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Careers and organisational objectives: managing competing interests in cooperative research centres

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Publication Details

Garrett-Jones, S., Turpin, T. & Diment, K. (2013). Careers and organisational objectives: managing competing interests in cooperative research centres. In D. Gray, C. Boardman & D. Rivers (Eds.), *Cooperative Research Centers and Technical Innovation: Government Policies, Industry Strategies, and Organizational Dynamics* (pp. 79-110). New York: Springer.

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Keywords

interests, cooperative, research, centres, organisational, objectives, managing, competing, careers

Disciplines

Business | Social and Behavioral Sciences

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Chapter for: Denis Gray, Craig Boardman and Drew Rivers (eds.) *Cooperative Research Centres and Open Innovation*, Springer.

Careers and organizational objectives: managing competing interests in cross-sector research and development centres

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Words = 14,959

Version 4, 5th October 2011

Careers and organizational goals: managing competing interests in cross-sector research and development centres

Abstract

Research of potential socio-economic value is often conducted within cross-sector (government, university, business) centres. There has been growing interest among science policy researchers in seeking to understand the organizational dilemmas confronted in cross-sector research collaboration. While there is clearly a coalition of interests among partners engaged with collaborative research their broader organizational objectives and strategies may converge, diverge, or even compete. Yet little empirical evidence exists on (a) how individual researchers perceive the benefits of their participation, (b) how far the structures and functions of particular collaborative R&D centres coalesce around of researchers' expectations and, (c) what problems arise for researchers who opt for a 'second job' in the centre. Within the broad policy and organizational context of the Australian Cooperative Research Centres this chapter presents a qualitative analysis of a survey of respondents from public sector organizations and universities involved in the centres. We use the perspective of the individual research scientists to illuminate the management issues of trust, governance, and competition between functional domains, which emerge from the field of inter-organizational relationships (IOR) and which have been inadequately recognized in the context of collaborative R&D centres. The findings have implications for the management of the centres, for the careers of research scientists and for public policy.

Keywords

Cross-sector R&D, research organization, research policy, scientists' careers, university-industry linkages, inter-organizational relations, Australia, Cooperative Research Centres

1 Introduction: emerging fissures in the research system

The unprecedented growth in cross-sector (industry–academic–government) collaboration in research and development (R&D) reflects far-reaching changes in the relationship between sciences, notably in the organizations that carry out research. R&D is increasingly being carried out in organizational forms, such as university–industry collaborative research centres, which are built around cross-sectoral and trans-disciplinary teams with well-defined socio-economic objectives in mind.

Two influential models seek to explain the institutional configuration of cross-sector R&D observed: the ‘triple helix’ model of university–industry–government relations (Etzkowitz and Leydesdorff 1997) and the ‘Mode 2’ knowledge production of ‘science in the context of application’ which (Gibbons *et al.* 1994) contrast with ‘Mode 1’ traditional science pursued within discipline-based structures like university departments. Critics of these models argue that they reflect nothing new: that academic research has always been heterogeneous in character and comprised elements of trans-disciplinary and strategic research (Rip 2000; Ziman 1991). In our view, this overlooks the significance of the new forms of collaborative organization, their scale and complexity, their novelty (e.g. as distributed or virtual centres) and their effect on existing institutions like university departments and disciplines (Turpin and Garrett-Jones 2000). We consider the models limited because they fail to explain how the new cross-sector R&D organizations are best structured, managed and sustained and how the process of renegotiation takes place between the centres and the member institutions.

Academic staff involved in collaborative research centres in the US generally hold continuing appointments in a university department (Boardman and Bozeman 2007) or, in Australia, may be researchers with government institutions. Effectively they hold multiple jobs or roles. Through their affiliation with the centre, these staff not only accept additional responsibility, but responsibilities which may sit incongruently with those in their home institution. This arrangement parallels Merton’s observation about the competition for resources and potential incompatibility between the multiple roles involved in a position as a university professor or scientist in a research organization (Merton and Barber 1976). Examples of situations that might lead to work incompatibility (Boardman and Bozeman 2007) are the different reward and incentive systems in the centres by comparison with academic departments, or divergences in research interests between the problem-oriented centre and the discipline-based academic department. (Shove 2000:64) speaks of ‘a

multiplicity of research regimes’ and ‘a range of settings each of which interprets, values and rewards research differently’.

Life in the ‘triple helix’ has been portrayed in terms of choices made by individual researchers in the extent they wish to commit to ‘involvement in multiple worlds’ (Henkel 2004). The social scientists surveyed by Shove (2000) were ‘struggling with the stresses and strains of simultaneously inhabiting different worlds’. Gulbrandsen (2000) sees it not as a question of resolving tensions (e.g. between scientific excellence and utility), but balancing them – constructing various individual strategies of ‘portfolio management’, as Shove (2000) puts it. Gibbons *et al.* (1994:48) argue that universities and government laboratories have entered ‘the game of dynamic competition’, where ‘knowledge resources are held in different organizations and can be shifted between environments which are at one moment competitive and at another collaborative’. These environments are not discrete, but are populated by actors who ‘move back and forth’, for example, researchers who work concurrently in a university department and a centre. While acknowledging the movement of researchers, Gibbons *et al.* (1994:41) on the other hand talk about the ‘strain of multifunctionality’ as an *institutional* challenge affecting, for example, universities and professional societies rather than individuals.

Recent work by Boardman and Bozeman (2007:431) interprets the ‘multiple and perhaps conflicting demands of multiple allegiance’ within the ‘unusually complex institutional environment of [centres]’ (Boardman and Bozeman 2007:440). It thus covers similar ground to the current paper. Boardman and Bozeman’s contribution is to use role theory to examine these tensions and to extend the idea of individual ‘role strain’ or ‘role conflict’ within a single organization (Box and Cotgrove 1966)¹ to encompass the ‘centre-induced role strain’ that may be produced by working across organizations. As in the current paper’s discussion of ‘functional domains’ Boardman and Bozeman (2007:439) examine problems at different organizational levels (e.g. within-department or within-centre role strain versus centre-department role strain). Rightly Boardman and Bozeman play down Box and Cotgrove’s (1966) notion of ‘strain minimization’ as the prime individual response, pointing out that, as in the Australian study discussed in this chapter, participants voluntarily take on the challenge of working within the setting of a cross-sector research centre. In conclusion Boardman and Bozeman quote NSF’s Erik Bloch in saying ‘it’s up to the

¹ Role strain results from ‘a lack of congruence between the needs and interests of the individual and the demands of the organization’ (Box and Cotgrove 1966:24).

individual' whether or not he/she is prepared to work within a cross-sector R&D centre and propose a focus on the 'personnel management and policy issues' provoked by such centres.

We acknowledge the importance of centres for individual researcher's career choices (Turpin *et al.* 2005) and the salience of the voluntary/cooperative aspect of participation in centres. But, in our view, managing the competing demands within cross-sector centres cannot be relegated to a problem solely for the individual, or 'a side effect requiring clarification and remedy' (Boardman and Bozeman 2007:437). Rather it reflects a central and deliberate feature of the complex and hybrid institutional environment of collaborative research centres and must be specifically addressed when designing management structures and regimes for the centres.

One explicit goal of policies which institutionalize cross-sector multidisciplinary research, including Australia's Cooperative Research Centres (CRC) program, is to challenge the conservative norms and cultures of academic disciplines, universities, research organizations and firms by exposing them to each others' cognitively different worlds. It is long recognized that productive research teams require a balance between challenge and security, a range of 'creative tensions' whose dimensions include the relationships between science and its application, and between individual independence and organizational coordination (Pelz and Andrews 1976). As Nooteboom (2000) points out, one reason why inter-organizational networks encourage innovation is that they bring together people with a greater 'cognitive distance' (CD) between them – an idea akin to the 'creative tensions' of Pelz and Andrews (1976). Leydesdorff and Etzkowitz (2001:n.p.) 'expect[s] differences of perspective, leading to creative interactions in which the participants can transcend the *idées reçues* of their respective organizations'. Thus the goal is to promote creativity without undermining the traditional strengths that the participants bring to the collaboration, such as commercial focus, mission-orientation or intellectual rigour.

Recent empirical work by Cummings and Kiesler (2007, 2005) examines coordination and the trade-off between innovation opportunities and coordination costs within multi-university research collaboration. The authors find a direct correlation between coordination activities, which include 'relationship development' (Cummings and Kiesler 2005:704) and project outcomes, but conclude that coordination costs are a significant barrier to collaboration. Their arguments draw upon several institutional-based views of the problem: organization theory and forms of coordination, the knowledge-based view of collaboration between firms, and theoretical and empirical studies of distributed work practices (Cummings and Kiesler 2007) and social network research (Cummings and Kiesler

2005). They conclude that the trade-off between the benefits of collaboration and the transaction costs is a general issue within distributed innovation systems.

