of funding other than NHMRC. Therefore, NHMRC schemes support research that would not have otherwise occurred. Targeted schemes are particularly important, as they fund research that has previously been rejected through NHMRC general schemes (sometimes on multiple occasions), or research that grantees did not even try to get funded by NHMRC because the project involved international collaboration and risky research.
Secondly, NHMRC schemes affect research through the level of support for the necessary conditions of international research collaboration they provide, and the strategies this level of support then triggers in researchers. Gaining a targeted scheme also appeared to assist a researcher’s reputation, which led to further international networks and offers to be part of internationally-funded projects. This also confirms the finding of other laboratory studies (Knorr Cetina, 1981; Latour & Wooldgar, 1986 [1979]) that the researchers, themselves, must make strategic decisions regarding their research, rather than these decisions being imposed by funding agencies. The HFSP requires there be at least one new collaborator, and research must be interdisciplinary. Three of the four HFSP-funded projects of investigation were unable to combine collaborative contributions due to lack of personal relationships and being unable to develop a shared language based on shared knowledge.

Researchers were found to adopt strategies to undertake international research when supported through the general schemes. Researchers under the general schemes had to bootleg, downsize, stretch, target easy collaborators, accommodate patrons, reduce their research intensity, target rich collaborators and target international funding sources. Those funded through general schemes could only engage in service collaborations and thus were limited in fully realising the benefits of international collaboration.

On the other hand, projects of investigation funded through targeted schemes were found to engage in all types of international research collaboration and, because researchers could work with international collaborators in a range of ways, they were able to undertake riskier research and better engage in world leading research.

Based on the findings described above, this study contributed to a middle-range theory of international research collaboration. This was done by identifying how researchers collaborate internationally, the conditions required for the different types of collaboration, and the role that NHMRC schemes play in supporting these conditions. In addition, this study explained how these schemes trigger different strategies in research conducting international collaborations, and how these strategies affect the research content. This study argues that contributing to this
middle-range theory is important because a lack of systematic knowledge about how funding schemes link to changes in research science policy may result in unintended, effects on research.

The findings of this study have implications for international research collaboration policy. Firstly, international research collaboration has different conditions compared to national research collaborations, and, as such, it requires specific support. Currently, the NHMRC has very few schemes aimed at supporting international research collaboration, so researchers have to make the best of national collaboration schemes to undertake international research collaborations. These conditions do not appear to be recognised within the NHMRC organisation. Needs of the funding organisation appear to be paramount when supporting international research collaborations. Therefore, the general policy recommendation of this study was that there should be more support for the necessary conditions of international research collaboration, noting that much international collaboration is not project-specific.

The NHMRC made policy changes in 2009 as a result of this study’s findings. These changes were made to better support international research collaboration with developing countries.

**Further Research**

Many of the effects on research and decisions regarding what is required for research is either assumed or gained through the researchers who are members of NHMRC committees and NHMRC staff. NHMRC committee members and staff can only provide their own experiences rather than a systematic assessment of effects as has been achieved in this study. They cannot provide information regarding situations outside their own person experience, such as in other research fields or other personal circumstances. Therefore, it is suggested that more research similar to this study is undertaken to enable a systematic assessment of the effects of funding schemes.
In addition, there were some important questions that this study was unable to answer that warrant investigation:

1. What effect does the funded research have on researchers' fields? This effect will appear only after the projects are completed and some time has passed.
2. What effects do international research collaborations have on the careers of researchers beyond the project of investigation?
3. Did Australian researchers continue to work with international collaborators after the project of investigation, and, if so, in what way?
4. How do researchers, in the long term, manage the tension between the fact that international research collaborations are ongoing, while project funding is limited?
5. What are the long-term impacts on Australian science and its contributions to the knowledge economy when researchers gain funding from overseas organisations that are outside the scope of Australian science policy?

Final Words

I am confident in this study's endeavour to attribute changes in international research collaboration conduct and content to NHMRC funding schemes. This is because I believe that this study has illustrated that the NHMRC targeted schemes, which support nearly all of the conditions for international research collaboration, changed the 'self-identification mechanism' of potential grantees in regard to international research collaboration conduct and content. Some of the grantees used ideas that they had had for some time to generate project proposals. They did so because, with the targeted schemes, they saw a chance of getting these projects funded for the first time.