Use of the role theory lens implies that independent variables related to individual scientists' values and expectations will be relevant. Indeed Box and Cotgrove (1966) originally proposed a trichotomy of types of scientist which they linked to particular occupational choices. Neither we (Garrett-Jones *et al.*, 2005a, 2005b) nor Boardman and Bozeman (2007) compare the views of researchers working within centres with a similar group of researchers who avoid centre-based research. What does emerge, however, is a rather surprising commonality of views among the centre-based researchers. We have found few significant differences in the responses of academic and government researchers to the quantitative questions in our survey (Garrett-Jones *et al.* 2005b). Likewise, Boardman and Bozeman fail to find any relationship between role strain and individual variables like gender, tenure status or academic discipline. They do however see organizational relations factors (such as the formality of relations, or the closeness of ties) as correlated with role strain. In our survey, again it was broader organizational factors (such as policies on access to national research council grants) that led to divergence of opinion between academic and government researchers, rather than factors related to individual motivations for centre membership.

What emerges from the empirical literature on R&D centres is (1) an agreement that inhabiting multiple roles, domains or worlds creates new or aggravated sources of tensions and problems; (2) an understanding that participation involves a trade-off between the benefits and costs of membership, the latter including costs of relationship-building and coordination; and (3) that organizational structures, such as degree of bureaucratic or participatory management (Chompalov *et al.* 2002) and activities, such as extent of communication (Cummings and Kiesler 2007) are demonstrably pertinent to the success of collaborations. However, the literature reveals ambivalence about the relative contribution of individual and organizational factors in responding to these challenges. Participation in cross-sector centres is voluntary and may be explained in terms of personal attitudes and individual choice. But the values held by researchers do not necessarily help in distinguishing between those who thrive in cross-sector research environments and those who do not. Forms of organization, which vary with factors such research field, scale of the collaboration and geographic dispersion, also influence collaborative outcomes. This leads Elzinga (2004:8) to be less than sanguine about 'Mode 2' and 'triple helix' collaborations, observing that 'democratic corporatism' and 'convergence and agreement [are

emphasized]...while potential conflict and exclusion mechanisms are toned down, giving rise to a picture of smooth and peaceful collaboration across institutional borders'. Are these tensions unique to cooperative research centres, or do they arise in other forms of inter-organizational collaboration?

2. Cooperative research centres as inter-organizational relationships

In some countries, CRCs are one of the most important mechanisms to foster collaboration. They usually take place in countries with strong federal programs, such as the United States, Germany and Australia, resulting in a wide and stable national network of centres, through which other funding mechanisms are allocated. A recent analysis of Australian CRCs drew attention to the ways in which different CRCs have evolved in the Australian system (Turpin *et al*, 2011). According to that analysis, after two decades since its introduction the Australian CRC program has reached a 'policy crossroad' and it is unrealistic to expect a single discrete program to manage the diversity of missions encompassed by the collective aims and objectives of organisations and personnel that comprise the contemporary cohort of centres.

A recent study of cooperative research in Norway has found that project based research funding and centre based funding were leading to unexpected differences in the extent to which collaboration was becoming institutionalised (Thune and Gulbrandsen, 2011). Their analysis showed that although centrally funded research centres were more formalised in structure and process, they were more weakly institutionalised than research collaborations supported through project based funding programs. Thune and Gulbrandsen's explanation for this difference was due to the many different modalities of collaboration and the variety of expectations of industry partners. This was a similar observation to the Australian analysis noted above with both suggesting a need for greater diversity in the design of funding systems directed toward the promotion of cross sector collaboration.

Recent studies into cooperative research centres in the United States provide an interesting contrast where progressive legislative changes since the 1980s have contributed to a huge growth in university based research centres. Gray (2011) has noted that according to the 2010 Research Centres and Services Directory there are almost 16,000 university-based non-profit research centres in the U.S. and Canada, a large proportion of which would be similar to the Australian CRCs. Yet, besides this more formal collaborative mode a great deal of cross-sector research collaboration takes place between individuals and institutions informally and *without* external policy intervention. Gray's analysis presents the U.S.

experience with cross-sector research collaboration as a diversified system of public policy that includes elements of a science policy, technology policy and innovation policy producing an innovative ecosystem from basic research to very downstream commercialisation efforts' (Gray, 2011: 131). In this complex policy environment Gray points to the pressing need for effective policy coordination and, because of program overlap, the redundancy of many programs and initiatives.

The emergence and consolidation of cross-sector collaborative R&D centres suggest the possibility of two separate career paths for scientists: one that progresses through an institutional structure such as a university or public research institute and one that is embedded in an industrial structure steered much by commercial opportunities, offering contract rather than tenured terms of employment. These pathways are not mutually exclusive and there is evidence that some scientists move regularly across the boundaries (Turpin *et al.*, 1996). However, there is also evidence that diversity in the nature of cooperative research centres has contributed to different modes of institutional collaboration. Schiller (2011) has drawn attention to the diversity of actors operating in a more bottom-up fashion that has led to the diversity of centres with different roles and impact on their national or regional innovation systems. He has argued that the differing expectations of scientists and their managing institutions has contributed to a 'reconfiguration' of the German science system that has influenced both formal organization within the system as well as informal practice. In order to better understand this process he offers an analytical framework for exploring the separate and different impacts of CSRC programs on (a) researchers, (b) the science sector and (c) the innovation system, according to the scope of the program, potential reward, and governance procedures. In his final analysis he argues that while some program configurations may lead to more formalised modes of governance others will continue as informal arrangements because they do not align easily with expectations or indeed the organisational structures concerning potential reward. The possibility of parallel career paths is certainly one way of ameliorating ambiguity between scientists' differing career opportunities and expectations.

The growth of cross sector collaborative research centres parallels the emergence of inter-organizational relationships (IOR) in business, notably the alliances of firms aimed at introducing technologically based new products and services in markets. Such centres and alliances can be regarded as a class of inter-organizational relationship, that has been variously termed 'hybrid organization' (Menard 2004; Lamb and Davidson 2004; Minkoff 2002), 'virtual organization' (Handy 1995; Hatch 1997; Holland and Lockett 1998;

Jarvenpaa and Leidner 1999) or form of ‘cooperative network’ (Castells 2001; Handy 1993). As Chompalov *et al.* (2002) observe, network forms of organization have been widely studied for firms, non-profit and government organizations, but less so for inter-organizational R&D arrangements.

The typology and dynamics of these hybrid organizations still remain poorly understood. Menard (2004:345-347) notes that hybrid organizations may be thought of as a ‘heterogeneous set of arrangements’ that ‘rely neither on markets nor hierarchies for organizing transactions’. He argues that hybrid organizations ‘form a specific class of governance structures’ (Menard 2004:368), which share common characteristics and problems. These include the difficulties of coordinating contractual arrangements that involve autonomous partners, particularly where a high degree of uncertainty about the value of the products of the collaboration is involved; and the fact that they are neither driven solely by market considerations, nor subject to the command and control of a single organization (Menard 2004).

The first issue in managing voluntary or loosely contractual relationships is therefore managing autonomous partners. If the collaboration is to arise and be sustained, all participants must see some benefit that they could not achieve more easily alone or in some other way, otherwise there is a ‘credible threat’ of unilateral action, for example, that they will unilaterally withdraw (Oster 1994:247). This raises the question of how partners (individually or institutionally) initially assess and continue to monitor the benefits and costs of their participation in cooperative R&D.

The notion of risk and trust in IORs is well expounded in the literature. Holland and Lockett (1998:606) describe the coalescence of virtual organizations around outcomes, and the need to deal with the risk that the outcome may not be achieved: ‘there is a significant level of risk associated with the outcome...and organizational trust has been hypothesized to be an explanatory variable for the development of such cooperative behaviour’. Nooteboom (2000:918) recognizes of two elements of what he calls ‘the slippery notion of trust’. These elements are *competence* (or the capability to deliver the agreed outcomes) and *intention* (the degree to which parties are committed to the avowed goals and avoid opportunism—that is, putting self-interest above the goals of the group or organization).

Hybrid organizations not only *combine* different organizational behaviours, but operate *across* broad and complex organizational environments. In this sense they are truly ‘boundary spanning’ (Steenhuis and Gray 2006). Minkoff (2002:381) makes the crucial observation that ‘hybrid organizations operate in multiple functional domains’, compared

with organizations that operate within ‘clearly defined technical and institutional boundaries’. Other authors term these functional domains ‘sub-cultures’ or ‘societal sub-systems’. Nowotny, Scott and Gibbons (2001) talk about hybridization also in the sense of combination of scientific disciplines and multidisciplinary. This allows the idea that different functional domains can exist *within* and *across* the partner organizations as well as *between* them. As Ziman (1991: 45-47) has shown, universities are quite unlike firms in this regard because of their highly segmented components—departments, research centres and so on; and the ‘blurred line’ between academics acting as university staff and performing as independent entrepreneurs. We suggest that Minkoff’s term ‘functional domains’ can be applied to encompass and extend these ‘different worlds’ and ‘research regimes’ posited by Shove (2000) and Henkel (2004). The idea of competition between functional domains thus provides an institutional counterpart to ‘role strain’ at the individual level.

A wide cognitive distance between the participants has the merit of bringing in new ideas, but also creates problems of mutual incomprehensibility. The partners will have different views—not just about the science of the project, but, as Gibbons *et al.* (1994) point out, also what constitutes ‘fair play’. This raises the question of what is the appropriate balance between trust and ‘formal government’ (Menard 2004) required to coordinate cross-sector R&D organizations, and what ‘governance’ and rules are accepted and enforced. It also brings up issues such as what is regarded as legitimate competition, collaboration, ownership and reward (Gibbons *et al.* 1994), and how the objectives and strategies of the centre are determined and implemented (Steenhuis and Gray 2006).

What the IOR literature brings to the discussion is (1) an emphasis on the autonomy of partners, and therefore on the benefit-cost equation from each partner’s perspective; (2) the extension of the idea of competing roles (at the individual level) into that of competing functional domains (at the level of the group or organization); (3) questions related to trust and reputation (and its breach), how partners are chosen, how trust is assessed and built, and how the risk of opportunist behaviour between partners can be reduced; and (4) questions concerning alternative forms of governance for collaborative research and particularly the choice between consensual or centralized, directive management.

These are all essentially management issues that potentially impact on scientists’ careers and the strategic directions of cooperative research centers and the organizational partners within their structure. Inherent contradictions in the process according to Howells and Edler (2011) are a driving force for new forms of institutional governance and configurations of relationships, a process that they call ‘structural innovation. Studies of

cross-sector research centres in Australia (Turpin et al, 2011) Germany (Schiller, 2011) and Norway (Thune and Gulbrandsen, 2011) are providing growing evidence that these hybrid organizations are driving ‘structural innovation’ in their national innovation systems. For example, in Australia there is evidence that the CRC model is evolving as part of a ‘whole-of-government approach’ to the implementation of major national policy, such as ‘Clean Energy Futures’. As the CRC Association has argued: ‘the CRC model is well suited to delivering the innovations that will be necessary to address these challenges’ (Peacock, 2011). The introduction of broader policy objectives into the management strategies of CRCs may serve to provide a stronger scientific base for the broader policy objectives. However, it is likely to contribute further to contradictions between career and multi-organizational objectives. The remainder of this chapter focuses on these competing demands in the Australian CRC experience.

3. Managing identities, divided loyalties and competing interests in Australian CRCs.

3.1. Propositions

This chapter explores the contention that lessons learnt from the management of IORs generally are of help in understanding the interactions between the partners in cross-sector R&D collaboration, including the experience of individual researchers, the effect on existing institutions like academic departments and disciplines and the structure and governance of the collaborative centre itself.

Using qualitative data from a survey of Australian CRC participants we analyze participants’ views on the attractions and problems of working within these new organizations. We structure the findings and discussion according to three sets of research questions:

- (1) What drivers and benefits of centre participation are reported by participants? What motivates researchers to found, join and remain in cross-sector R&D centres?
- (2) How are centre identities negotiated and agreed? What values do participants bring to the negotiation; how important is trust between participants and how is it defined? How do participants view the governance structures of the centres; how are boundaries and rules determined and enforced?; and
- (3) How are divided loyalties and competing demands perceived and resolved? What causes researchers to become dissatisfied or disillusioned with these centres, and how do they respond?

These themes emerged primarily from our initial analyses of the participants' responses. We chose to explore them further because of their resonance with issues raised both in the research policy and IOR literature and their bearing on the management of cross-sector R&D centres.

The following section introduces the cross-sector R&D model embodied in the Australian Cooperative Research Centres and describes the dynamic policy and organizational context within which they operate. This is followed with a description of the methods used in the survey of CRC participants and in analyzing the responses. In the remainder of the chapter we analyze the opinions of respondents in relation to each of the three sets of questions. Finally we consider implications for the management of the CRCs, researchers' careers, and policy initiatives supporting cross-sector, inter-organizational R&D centres.

3.2 The Australian Cooperative Research Centres (CRC) Program

The Cooperative Research Centres are geographically and institutionally distributed organizations that rely on the voluntary cooperation of independent partners within a contractual framework. There are currently 42 CRCs in operation, covering a wide range of industrially-oriented research (such as polymers or advanced automotive technology) and national interest research (such as Aboriginal health or greenhouse accounting), each funded for an initial seven-year term. They involve collaboration between universities, federal and state (provincial) government research agencies, individual firms and various industry-led public sector intermediaries. They sometimes engage a chief executive and administrative and R&D staff in a central office, but most CRC researchers are employed by their university, business or government laboratory where they continue to work, rather than by the CRC itself. CRCs are highly complex inter-organizational networks. For example, the CRC for Polymers combines 11 participant companies in the plastics industry (two of which are spin-offs from the CRC), two large federal government research agencies, 10 universities, a state government department and another independent cross-sector R&D centre.

3.3.1 The dynamics of the CRC Program

As the Program has matured an increasingly pertinent issue has been the extent to which cross-sector activities satisfy evolving program objectives and whether the specific

organizations that have emerged are sufficiently flexible and adaptable to deal with emerging challenges in end-user focussed activities. Table 1 summarises CRC Program objectives from inception to the most recent funding round (March 2010).

The objectives of the CRC Program have changed substantially over time, notably becoming far more condensed as Program thinking moved from implementation toward outcomes. The O’Kane Review (2008: 22) assessed the most significant change in emphasis as occurring around 2004-06, finding it ‘quite marked: on growth, research users, and research adoption/commercialization... the focus was on harder-edged outcomes for end-users’. The Productivity Commission (PC), in its earlier (2007) review of public support for science, also noted the move away from foci on research excellence and postgraduate training, and broad-based definitions of national and social benefit. The Productivity Commission (2007) argued that the emphasis on commercialization over early-stage R&D was risky from a public investment perspective. It created a strong likelihood that CRC collaborations were substituting for R&D that firms or industries would have conducted anyway, in the absence of CRCs, and that selection committees would favour ‘collaborations that pursue less risky project outcomes involving lower levels of spillover benefits’ (Productivity Commission, 2007: 447-8).

(Table 1 about here)

The response of the Australian Government to these independent reviews, and the substantial weight of support for these views contained in stakeholder input to them, was to move the Program objectives back toward their earlier focus. This included a reinstated emphasis on public good outcomes (social and environmental benefit), end-user focused education and training programs, and SME strategies designed to augment firm R&D capacity and innovation capability. The most recent Program Guidelines also de-emphasise commercialization and shift toward a broader basket of activities to ‘deploy research outputs and encourage take up by end-users’ (DIISR 2010a: 1). The definition of end-user includes all public organizations, communities or private industries *capable* of deploying research outputs from CRCs. For example, an end-user of a health focused CRC’s research output may be a public health authority, just as it may be a private pharmaceutical firm or a not-for-profit organization.

It is interesting to consider how changes in program objectives reflect policymaker expectations in terms of the actors engaged with centre activities. The earlier incarnations of the CRC Program envisaged hybrid actors formed through bottom-up initiatives amongst

coalitions of researchers and organizations. As economic actors these early CRCs could be considered science-push joint ventures, with expectations of their activities more about system coordination, capacity building and emergent collaborations than about direct market impact. In more recent times expectations became framed more strongly by demand-pull initiatives, particularly once activities were explicitly expected to produce a direct financial return on public investment. CRCs became faced with challenges presented by a range of economic activities that can broadly be referred to as ‘marketization’ activities (Çalışkan and Callon, 2010). These include activities such as venture capital sourcing, market feasibility studies, promoting prototypes, licensing products etc, which are required to bring a product to the attention of financiers, buyers and other types of commercial actors operating in and around markets. CRCs, instead of being intermediate organizations producing outputs for commercialization by specialist marketization actors, were expected to become *directly* involved in carrying out these activities themselves. The policy re-orientation was partly due to a continuing perception of weak science output commercialization capabilities amongst Australian SMEs (OECD, 2004). However, the focus on commercialization activities provided a range of significant challenges to CRCs, including broadening the expertise required within the organization, with the accompanying risk of weakening the focus on research excellence, training and other missions.

The relationships between the evolution of Program *objectives*, expanded Centre *activities* and forms of *organization* structure are important to note here. Perhaps the clearest example in this regard is in relation to intellectual property (IP) arrangements. In general, CRCs are either incorporated tax exempt legal entities or unincorporated joint ventures. While incorporated CRCs can act fully as a commercial agent and directly hold IP, unincorporated joint ventures have a principal agent and administering authority (usually a University) and often establish an external legal entity for commercial transactions including IP. From 2002, the government preference was for CRCs to become incorporated (OECD, 2004), fitting with the vision of CRCs becoming economic actors more fully engaged with marketization activities. Despite this, many CRCs preferred at this time to remain unincorporated, with a key public sector member holding IP developed within the CRC. Instead, legal entities were spun off from CRCs to deal with the challenges associated with holding IP and negotiating commercial agreements. In effect, CRCs appeared somewhat ambivalent on the question of functioning as economic actors fully engaged in marketization activities, preferring rather to create a third-party structure to cope with extended commercial imperatives. However, as older CRCs finished their funding period and newer

CRCs came into existence the overall balance of the Program shifted toward incorporated structures. By mid-2010, just eight of 42 CRCs (19%) were *not* incorporated (DIISR, 2010b), indicating the previous Program objectives had influenced CRC structures in the medium term. It will be some time before the marketization capabilities of current CRCs can be realistically assessed. With the most recent changes to Program objectives de-emphasising commercialisation, it also remains somewhat unclear as to what extent incorporated CRCs will pursue this activity directly.