All the other researchers funded through the targeted schemes had previously had their project of investigation rejected—some multiple times—through the NHMRC general schemes. The NHMRC targeted schemes are an almost-perfect match to the necessary conditions for all types of international research collaboration, while the general schemes are not. Therefore, research supported through targeted schemes
could realise more benefits of engaging in international research collaborations through their project of investigation.

However, targeted schemes are rare, and account for less than five per cent of the NHMRC’s annual budget. This study found that collaborating through general schemes meant that researchers could only engage in service collaborations with international collaborators. These researchers conducted international collaborations almost in spite of NHMRC general schemes, rather than because of them. This should be a concern, as Australia requires access to the 98 per cent of science and technology that is produced overseas.

Therefore, this study argues that international research collaboration has certain conditions, and, in Australia, health and medical researchers are reliant on the NHMRC to provide support for them. Currently, researchers have to rely on undertaking international research collaborations through NHMRC general schemes, which this study has demonstrated are unsuitable, even though, ‘Collaboration at the international level is not only desirable, but an absolute necessity’ (Commonwealth of Australia, 2010:1). Only when the conditions for all types of international collaboration are supported can researchers fully engage in research without borders. This engagement is vital ‘to secure the future prosperity of the nation’ (Corey, 2011).
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Appendix A: Statement from HFSP

Researcher: Sarojini Martin
‘The Effects of Funding Programs for International Research Collaboration in the Life Sciences Project’

HFSP DECLARATION

The HFSP will not be involved in any way with the conduct of Sarojini Martin’s PhD project ‘The Effects of Funding Programs for International Research Collaboration in the Life Sciences’. The HFSP will not have access to the data collected by Sarojini Martin except via her scholarly publications, where the privacy of participants will be protected.

Professor Wiesel
HFSP Secretary General
March 2006
Appendix B: Statement from NHMRC

Researcher: Sarojini Martin

"The Effects of Funding Programs for International Research Collaboration in the Life Sciences Project"

NHMRC DECLARATION

The NHMRC will not be involved in any way with the conduct of Sarojini Martin's PhD project 'The Effects of Funding Programs for International Research Collaboration in the Life Sciences'. In particular, the NHMRC will not have access to the data collected by Sarojini Martin except via her scholarly publications, where the privacy of participants will be protected.

Professor Warwick Anderson
Chief Executive Officer
NHMRC
2006
Appendix C: Interview Guide for Australia Researchers

Interviewee:

Date and Time:

INTERVIEW GUIDE: RESEARCHERS

• Thank you for making time for this interview. I’m interested in the effects of NHMRC programs set up specifically to promote international research collaboration.

• I’d just like to remind you that I work part-time for the NHMRC. But I’d also like to stress that this study is totally independent of the NHMRC and I am undertaking the study as a self-funded ANU PhD student. All information I have about your research is from public sources, such as the internet and the Web of Science.

• Before I ask you any questions, I need your written consent.

• Everything you say is confidential. Are you happy for me to tape the interview?

• We’re going to cover three areas: firstly your research in general, then the project grant you were awarded in 2004, in which you are collaborating with international colleagues, and lastly other international collaborations with whom you are working.

Part 1: Research Biography

It is very important for me to understand your research, at least at a layperson’s level. I understand you’re an X and your research focuses on X.

1. Could you please explain the area you work in with a bit more detail?

2. Before I ask you in detail about your Project grant, entitled X, I would like to get an idea about your current work in general. Could you please describe what other
research projects you are currently working on? (Confirm he or she spends 100% of
time on research.)

What are the problems you solve?

How do you solve these problems (by which methods)?

With whom do you collaborate?

How are these projects funded?

3. How do these projects link with the Project grant?

Part 2: International Collaborative Project Grant

I would now like to ask you some questions about your Project grant, entitled X.

4. How did the idea for this project emerge?

When was the idea turned into a project?

How did you choose this topic, method and object?

5. Was this a new area of research for you or did it follow on from previous work?

If yes, why did you move into this new area?