(Table 2 about here)

A second important change in the structure of the CRCs has been driven by trends in the sectoral contributions to R&D and innovation in Australia. Table 2 shows government funding and participant contributions for each round of CRCs from 1990 to 2006. Over the life of the program nearly A\$12 billion has been invested in the centres through government grants and partner-contributed funds or ‘in-kind’ contributions. The government grant to the centres has leveraged about three times its cost in funding from other partners. Each CRC requires a higher education partner and it is no surprise that universities are the major contributors to CRCs, providing at least one-fifth of the resources in each funding round. In the 2000 and 2002 rounds universities’ contribution exceeded 30 per cent of CRC resources, leading some universities to find themselves overexposed to the CRC Program. O’Kane noted that Go8 (large, established metropolitan) universities were becoming increasingly reluctant to participate in new CRCs (O’Kane, 2008). While the Go8 dominate, contributing around half of the university resources to CRCs, the proportion of university resources from the non-Go8 university grew slightly from 47.7 per cent in the first five rounds to 51.4 per cent in the second five rounds. Three trends in the data in Table 2 mirror the broader changes in the national innovation system. First is the general increase in industry funding to the centres. As a proportion, industry and industry association contributions to the centres grew from 16.4 per cent of the centres’ budgets in the first five rounds to 21.5 per cent in the second five rounds. Second, the universities’ contribution also grew proportionally from 21.8 to 26.5 per cent of the centres budget. Lastly, and most markedly, is the decline in CSIRO participation in the Centres, from 17 per cent of resources in the 1990 round to less than 3 per cent in the 2006 round. Overall, CSIRO’s contribution declined as a proportion of resources from 14.7 per cent in the first five rounds to 7.1 per cent in the latter five rounds.

From being a three way collaboration of university, industry and government researchers the CRCs are now dominated by bilateral partnerships of universities and industry.

The third point we wish to make here is the great diversity in the objectives and aspirations of the CRCs themselves. The outputs from CRCs provide an indication of what it is that they value. Output 'value' is clearly articulated in centre research and management plans. In a collection of CRC output data (Garrett-Jones & Turpin, 2002) centres were asked to nominate what they described as their most valued outputs. Academic publications outputs are highly valued in terms of benefit to careers and academic research funding. Interestingly, apart from the typical research breakthroughs and advances made in their key fields, a wide range of activities were nominated. For example, the following outputs were defined by some CRCs as among their most 'valued' achievements:

- A forestry CRC described their Forestry 'Tool Box', information sheets distributed at field days and agricultural shows as a significant output (rural manufacturing sector).
- In contributing to their community awareness objective the CRC for conservation management initiated the 'Great Australian Marsupial Night-stalk' a community based spotlight surveys involving people of all ages from all over Australia (environment sector).
- The Centre for Mining technology and equipment noted that they specifically targeted trade journals, magazines, newspapers as a key mechanism for diffusing research outcomes (mining and energy sector).
- The Aboriginal health CRC specifically targets Aboriginal health workers for professional training rather than typical PhD or Masters programs (medical and health sector).

These are clearly valuable outputs in terms of the CRC objectives and are directly aligned with their Centres' objectives and strategies. But in practice valued outputs from the perspective of individual researchers and centre managers may vary. Further, how they align with the organisational priorities and institutional structures that determine researchers' careers or with the performance measures and the funding formulae imposed by the federal government is another matter. But unless their value is aligned with other varying centre outputs there will be the possibility for tension between the career expectations of researchers and the development expectations of CRCs.

The above discussion leads us to several conclusions on the dynamics of the CRCs as cross sectoral R&D centres.

1. There is still an active debate about the role and scope of the CRC program, including (1) how broadly should we define ‘industry and other end-users of research’ in the context of the CRCs and other collaboratives; (2) what is an appropriate balance between ‘commercial’ and ‘public good’ research within various schemes; and (3) should programs such as CRCs legitimately support research which primarily benefits only one company? In other words, how far should CRCs span the spectrum of public, socially oriented research on the one hand, and appropriable industrial research on the other?
2. Over time, and due to structural changes in Australia’s public research sector, CRCs have become dominated by industry and academic researchers and have moved away from government involvement both directly (government researchers) and indirectly (CRC program grants).
3. We have argued that a push to ‘marketization’ risked the CRCs becoming too conservative in their research agendas, and thus less attractive to academic researchers. Whatever policies guide cross-sector R&D collaboration, they need to allow for the demonstrated great variance in objectives and outputs. Following a period of emphasised commercial orientation, the funding guidelines and structures of individual CRCs have recently become more heterogeneous, both in the funding period, the mode of organisation and scope of disciplinary research permitted.

Our purpose here is not to pursue each of these debates in detail. Rather it is to show that the nature of formalised cross-sector R&D collaboration has changed significantly in several important dimensions related to objectives, performance measures and organization even over the course of a single government program – the CRC program. We note that each centre’s context is shaped by national policy and funding regime, factors specific to the disciplinary and sectoral environment of the centre, and factors specific to the collaborating institutional partners. The management of the centres operate within this context and these constraints.

3.3 Research Methodology

The results reported in this paper come from a ‘research culture’ survey of respondents ($n = 370$) from public sector organizations involved in the management and conduct of collaborative R&D in the Australian Cooperative Research centres, which was carried out in

2004-05. The paper presents a qualitative analysis of the comments from 209 of these respondents who chose to answer 'open ended' questions in the survey.

A written, mixed-mode (postal and web-based) survey (Diment & Garrett-Jones 2007) targeted a non-random but representative sample of about 1100 staff involved in the management and conduct of CRC-based research in public sector organizations – i.e. excluding industry partners which were the subject of a parallel study (Fulop & Couchman 2006). The survey achieved a 34 percent response rate. Respondents comprised researchers and research managers from 37 CRCs, most of whom were involved directly as formal participants. The majority (53 percent) of respondents identified themselves as from the higher education sector, with 21 percent from the government research sector (see Table 1). The respondent set was quite homogeneous: 82 percent of the respondents were men, 77 percent held a doctoral degree, and 11 percent held a masters degree. Two-thirds of the respondents had participated in one CRC only, while the rest had been involved with between two and seven CRCs.

The survey questionnaire presented 48 propositions about the respondent's experience with the CRC program. Analysis of these responses permitted a quantitative ranking of the main benefits and problems in CRC participation, the management strategies adopted, and the effect of CRC participation on research careers (Garrett-Jones and Turpin 2007) and comparison between the views of academic and government researchers (Garrett-Jones *et al.* 2005). The final question (optional) in each section allowed an open-ended response to the themes of benefits, problems, administration issues and impact on career. Of the respondents 209 (or 57 percent) chose to respond to one or more of the optional questions. Their characteristics were almost identical to the full respondent group in terms of their gender, highest qualification, length of time with the CRC and where they were employed (Table 2) except that the miscellaneous 'other' group (which includes past participants) is over-represented. The respondents did not seem unduly constrained by our themes and furnished comments on a wide range of issues.

Every response was analyzed with the assistance of the QSR NVivo 2 software. NVivo is a database management program designed for exploring complex unstructured qualitative data. The program permits dynamic coding (establishment of categories and the tagging of particular passages or words in the responses to one or more of these categories) of selected passages from the responses and querying of the data by category, by respondent and by other independent variables.

Analysis was framed initially under the four themes of the survey: benefit, problems, management strategies and career impacts (positive and negative). We then created hierarchies of nodes in NVivo to capture and categories all of the respondent comments from the survey that we deemed material, as in Chart 2. One of the benefits of the program is that these nodes are dynamic and can overlap: a respondent's comment, or part thereof, can be referenced by multiple nodes. This allowed us to explore responses both from the perspective of the individual respondent and their institutional affiliation, and the perspective of institutional setting or functional domain to which they attributed particular benefits or problems of centre membership. We then extracted views that seemed relate to the issues identified from the literature: the cost/benefit determination made by respondents – how they described the benefits of participation and decided that the benefits outweighed the costs; different forms of trust and how they were assessed; and governance of the centres and causes of and responses to dissatisfaction.

The choice of respondents' comments reported here is subjective, but we have tried to reflect the range of views and to balance disparate views where these exist. We note that the respondents' comments do *not* necessarily reflect the views of all respondents as reflected by the survey as a whole. The more disaffected respondents may be 'self-selecting', for example. However, this does not detract from the value of the results in highlighting potential problems for the management of the centres.

(Table 3 about here)

(Table 4 about here)

4 Findings

4.1 Drivers of centre participation

The motivating factors underlying individuals' choices to join CRCs concerned mainly intangible benefits. These included widening the range of scholars available for collaboration, better access to industry partners and working with a larger cohort of scholars with similar scientific interests. These expectations were expressed in similar terms by almost all participants, irrespective of their sectoral background. In short, the expectation of intensive research cohesion around a group of researchers from government, universities and industry was the main attractor for most participants in the survey. Respondents reported significant benefits in membership of their CRC. Indeed, two government researchers were

effusive: ‘my association with the CRC has been extremely beneficial and rewarding and I can think of few downsides to my participation in the CRC’; and ‘it is one of the best things that has happened for me’.