6. Were any major changes made to the project submitted compared to the original
idea? (E.g. aims, methods, collaborations, duration of project.)

7. Under ideal conditions, would the project have looked differently?

If yes, how?
I understand that you are collaborating with Professors Alewood, Adams and Christie in Australia, but with whom are you collaborating internationally?

8. Why did you collaborate with these international collaborators on this project? (Were they the only ones who had this expertise, had you worked with them before, are they the best in the world in this area, did the scheme mean that you had to collaborate with international partners, did they have other funding/personnel/objects/equipment that you could use?). The other collaborators are developing different versions of a vaccine and these are being tested by Professor X.

Were there other international collaborators with whom you would have liked to work on this project, but didn’t? (Question added February 2007)

If so, why didn’t you collaborate with them? (Question added February 2007)

9. How did you find your collaborators?

Had you collaborated with them before this project?

10. How did your collaborators participate in the project proposal?

Did you meet prior to the proposal being submitted?

If yes, how was this funded?

Funding is very important for conducting research. The following questions relate to the issue of funding for this project.

11. Why did you apply for funding under this scheme?

12. Did you apply under other schemes to fund this project?
If yes, what was the outcome?

13. Could you have financed this project from other funding sources?

14. Can you give me a rough idea what is funded under this project?

15. Did you get all the funding you applied for?

16. Approximately how is the funding divided between the collaborators?

17. What are their specific contributions to the project? (E.g. exchange of objects/data, joint interpretation of results, exchange of personnel, etc.)

How does this work?

Do you meet and, if so, how often?

How are the meetings/communications funded?

18. What difficulties have you experienced with the international collaboration? (E.g. communication, time differences, etc.)

19. Have you published as part of this project?

If yes, where did you publish and why?

How do collaborators participate in the publication process?

How do you decide who is the last author on an article?
Part 3: General International Research Collaboration

20. Apart from those with whom you collaborate as part of your 2004–2009 Project grant, with who else do you collaborate internationally?

Where are they based?

*Are there* international colleagues *with whom you would like to collaborate, but do not?*

If so, why don’t you?

In what ways would you like to collaborate? (E.g. development of aims, exchange of objects/data, methods, joint interpretation of results, exchange of personal etc.)

21. *What do you believe are the advantages and disadvantages of the NHMRC Project grants scheme for international collaboration?*

This brings us to the end of the interview. Is there anything else you would like to add or clarify?

Thank you for your time. After I have finished my study, I would be happy to inform you of the results.
Appendix D: Interview Guide—International Researchers

Introduction

Thank you for making time for this interview. I’m interested in the effects of the Australian National Health and Medical Research Council programs on international research collaborations. I am interviewing Australian researchers and their international colleagues. However, before I can ask you any questions I need your written consent, so could you please consider this document and, if you are happy, sign it. Please note that everything you say is confidential. Also, are you happy for me to tape the interview? In terms of what we will be covering, the main focus of the interview will be on how you work with your Australian collaborator, Professor X, as part of your project, entitled X. But firstly, I will ask about your research in general. After asking you about Project X, I will finish by asking you briefly about other international collaborators with whom you are working.

Part 1: Research Biography

It is very important for me to understand your research, at least at a layperson’s level. I understand you’re an X and you research X.

1. Could you please explain the field you work in with a bit more detail? (Ask where their research is on the basic to applied dimension.)

Part 2: Grant

I would now like to ask you some questions about the collaborators with whom you work on Project X.

2. How did the idea for the project, entitled X, emerge?

When was the idea turned into a project?
How did you choose this topic, method and object?

4. How were all the collaborators involved in developing the project proposal?

Did you meet prior to the proposal being submitted?

If yes, how was this funded?

5. How does this project fit in with your overall work?

Was this a new area of research for you or did it follow on from previous work?

If yes, why did you move into this new area?

6. Did the idea for the project change in any way during the process of writing the application? (E.g. aims, methods, collaborations, duration of project.)

7. Under ideal conditions, would the project you submitted have looked differently?

If yes, how?

8. Why did you collaborate with Professor X from Australia and Professor X from X on this project?

Were they the only people in the world with this expertise?

In your opinion, are they the best in the world in this area?