The CRCs provided material resources; both financial and human. Senior academic respondents nominated ‘money for continuing research activities’, with ‘greater stability and longer-term funding’ than available elsewhere. Government researchers mentioned funds for staff and ‘generous PhD scholarships’ and for research communication activities such as ‘opportunities for conference attendance/workshop participation not otherwise supported by my organization’.

Most benefits identified were intangible and came from the interaction with partners in the CRC. Comments praised the value of peer relations with researchers in their own field: ‘membership in a group of otherwise disparate scholars’; ‘a spirit of belonging to a broad research community’; or simply ‘access to ideas’. These contacts were either unavailable through their home organization, or more difficult to arrange: ‘If I weren’t associated with the CRC I would be working mostly in isolation’ said a postdoctoral researcher. Some researchers reported a significant cost in *not* being part of a CRC, because it provided an element that was otherwise missing from the respondent’s ‘scientific domain’.

The CRC not only embedded the researchers in their peer groups, it also helped them to broaden their research perspectives through positive interaction with scientists working in other disciplines. For one academic environmental scientist, it ‘opened up my eyes to a different approach to research’.

Other benefits nominated by both academic and government respondents were directly related to their own careers and capabilities. This ranged from employment to assisting with career progression: ‘greatly increased scope and confidence...in applying for senior jobs’; or other personal goals: ‘promised opportunities to remain in a rural town’; ‘spin-off company giving broad experience and consulting work post-retirement from the university and CRC’. Involvement with the CRC led to new personal skills, notably in management and leadership. It ‘allowed me to fulfil or expand [my] scientific management aspiration’ explained a government agricultural scientist); gave one respondent a ‘better understanding of IP management and commercialization’; and for an academic, ‘got me to work more efficiently (to meet deadlines)’.

Comments also related to consolidating or changing participants’ research direction. Several respondents commented on the value of closer relations with industry, and provision of a business or commercial focus for their research. One late-career researcher gained a

‘wider view of my research area, especially with respect to application of results in industry’. The CRC allowed one ex-government researcher to ‘continue to undertake research in the same field as that for my PhD’. For a senior government researcher, ‘networking and identification of other commercial/clinical areas have re-focused my research career’.

Benefits for research groups within the partner organizations were also identified. CRC involvement provided a ‘means of uniting the interests of [university] departmental members who would otherwise have quite disparate interests’. For one government researcher, the ‘program [gave] a strong strategic focus for a major research group in [my organization]’. Others found that improved status and recognition had resulted: ‘a useful lever to get better support within my organization’; and ‘the CRC has increased my visibility among peers and industry partners’.

The benefits identified by respondents were varied, but they overwhelmingly related to the domain of ‘science’ and the quality of the research they personally, and within their immediate research groups, were able to do. They valued the improvement in their interaction with the scientific community, the perspectives that researchers in other disciplines and institutions brought to *their* research, and the view of ‘different ways of doing things’ that interaction with commercial firms gave to *their research*. They were closely aware of the personal benefits to them as career researchers, for continuing the kind of work they found productive, extension of their skills and career prospects, and their standing within their institution and the scientific community. While they valued the cohesion that the focus of the CRC work gave to their research group or department, they rarely expressed benefit in terms of advantage to their organization *per se*. Their perspective of benefit was almost solely on what we might term the ‘scientific’ and ‘academic’ domains.

This ‘science-based’ view of the benefits also influenced our respondents’ views of the costs of participation. Broadly, anything that distanced them from the network of high quality researchers, or diverted them from their own research, was seen as a cost. These costs emerged when we looked at the role of trust and competition in developing a cohesive group identity for the centre.

4.2 Negotiating centre identities

Like many new organizational structures newly established CRCs undergo a period of organizational identity building. Drawing the constituent elements into a coherent organizational culture is, in a sense, a community activity. Building trust, negotiating

priorities, and steering a common course through potential rewards and risks are all part of this process. The impression of the centres received from the respondents' comments is one of a rather fragile coalition of interests. The 'glue' that holds this collaboration together is firstly mutual trust between the participants, and, second, a range of formally agreed activities and rules.

4.2.1 Perceptions of trust

Both trust in competence and trust in intention (Nooteboom 2000) were important in the minds of our respondents when describing relations with their partners in the CRCs. Competence expressed itself particularly in respondents' assessment of the quality of the researchers in the collaboration:

Inconsistent calibre of researchers—the CEO was not in a position to tell research agencies that their researchers were inappropriate (because of their skills or performance) the CRC had to adopt a 'lowest common denominator' approach. It was slowed down by its weakest members (CRC survey respondent, 2005).

In the view of another respondent, 'company members supply their second-level staff'. Initial selection of partners was seen as crucial, and yet a government respondent made the criticism that the quality of the researchers appeared to be a secondary consideration:

The university with the most knowledge may not necessarily be working on the project. Who is doing the work is more likely to be the uni that initiates the proposal (CRC survey respondent, 2005).

Respondents also identified partners as unable (rather than unwilling) to manage themselves to deliver appropriate inputs, rather than lacking in scientific competence: 'lack of vision by industry partners' said a senior manager of the CRC, and 'very little feedback on the adoption of research outcomes by industry/partner agencies/stakeholders' commented a senior government researcher. Criticising a specific government agency, one respondent claimed:

...[named agency] is the bureaucracy-laden, meetings/talkfest focused organization, not the CRC; CRC staff are too busy doing what industry actually wants and thereby get another term to waste the amount of resources [named agency] staff do (CRC survey respondent, 2005).

Generally, however, failings by other partners resulting in 'competition at the expense of collaboration' were interpreted in terms of the party's self-interest and lack of commitment, rather than their incapacity. Both individuals and organizations were nominated as opportunist and unwilling to collaborate openly and fairly: 'certain individuals from other

academic institutions [forgot] that the first ‘C’ stands for cooperative’; and ‘some institutions are NOT ‘cooperative’ said several academic respondents.

In summary, respondents lost faith in their partners when they were: (1) viewed as poor quality researchers, (2) viewed as incapable of delivering knowledge, results or feedback, or (3) seemed to lack commitment to the ethos of cooperation or were perceived to be pursuing their own ends.

Two factors commonly mentioned that led to this lack of trust were: (1) inadequate commitment of resources (usually people and money)—either actual or perceived (or unverifiable), and (2) domination of or undue influence on the direction of the collaboration or of the potential rewards. Academics and government respondents suggested that the way that CRCs were structured made it difficult for partners to assess whether each other was ‘pulling their weight’. ‘Costing models between partners are wildly different and project budgeting is a major source of mistrust’, said one. Reneging on commitments was viewed seriously: ‘ensuring in-kind contributions match commitments’; ‘multi-partner programs are unwieldy when [the] percentage commitment of individual staff is low (<30%) and overridden by host institution priorities’ were raised as problems. ‘Inflexible and one-sided IP arrangements’ were also viewed with distrust as a form of self-interest.

The factors contributing to the maintenance of trust *between partners* appeared similar to other IORs, but judgments of trustworthiness were made more difficult by the inherently unmeasurable nature of R&D outcomes and difficulty of assessing the actual level of resources (particularly ‘in-kind’ staff time) actually being committed by the partners. The actions that seemed to be regarded as most trustworthy were: being able to carry out quality research, exchanging information and knowledge, executing agreed tasks and generally being accommodating to and cooperative with other partners.

The challenge to both individual and institutional participants in the centres was to ‘make stronger efforts together to achieve the main aim’ and acknowledge ‘each other’s needs and goals’, in the view of one CRC employee; or simply, ‘to learn how to cooperate rather than compete’ by a university-based respondent. In the following section, we consider what implications these views have for the governance of CRCs.

4.2.2 *Perceptions of governance*

The role of governance is to unite the CRC around agreed strategies and to reconcile various goals. There is also formal obligation to report to the partners and the funding agency on research projects and outcomes. Surprisingly, respondents were quite ambiguous about the

governance of the centres and regarded these activities as unnecessary costs. Many found administration frustrating, cumbersome and burdensome. 'Transaction costs are very high' and 'there is a large administrative cost linking different institutions'; 'dual reporting needs', were typical responses when asked about problems with the management of the CRC. Transaction costs were viewed as more onerous than with alternative forms of research support: 'compared to an [Australian Research Council] grant, a CRC has a much greater administrative cost and suffers from the possibility that the funds can be altered through the life of a project' commented a senior academic. Respondents found the CRCs cumbersome and unresponsive in more commercially-oriented activities too: 'slow processes with regards to commercialization, licensing and marketing' charged one information technology academic.

Respondents commonly criticised the centres' (and the program's) governance activities because of their detrimental effect on research. The management burden distracted them from their main concern of carrying out research: a 'massive percentage of funds spent on administration rather than research'; and, 'the CRC reporting requirements strongly impinge upon research time and activities' were typical claims. Another academic was annoyed about 'arbitrary decisions to reduce committed funding to enable 'communication'.