Had you worked with them before?

Did the scheme mean that you had to collaborate with international partners?
Did they have other funding/personnel/objects/equipment that you could not otherwise access?

9. How did you find your collaborators?

Had you collaborated with them before this project?

10. Were there national collaborators that had similar expertise with whom you could instead have collaborated on this project?

If yes, why didn’t you?

11. What are the specific contributions of each collaborator to the project?

Do you discuss how the project is addressing its aims?

Do you exchange objects?

Do you discuss methods?

Do you share equipment?

Is there joint interpretation of results?

Do you exchange personnel?

Do you meet and, if so, how often?

What is discussed at these meetings?

How are the meetings/communications funded?
12. What difficulties have you experienced with the international collaboration? (E.g. communication, time differences, historic events (such as the New York attacks on September 11, 2001) that may have affected exchange of information, visas for visiting personnel, travelling with certain materials, transportation of materials, time and resources needed to invest in collaboration, etc.)

Funding is very important for conducting research. The following questions relate to the issue of funding for this project.

14. Why did you apply for funding under X scheme? (HFSP, ICRG and EU grant holders.)

15. How did you learn about the X funding scheme? (HFSP, ICRG and EU grant holders.)

16. How is the collaboration for your work on this project funded? (Program and Project grant holders.)

17. Did you apply under other schemes to fund this project/work?

If yes, what was the outcome?

18. Could you have financed this project/work from other funding sources?

19. Can you give me a rough idea what is funded under this project? (HFSP, ICRG and EU grant holders only.)

20. Did you get all the funding you applied for?

If no, did you have to make changes to project, and, if so, what were they?

21. Approximately how was the funding divided between the collaborators?
Part 3: General International Research Collaboration

22. Apart from those with whom you collaborate as part of your X grant, with who else do you collaborate internationally?

Where are they based?

23. What do you believe are the advantages and disadvantages of the X scheme for international collaboration?

This brings us to the end of the interview. Is there anything else you would like to add or clarify?

Thank you for your time. After I have finished my study, I would be happy to inform you of the results.
Appendix E: Interview Guide-NHMRC Manager

Thank you for making time for this interview. I’m interested in the effects of NHMRC funding schemes on international research collaborations. As you are aware I did work at the NHMRC for a number of years however I am undertaking the study as a self-funded ANU PhD student. Before I ask you any questions I need your written consent and may I remind you that everything you say is confidential. Also, are you happy for me to tape the interview? The interview shouldn’t take more than an hour and we’re going to cover the following 4 areas in the interview:

1. Your role at the NHMRC
2. What you believe are the necessary conditions to support international research collaboration
3. Your involvement in development of policies/schemes to support international research collaboration
4. Ideally, how you think the NHMRC could best support international research collaboration

Part 1: Role at NHMRC

1. Could you please briefly describe what your role was at the NHMRC?

Part 2: Necessary conditions to support international research collaboration

2. What do you believe are the necessary conditions to support international research collaboration?

   - Do you think there are different necessary conditions for supporting international and national research collaboration?

        If yes what are these?

3. I’ve interviewed a number of researchers on how they think the NHMRC meets the necessary conditions to support international research collaboration but I am really interested to get your view on how you think NHMRC meets these conditions?

   - What (if any) do you believe are the barriers to meeting these
conditions?

Part 3: Involvement in development of policies (by policies I mean it a broad sense) to support international research collaboration

5. What policies were you involved in developing, that supported international research collaboration? By policies I mean any way that the NHMRC supports/encourages/facilitates international research collaboration. Involves activities such as funding schemes, supporting membership to international organisations and or the NHMRC engaging in the international scientific system (OECD, WHO etc).

6. When you think back to setting up these policies/measures, what were the original intentions? (For questions 6-9 go by scheme/initiative)

7. How did these address the necessary conditions of international research collaboration you identified earlier?

8. Who was involved and what were their responsibilities/roles?

9. Were there any barriers to including the necessary conditions?

   If yes what were they?

(May not need to be asked questions 10-14 if already answered under questions 5-9)

10. In my study I am looking at the effects of 5 NHMRC funding schemes on international research collaboration; Program grants, Projects grants, HFSP, ICRG and EU. How were you involved in developing these funding schemes?