A further point of contention was the 'politicking' and power relations within the centres. As one senior academic succinctly put it: 'if you can capture the centre, you are provided for; if not you are marginalised'. 'Autocratic leadership; high staff turnover; lack of communications; lack of transparency on employment of researchers' were some of the specific problems listed. 'This is not a collaborative organization...internal politics rather than rational assessment of priorities determines resource allocation'; and administration seemed 'pointless', with 'no management feedback even to project leaders' claimed two academic respondents.

Some respondents felt ignored, 'I do not have much say in the affairs of CRC. I know I have the capacity to contribute more but no takers'. Others felt controlled, 'we get told what to do', or even coerced: 'many of us were put in the [nominated] CRC by senior [university] management without any discussion in order to meet...targets shown in the proposal. Most of us were not even aware of the proposal, nor asked if we wished to be involved... Attempts to be removed from the [nominated] CRC were met with threats of dismissal'.

Two main findings emerge. The first is the 'coordination burden' or increased transaction costs of complex cross-sectoral, multi-organizational collaboration. Respondents

expected their 'CRC experience' to be about research, *not* about administration. This was particularly felt when feedback and communication were lacking. The second is the expectation of collegiality and cooperation in the governance of the centres. The respondents demanded a strong say in the strategy and running of the CRC and were unhappy when they were not consulted and engaged.

Negotiating a CRC 'identity' is revealed as very much a collective process. But it is not simply generating a coalition of interests from participating partner organizations. It is a social process of defining boundaries: who we are; what we do; what is acceptable and what is not; who is in and who is out. It is these very individual definitions as much as any organizational expectation that drives centre identity building.

4.3 Resolving competition

To the extent that individual expectations are part of the 'centre building' process there are likely to be conflicts of interests or divided loyalties, particularly among those on part-time secondment to CRCs. As noted, researchers generally commit only part-time to the CRC and remain based in their 'home' organization—their university or government laboratory. This led to respondents' experiencing the symptoms of 'role strain', identifying overload and 'divided loyalties as an issue, particularly with long running CRCs'. Having two masters made it harder to work within the CRC framework than on projects which were less complex in structure, as one government researcher observed:

It is a constant challenge to meet the multi-layered management requirements of both [the home organization] and the CRC. There is potential for both conflict and administrative overload, which makes CRC participation significantly harder work (albeit rewarding) than simply working 100% on [the home organization] projects (CRC survey respondent, 2005).

Another government-based respondent interpreted this as losing control of the project:

...organizational commitment to allowing time (that is, having time left over from other organizational duties to dedicate to CRC projects) which means much of the running of the projects is necessarily left to university researchers (CRC survey respondent, 2005).

'Interaction with parent institution' and 'an inherent problem of split loyalty between the employer and the CRC' were identified as problems by a large number of respondents: '[it is] difficult to know who is the master, the CRC or [the partner]'. A senior manager employed in a CRC, saw it more starkly: 'their host organization always dominates the researcher priority as that is who promotes and pays them'.

Several sources of conflict were identified. The first was competition for resources—primarily researchers’ time between the work of the CRC and the work of the parent organization. Researchers felt pulled between their ‘regular job’ and their commitment to the CRC: ‘meeting deadlines due to ‘normal’ core commitments’; and ‘too much of my time spent in managing researchers and contracts for the CRC’. But rather than seeing the issue simply as one of individual choice, they criticised their organization. One academic complained that ‘my university/school has not honoured my in-kind contribution to the CRC’. A government researcher similarly observed ‘I was a program leader in the CRC. I don’t think I was properly supported in the role by my own organization’. Researchers had chosen to work with the CRC and expected their employer organization to support them and to manage any conflicts. When the organization did not, this competition for resources could affect researchers who were not affiliated with the CRC, and give rise to competition *within* the partner organization, as in the case of this university:

The CRC research and time commitments done by faculty in our school who have contract agreements is being subsidised by another faculty. This is because no [money] was given to the school to cover the teaching and administrative responsibilities of these faculty members. It has led to a major rift within our school and has severely impacted the ability of non-CRC committed faculty to engage in research (CRC survey respondent, 2005).

The second conflict was between the ways that CRC acted and the practices and norms of the partner organizations. A senior manager in government characterised this as a ‘clash in management ethos between [the CRC’s] CEO and the practice of the participating organization’, while a CRC manager commented on the participants ‘interfering with management structures of other parties’. This was found in communication, timing of activities, accepted protocols for supervision of research students and so on: the ‘CRC attempts to control [postgraduate] students with no regard to supervisors’, claimed a senior academic; while a senior government researcher countered:

[The] main work force in CRC [is] derived from PhD students. This leads to a conflict between research and commercial priorities. Students need to do work to complete their PhDs whereas industry is focused on producing products (CRC survey respondent, 2005).

Another academic respondent welcomed ‘funding for students’ as a benefit, but noted that ‘regrettably [the funding] does not go through university channels’ and thus did not earn matching funds from university block grants for research.

A particular conflict was identified between the work of the CRC and the reward structures of the partner organization. This could have a direct and immediate effect on the

career of the researcher if the researcher's service was not recognized by the partner organization:

When my contract with [nominated agency] expired...I had worked for the organization [for more than seven years]. However, I was advised I was ineligible for 'indefinite' appointment because I had been a CRC associate employee for most of this time! So no, I got no benefit from being a CRC employee with [nominated agency] (CRC survey respondent, 2005).

In many cases, as an early-career researcher employed by a CRC observed, 'researchers in CRC do not have [a] clear career path'. Often, the impact was more subtle. 'The research success of an employee in a CRC project may not necessarily be properly acknowledged by the employer' said a semi-retired respondent. Another, seconded to a CRC at a senior level, found a 'complete disjoint between performance appraisal by my employer and my actual work in CRC'.

Conversely, the requirements of the CRC might prevent or stifle peer recognition of the researcher, either by their employer, or in their wider scientific peer group. Two areas specifically identified were: (1) constraints on free publication and (2) access to prestigious research grants from bodies such as the Australian Research Council (ARC). Several academic respondents nominated 'publication restrictions' and 'delays in publishing while CRC makes decisions about IP protection'. Another academic who had experienced publication delays lamented, 'the short-term objectives of the CRC are destructive for an academic career'. Ineligibility for ARC funding in particular was hard felt by academics. It potentially hampered recruitment to the CRC and collaboration with researchers outside the CRC, as a senior government researcher noted:

Academics on ARC funding [are] very unwilling to collaborate lest ARC and CRC support is seen to mix—a number of very exciting and important collaboration opportunities [were] lost as ARC funded researchers were unwilling to 'risk' their ARC support by taking benefit from CRC projects (CRC survey respondent, 2005).

Because CRCs bring together research and commercial interests, it is not surprising that a further field of conflict within the CRC can be a philosophical clash between the rationale of CRC and its industry partners and the norms of 'science'. This may not adversely affect immediate rewards, but some researchers clearly felt uncomfortable about the direction of the CRC and the balance of its activities. Comments by academics on particular CRCs included: 'too much emphasis on commercial outcomes and not enough emphasis on research'; 'lack of scientific vision —short-term objectives prioritised'; 'suppression of truly innovative basic research'. Conversely, a senior government researcher charged that 'some academic researchers [are] biased against 'applied' CRC research'. Criticism was also made

of the program as whole: ‘if the Science is left out in favour of commercialization issues I believe the image and product of the CRCs will suffer considerably’ said an environmental scientist working for government agency.

Some participants reacted personally to these problems. One ex-industry researchers suggested that ‘evasion’ takes place:

The CRCs message as conveyed by the CEO, the Executive Research Committee and the relevant program coordinator has been effectively ignored by project leaders, who have been protected by their institution’s management (CRC survey respondent, 2005)

‘Exit’ is an option too. Several respondents reported that they were quitting. An early-career academic commented, ‘my attempts to maintain an external collaboration tore me apart (double management reporting presentation etc) so much that I am leaving this job with the CRC to take a regular funded position overseas’. Others had ‘decided not to participate in other CRCs’, or, more forcefully, ‘it has clarified my directions—I never want to work with one again’. At the organizational level, selective exit was considered: ‘Some projects were withdrawn from the CRC so that a higher level of external investment and low level of encumbrance could be achieved’ revealed a senior government manager.

In highlighting these different aspects of competition we argue that they reveal different ‘functional domains’ that co-exist within the centre and across the partner organizations. Individual participants’ expectations are formative in defining these domains – for example, adherence to the norms of science, or expectation of advancement in an academic career – but their management and interrelationships are matters for the organizational partners. Without effective institutional management, individual participants have little redress but withdrawal.