11. Thinking back to when these were developed what were the original intentions of each of the schemes you have mentioned you were involved in?
12. Who was involved in developing each of these schemes and what were their responsibilities/roles?

13. How did these schemes address the necessary conditions to support international research collaboration you identified earlier?

14. Were there any barriers to including the necessary conditions? 
   If yes what were they?

Part 4: How could the NHMRC ideally support international research collaboration?

15. In an ideal world, what do you think would be the most effective way/s for NHMRC to support high quality international research collaboration?
   
   - Who would need to be involved (e.g. other Depts./Universities/Industry), why and how?
   
   - What (if any) would the barriers be and why?

This brings us to the end of the interview. Is there anything else you would like to add or clarify? Thank you for your time. After I have finished my study, I would be happy to inform you of the results.
Appendix F: Variables and their Dimensions

1. **Independent variable: Institutional** (Rules of NHMRC funding schemes that support international collaborative research).

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
</tr>
<tr>
<td>NHMRC funding scheme</td>
</tr>
<tr>
<td>Scope of the rule</td>
</tr>
<tr>
<td>Subject of the rule</td>
</tr>
<tr>
<td>Description of the rule</td>
</tr>
<tr>
<td>Cause</td>
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<tr>
<td>Effect</td>
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</tbody>
</table>

2. **Intervening variable: Epistemic** (Field specific conditions and conditions of the local working environment).

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<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
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<tr>
<td>Field</td>
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<tr>
<td>Aspect</td>
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<tr>
<td>Value</td>
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<tr>
<td>Cause</td>
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<tr>
<td>Effect</td>
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</table>

3. **Intervening variable: Economic** (Secured and unsecured funds and time for research).

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<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Scheme and project (scheme will reflect source of resource)</td>
</tr>
<tr>
<td>Type of resource</td>
</tr>
<tr>
<td>Value of each resource requested</td>
</tr>
<tr>
<td>Value of resource funded</td>
</tr>
<tr>
<td>Cause</td>
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<tr>
<td>Effect</td>
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</tbody>
</table>

4. **Intervening variable: Social** (Trust, friendship, relationship with collaborator prior to project of investigation).

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<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>Value</td>
</tr>
<tr>
<td>Cause</td>
</tr>
<tr>
<td>Effect</td>
</tr>
</tbody>
</table>

5. **Intervening variable: Cultural** (Research cultures/styles of doing research and national cultures).

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<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
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<tr>
<td>Source</td>
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<tr>
<td>Characteristic</td>
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<tr>
<td>Value</td>
</tr>
<tr>
<td>Cause</td>
</tr>
<tr>
<td>effect</td>
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</tbody>
</table>
6. **Intervening variable: Individual researchers’ traits** (Collaborating researchers’ goals and interests, age, career stage, status, position at organisation of work and performance).

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<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
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</table>

7. **Intervening variable: Other institutions** (Rules other than the NHMRC funding scheme that affect research such as regulation of research, university rules and rules of other funding schemes).

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td>Time</td>
</tr>
</tbody>
</table>

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Appendix G: Consent Forms for Researchers

**Project: ‘Effects of NHMRC Funding Schemes on International Research Collaboration’**

<table>
<thead>
<tr>
<th>Principal Investigator</th>
<th>Supervisors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarojini Martin PhD Candidate (Sociology)</td>
<td>Dr Jochen Gläser, Senior Research Fellow</td>
</tr>
<tr>
<td>International Research Collaboration Project</td>
<td>Dr Grit Laudel, Research Fellow</td>
</tr>
<tr>
<td>Faculty of Arts</td>
<td>Research School of Social Sciences</td>
</tr>
<tr>
<td>The Australian National University</td>
<td>De Kevin White, Reader</td>
</tr>
<tr>
<td>ACT 0200</td>
<td>Faculty of Arts</td>
</tr>
<tr>
<td>Ph. (02) 6125 5913</td>
<td>The Australian National University</td>
</tr>
<tr>
<td>Fax (02) 6125 2222</td>
<td>ACT 0200</td>
</tr>
<tr>
<td>email: <a href="mailto:sarojini.martin@anu.edu.au">sarojini.martin@anu.edu.au</a></td>
<td>email:</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:jochen.glaser@anu.edu.au">jochen.glaser@anu.edu.au</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:grit.laudel@anu.edu.au">grit.laudel@anu.edu.au</a></td>
</tr>
<tr>
<td></td>
<td><a href="mailto:Kevin.white@anu.edu.au">Kevin.white@anu.edu.au</a></td>
</tr>
</tbody>
</table>