The survey comments reveal that participants have a clear expectation of the benefits that their centre membership will provide, clear benchmarks on how to assess their collaborative partners behaviour, and strong ideas on how the centre is run cooperatively with the least administrative burden. When it came to identifying the problems with collaboration there is multiple evidence of competing performance demands, ‘divided loyalties’, lack of awareness of performance measures in partner organizations, lack of a career path, hampering of access to publication or funding opportunities, and lack of a fundamental or longer term view of research. This provides evidence of both individual and institutional ‘role strain’. It also suggests that the risks of collaboration are borne both by the individual researchers and by the institutional partners. The individual feels this risk to their

career trajectory – whether being tied to unproductive research, or out of a job - while the institution considers opportunity costs and detriment to other staff or activities.

5 Conclusions:

5.1 Negotiating open science, trust and careers

The chapter distils the views of more than 200 participants in a particular form of cross-sector research centre in Australia. We conclude that the working environment and sustainability of such centres cannot be understood by looking solely at the individual choices of researchers, nor solely at the strategies of the partner organizations. Both are formative, and both, in turn, are influenced by the broader institutional and policy contexts in which they operate. In highlighting important management issues which have been recognized generally within IORs and illuminating these with the views of the CRC participants we aim to improve the management of the dynamic organizations that are collaborative R&D centres. The IOR perspective is useful in emphasising the role of trust in loosely collaborative relationships, the ambiguity of formal governance, and the co-existence of organizational ‘functional domains’ which have the potential to compete or conflict. These are issues that have not been ignored in relation to cross-sector R&D, but have perhaps been under-researched.

Our respondents tended to see the benefits of the CRC first in terms of advantage to their own research career and second in terms of the ‘scientific’ domain in which their career resided. Their most immediate concern seemed to be that of their own career—how they were able to perform their research, their conditions and rewards—their prospects for advancement. They regarded as a cost or a burden anything (administration, reporting, short-termism, constraints on publication) that diverted them from their research career. At the same time, the presence of commercial partners and the government’s goals for the CRC program, which imposed a commercial imperative on the collaboration, was not unwelcome in itself. In this sense our findings are unremarkable: the respondents’ expectations are not that different from those found in other research groups ‘at the interface of, university research’ (Harvey, Pettigrew and Ferlie 2002). What our findings do show is that CRC researchers frame their identity primarily in terms of a culture of open science, built on the quality and validity of research performed, which is ensured through public sharing of knowledge (Liebeskind and Oliver 1998; Ziman 1991).

The second conclusion we draw is in relation to the importance of informal ‘trust’ by comparison with formal governance of the centres. Respondents were quite clear in the

importance they attached to their research partners' competence and commitment. However they were far more ambiguous about the governance and coordination activities of the centres. There are two ways of looking at how cooperation can be ensured: (1) a social theory approach—reciprocity, mutual forbearance, relational trust (based on experience); and (2) using transaction cost economics—with the concept of opportunism (not acting cooperatively), and monitoring of performance, sanctions (legal punishment, penalties and so on) (Menard 2004; Handy 1995; Nooteboom 2000). While the level of administration and reporting in the CRCs might imply the latter approach, in reality, any form of imposed sanction was viewed by respondents most unfavourably. Thus, although the collaboration between the partner organizations is contractual (because they are legal entities), its implementation and enforcement at the level of the department and individual researcher appears to be informal. This raises the question of effective coordination in a multi-institutional environment, where the partners and individual researchers essentially remain free agents, despite contractual commitments.

Respondents were clearly expecting reciprocity in the degree of commitment and expertise, provision of resources and information, forbearance of different ways of working and an absence of opportunism. Any evidence of a breach caused respondents to become less enthusiastic about the centre, and sometimes to quit the CRC. Monitoring of performance might have helped to identify breaches, but there were few sanctions that could be applied on one partner by another. The only sanction therefore was to withdraw, or threaten to withdraw, from current or future collaboration, thus breaking the durability of the relationship.

The findings support the need to consider closely the 'costs of coordination and relationship development in these collaborations' (Cummings and Kiesler 2005:704). But in contrast to Cummings and Kiesler's claim that greater trust and respect is associated with more frequent communication, respondents in our survey did not universally applaud effort on formal 'communication activities'. Further research is clearly warranted on how formal activities within the centres can buttress rather than undermine construction of trust between the partners in different settings.

Lastly, our findings suggest the existence of a range of tensions and competing demands within cross-sector R&D arrangements which go beyond the notion of individual 'role strain'. Certainly individual scientists may become torn between the objectives of their own academic 'identity', the norms and requirements of their university department and scientific discipline and the mission of the CRC. Our survey shows that many of the

participants will not accept a high 'power distance' and expect to be allowed to behave in an 'individualistic' manner (Hofstede and Hofstede 2005) in relation to their scientific creativity. These tensions imply an institutional as well as an individual response. For example, if we consider the management problem of 'threat of exit' we need to recognize that this 'threat point' can occur at different levels. It is possible for a researcher (academic level) to decide to or threaten to withdraw from CRC participation, even though continued participation may be to the benefit of their discipline (scientific) or laboratory/university (organizational).

Managing an organization like a CRC requires recognition of the needs of these different functional domains and relationships, as well as an understanding of the competition that they provoke. This includes the potential for conflict internally over governance and strategy and between the CRCs and the norms and practices of the contributing partners. Intangible benefits and their implications for individuals' careers are important factors that motivate researchers to participate in CRCs. Organizational partners are usually seeking more tangible outcomes although they too are also motivated by the potential for enhanced scientific prestige. As centres endure some of these expectations are met and some are not. Individuals and organizational partners will continue to negotiate the costs and benefits of meeting their expectations. As the process unfolds for individuals and organizational partners some will come and some will go. Consequently it is likely that while there are conflicts of interest to be resolved the centre identities will continue to be renegotiated.

We have shown that the experience of researchers in CRCs is coloured by influences operating at several different levels. First is the broad national policy environment. CRCs are funded under a federal government program, in place for over two decades. Over this period, government funding has remained relatively static in dollar terms. These funds have leveraged increasing contributions from other participants, notably industry and universities. The funding guidelines for the program, and government rhetoric, have reflected changing currents in the policy debate over the function of such cross-sectoral R&D centres, and have led to several significant changes in direction and focus for the centres. Unrelated to the CRC program, but affecting it have been other shifts in the national system, such as the declining role of government laboratories and the growth of the university sector. As a consequence the role of government as a research partners in the CRCs has declined substantially.

Second is the immediate institutional, scientific and sectoral context of the particular CRC. Universities will adopt different approaches to managing their involvement in CRCs. The drivers and performance measures of CRCs in the medical prosthetics or growth factors sectors are quite different from those of centres in Aboriginal health or greenhouse gas accounting.

Lastly is the immediate organizational management of the CRC itself and the relationship between its researchers and with its partners. The Australian CRCs embody many features of ‘Mode 2’ collaborative science, with its flexibility and ability to respond to contextual changes in science itself and in the application of science. Indeed it may be counterproductive for individual CRCs to become entrenched. However, if the important role of cross-sectoral collaborative R&D centres is to be retained without damage to the science and innovation system as a whole, the ‘academic’ and ‘scientific’ domains that we describe must be nurtured, not eroded. This may require new styles of management, by the CRCs themselves and their participant organizations, which recognize the knowledge resources—the scientific disciplines and careers of individual researchers on which they are founded.

5.2 Broader policy implications

It has been claimed that one of the outcomes of CRC funding has been their formative role in acting as agents of change in the university research system. The question is important because as government sponsored collaborative research programs have expanded so too has their potential to transform career patterns of researchers, the disciplinary boundaries in universities and the organizational structures and regulations that govern them. The current review suggests two further lines of investigation. The first is the effect of scales and forms of organization on cross-sector R&D outcomes while the second is in relation to the dynamics and sustainability of cooperative centres.

Scale and forms of organization constrain the management issues. For example, in European studies (Jacob 2000:25) the question of ‘is Mode 2 research worth it from the individual researcher’s point of view?’ is couched in terms of disadvantaged ‘contract’ researchers (in the centres) on the one hand, in contrast to well-resourced ‘tenured’ academics (in traditional university departments) on the other. In the Australian CRCs the situation is more akin to the US model described by Boardman and Bozeman (2007) where researchers face competing demands. The majority of academic researchers retain their existing university position, and agree to commit a proportion of their time to the

collaboration. Similarly, government researchers are not seconded to the CRC but remain employed by their partner organization. Relatively few researchers (with the exception notably of postdoctoral fellows) are employed directly by the CRC itself. In this regard, CRCs are perhaps atypical of cross-sector R&D centres which directly employ staff or second them full time on contract.