**Project description:** The aim of this project is to explain how funding programs for international collaboration in the life sciences affect the conduct and content of research. The study will include researchers from different Australian and international universities in the life sciences that are funded under a range of National Health and Medical Research (NHMRC) programs that support international collaborative research. I will interview researchers and decision-makers at different levels in the NHMRC.

**Interview:** The subject of the interview will be your research work, particularly your decisions regarding projects, working with international collaborators, and selection of funding sources.

If you agree, the interview will be tape-recorded and subsequently transcribed. You may refuse to answer certain questions, or may ask that answers to single questions not be recorded. You may withdraw at any time.

**Protection of participants’ identities:** No other person will have access to the raw data produced by the aforementioned methods. When results of the studies are published, no data will be used that reveal—alone or in combination with other data—the identity of the
interviewed persons or the departments that have been investigated. Names, institutional affiliations, details of research and any other information that might reveal participants’ identities will not be disclosed in publications. Data will be kept in a locked, secure cabinet for five years once the study is completed. Thus, confidentiality will be guaranteed as far as the law allows. (Under Australian law all data can be subpoenaed, and the investigator might be legally required to testify in court).

**Ethical considerations:** For any questions or concerns about the ethical aspects of this study, the ANU’s Human Ethics Officer may be contacted.

Ms Yolanda Shave  
Human Research Ethics Committee, Secretariat  
The Australian National University  
ACT 0200  
*Telephone:* 02-6125-7945  
*Fax:* 02-6125-4807  
*Email:* Human.Ethics.Officer@anu.edu.au

I, ________________, understand what this study involves and agree to participate. I have been given a copy of this consent form.

Signature: --------------------------- Date: -----/-----/  
*(Participants signed two copies and kept one)*
Appendix H: Consent Form Interviews—NHMRC Policy

Managers

Project: ‘Effects of NHMRC Funding Programs on International Research Collaboration’

<table>
<thead>
<tr>
<th>Principal Investigator</th>
<th>Head of supervisory panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarojini Martin PhD Candidate (Sociology)</td>
<td>De Kevin White, Reader</td>
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<td>ACT 0200</td>
</tr>
<tr>
<td>ACT 0200</td>
<td>email: <a href="mailto:kevin.white@anu.edu.au">kevin.white@anu.edu.au</a></td>
</tr>
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<td>Ph. (02) 6125 5913</td>
<td></td>
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<tr>
<td>email: <a href="mailto:sarojini.martin@anu.edu.au">sarojini.martin@anu.edu.au</a></td>
<td></td>
</tr>
</tbody>
</table>

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**Interview:** The subject of the interview will be your role at the NHMRC and your work in relation to the five schemes that are the focus of my study: Program grants, Project grants, the Human Frontier Science Program, the International Collaborative Research Grants and the European Health Research Grants. I will particularly be examining how these support international research collaboration.

If you agree, the interview will be tape-recorded and subsequently transcribed. You may refuse to answer certain questions, or may demand that answers to single questions not be recorded. You may withdraw at any time.

**Protection of participants’ identities:** No other person will have access to the raw data produced by the aforementioned methods. When results of the studies are published, no data will be used that reveal—alone or in combination with other data—the identity of the
interviewed persons or the departments that have been investigated. Names, institutional affiliations, details of research and any other information that might reveal participants' identities will not be disclosed in publications. Data will be kept in a locked, secure cabinet for five years once the study is completed. Thus, confidentiality will be guaranteed as far as the law allows. (Under Australian law all data can be subpoenaed, and the investigator might be legally required to testify in court).

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Signature: ---------------------------  Date: -----/-----/  
*(Participants signed two copies and kept one)*