It also raises the question of how durable the cross-sector R&D organizations are and how their management can change over time. On one hand, this form of organization is becoming more dominant. On the other, the collaborations need to remain flexible and responsive with ‘ceaseless reconfiguration of resources, knowledge and skills’ (Gibbons *et al.* 1994:47). CRCs are not ‘cooperatives’ in the sense of being member-based, democratically controlled organizations. But they may start this way, recruiting voluntary participants in the bid for grant funding. In terms of Handy’s four organizational ‘cultures’ (power/role/task/person) they start as a ‘person culture’ and move into a ‘task culture’ once goals are agreed and funding achieved. This sequence implies a balance between cooperation and cohesion (which, to some extent, implies control), a view endorsed by Chompalov *et al.* (2002:752) who ‘suggest that collaborations be viewed in terms of the principle that ‘consensus precedes hierarchy’’. CRCs start as cooperative bids, but must develop more cohesion and coordination to be effective. The problems, as Nooteboom (2000) observes, is that if networks are too cohesive they may become exclusionary, and if too durable they create inertia. They may be very effective for particular well defined tasks, but in the process they lose flexibility and ability to change. At the extremes, two scenarios may play out in the life cycle of a CRC. First, is ‘disintegration’, where the ground rules are either too weak or not accepted or adhered to by all partners and individual participants. The second is ‘integration’, where the rules are so effective that they stifle change—perhaps for good reason, such as a focus on commercial production. We conjecture that CRCs that form as a stimulating cooperative research environment may change into a setting that some researchers find unproductive or frustrating to their science or their careers. They usually have the option of retreating to their ‘parent’ organization and leave the collaboration if the strain becomes too great. We were unable to make a longitudinal study of particular CRCs, although we were able to contrast the views of researchers who had been associated with the CRC program for shorter or longer periods. This speculative proposition therefore needs testing through further longitudinal studies of cross-sector R&D organizations.

Acknowledgements

This project was supported in part by an Australian Research Council Discovery Grant No. DP0211298, 'Managing the risks of cross-sector R&D collaboration'. We thank: Jörg Sydow for his helpful critique of an earlier version of this paper, which we presented at the European Group for Organizational Studies (EGOS) 22nd Colloquium, Bergen, Norway, in July 2006; Magnus Gulbrandson for productive discussion; four anonymous reviews for their comments; Denis Gray for helpful suggestions and Sarah Endacott for editorial advice. This chapter is an expanded version of Garrett-Jones *et al.* (2010).

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Table 1 Evolving CRC Program objectives over the 12 funding rounds from 1990 – 2010

1990-92	2000-02	2004-06	2009-10
<p>To support long-term high-quality scientific and technological research which contributes to national objectives, including economic and social development, the maintenance of a strong capability in basic research and the development of internationally competitive industry sectors;</p> <p>To capture the benefits of research, and to strengthen the links between research and its commercial and other applications, by the active involvement of the users of research in the work of the Centres;</p> <p>To build Centres of research concentration by promoting cooperative research, and through it a more efficient use of resources in the national research effort;</p> <p>To stimulate education and training, particularly in graduate programs, through the active involvement of researchers from outside the higher education system in educational activities, and graduate students in major research programs.</p>	<p>To enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;</p> <p>To enhance the transfer of research output into commercial or other outcomes of economic, environmental or social benefit to Australia;</p> <p>To enhance the value to Australia of graduate researchers; and</p> <p>To enhance collaboration among researchers, between researchers and industry or other users, and to improve efficiency in the use of intellectual and other research resources.</p>	<p>To enhance Australia's industrial, commercial and economic growth through the development of sustained, user-driven cooperative public-private research centres that achieve high levels of outcomes in adoption and commercialisation.</p>	<p>To deliver significant economic, environmental and social benefits to Australia by supporting end-user driven research partnerships between publicly funded researchers and end-users to address clearly articulated, major challenges that require medium to long-term collaborative efforts.</p>

Source: O'Kane, 2008; DIISR, 2010a.

Table 2 CRC Program funding and contributions by selection round, 1990 to 2006

<i>Contributions</i>	<i>A\$ million (current prices)</i>												
<i>Selection Round</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1994</i>	<i>1996</i>	<i>1998</i>	<i>2000</i>	<i>2002</i>	<i>2004</i>	<i>2006</i>	<i>Sub-total 1990 - 1996</i>	<i>Sub-total 1998 - 2006</i>	<i>Total</i>
CRC Program Funding	253.8	199.2	175.8	141.6	231.9	410.2	323.2	473.0	414.0	317.8	1,002.3	1,938.2	2,940.5
Universities	174.4	166.0	135.5	111.2	183.4	478.8	488.8	704.6	273.6	231.5	770.5	2,177.3	2,947.8
Sub-total Go8 Universities	140.9	85.3	61.9	37.8	77.2	278.4	302.7	278.2	124.3	73.8	403.1	1,057.4	1,460.5
CSIRO	143.5	96.2	115.8	66.0	98.1	196.2	141.5	101.3	109.2	32.2	519.6	580.4	1,100.0
Industry	113.6	61.9	69.5	72.5	176.0	303.9	195.5	456.8	230.6	253.6	493.5	1,440.4	1,933.9
Industry associations	18.5	15.8	3.9	24.6	22.2	45.0	72.4	62.6	69.3	71.8	85.0	321.1	406.1
Federal Government (excl. CRC Program Funding)	44.2	32.7	20.8	8.3	31.0	99.4	34.3	119.7	32.8	18.8	137.0	305.0	442.0
State Government	32.8	71.2	81.7	83.8	58.9	216.9	258.8	223.4	191.2	121.8	328.4	1,012.1	1,340.5
Other	63.9	16.7	3.4	15.8	95.3	75.5	32.6	206.2	9.8	104.0	195.1	428.1	623.2
Total contributions (excl. CRC Program Funding)	590.9	460.5	430.6	382.2	664.9	1,415.7	1,223.9	1,874.6	916.5	833.7	2,529.1	6,264.4	8,793.5
Total	844.7	659.7	606.4	523.8	896.8	1,825.9	1,547.1	2,347.6	1,330.5	1,151.5	3,531.4	8,202.6	11,734.0

<i>Selection Round</i>	<i>Per cent of total</i>												<i>Total</i>
	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1994</i>	<i>1996</i>	<i>1998</i>	<i>2000</i>	<i>2002</i>	<i>2004</i>	<i>2006</i>	<i>Sub-total 1990 - 1996</i>	<i>Sub-total 1998 - 2006</i>	
CRC Program Funding	30.0	30.2	29.0	27.0	25.9	22.5	20.9	20.1	31.1	27.6	28.4	23.6	25.1
Universities	20.6	25.2	22.3	21.2	20.5	26.2	31.6	30.0	20.6	20.1	21.8	26.5	25.1
Sub-total Go8 Universities	16.7	12.9	10.2	7.2	8.6	15.2	19.6	11.9	9.3	6.4	11.4	12.9	12.4
CSIRO	17.0	14.6	19.1	12.6	10.9	10.7	9.1	4.3	8.2	2.8	14.7	7.1	9.4
Industry	13.4	9.4	11.5	13.8	19.6	16.6	12.6	19.5	17.3	22.0	14.0	17.6	16.5
Industry associations	2.2	2.4	0.6	4.7	2.5	2.5	4.7	2.7	5.2	6.2	2.4	3.9	3.5
Federal Government (excl. CRC Program Funding)	5.2	5.0	3.4	1.6	3.5	5.4	2.2	5.1	2.5	1.6	3.9	3.7	3.8
State Government	3.9	10.8	13.5	16.0	6.6	11.9	16.7	9.5	14.4	10.6	9.3	12.3	11.4
Other	7.6	2.5	0.6	3.0	10.6	4.1	2.1	8.8	0.7	9.0	5.5	5.2	5.3
Total contributions (excl. CRC Program Funding)	70.0	69.8	71.0	73.0	74.1	77.5	79.1	79.9	68.9	72.4	71.6	76.4	74.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Leveraging (CRC Program funds: Contributions)	2.3	2.3	2.4	2.7	2.9	3.5	3.8	4.0	2.2	2.6	2.5	3.2	3.0

Source: O'Kane (2008), Appendix 4

Table 3 Demography of survey respondents

<i>Sector of employment</i>	<i>CRC</i>	<i>Higher Education</i>	<i>Government Research ^(a)</i>	<i>Government Other ^(b)</i>	<i>Other ^(c)</i>	<i>Total</i>
Number of respondents	34	196	78	43	19	370
Proportion of respondents	9.2%	53.0%	21.1%	11.6%	5.2%	100.0%
Number of respondents answering open-ended questions	18	108	45	23	12	209
Proportion of respondents in category answering open-ended questions	52.9%	55.1%	57.7%	53.5%	63.2%	56.5%

(a) A government organization whose primary purpose is research

(b) A government organization whose primary purpose is other than research

(c) 'Other' includes currently unemployed respondents, private consultants, staff employed by business subsidiaries of the public organizations etc.

Table 4 Example of hierarchical ‘nodes’ used in NVivo coding of responses

1.	Problems
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1.1.	Between partners
1.1.1.	Trust
1.1.1.1.	Competence
1.1.1.2.	Intention/opportunism
1.1.1.2.1.	Attitude
1.1.1.2.2.	Funding/resources
1.1.1.2.3.	Control/domination

1.2.	Within home organization
1.2.1.	Resources/time
1.2.1.1.	Lack of support
1.2.1.2.	Competition for resources
1.2.2.	Rewards
1.2.2.1.	Lack of recognition

1.3.	In management of CRC
1.3.1.	Transaction costs, bureaucracy
1.3.1.1.	Burden of reporting, dual reporting
1.3.2.	Conflict with norms of science
1.3.2.1.	Publication restrictions
1.3.2.2.	IP ownership
