



# Australia's Cooperative Research Centre Program: A transaction cost theory perspective



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## ABSTRACT

Cooperative Research Centres (CRCs) in Australia are underpinned by funding from the Australian Government. Among their many goals, they are intended to lead to long-term sustainable relationships between industry and academic institutions without the need for further public funding. Yet concerns have been raised in various reports and reviews about the ability of CRCs to achieve sustainable collaboration beyond their initial seven-year life, despite the general observation that CRCs have proved beneficial to the broader Australian community and the economy in general. This study adduces Transaction Cost Theory to determine the impediments to long-term sustainable collaboration between industry and academia. It does so by examining relationships between CRC members at a member organisational level, rather than at an individual researcher or program level, as previous studies have done. The article concludes by introducing testable governance attributes that have the potential to minimise transaction costs between participants in industry-academic collaboration and therefore foster long-term research collaborations.

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## 1. Introduction

There has been significant recent debate about the place of government-funded collaborative research in Australia. In particular, the ability of the flagship vehicle for collaborative applied research between the university sector and industry, namely the Australian Government's Cooperative Research Centre (CRC) Program, to deliver financially sustainable, long-term engagement between the two sectors has been questioned. Indeed, the CRC Program has been criticised in a number of official reports, such as the [Commission of Audit Report \(2014\)](#), the [Productivity Commission \(2007\)](#) and the [O'Kane \(2008\)](#) review. For example, the [Commission of Audit Report \(2014\)](#) claims that collaborative research does not appear to rank highly on the agenda of industry, with Australian businesses not necessarily seeing the lack of collaboration with academia as an impediment to innovation ([ABS, 2012](#)). These pessimistic thoughts would appear to have guided the Australian Government's recent decision to cut back the Program's budget by \$80 million. This move suggests that there is some doubt about

the CRC Program's ability to deliver what the Chief Scientist of Australia, Professor Ralph Slatyer, had in mind when he oversaw the Program's establishment in 1991, this being the creation of financially self-sufficient CRCs that, in time, would not require additional government funding ([O'Kane, 2008](#); [Allen Consulting Group, 2012](#)).

Numerous program reviews have demonstrated the broader economic benefits associated with the CRC Program (e.g. [Howard Partners, 2003](#); [O'Kane, 2008](#); [Allen Consulting Group, 2012](#)). It remains unclear, however, if the current CRC model is the most appropriate vehicle to achieve ongoing, financially sustainable collaborative relationships between industry and academia. In fact, [O'Kane \(2008, p. 54\)](#) observed that 'self-sufficiency has proven to be out of reach' and that 'there has been a potential for CRC energies to be diverted from the main game', which, of course, is the facilitation of interaction between universities and industry. The University of Queensland, in a submission to the National Innovation System (NIS) review in 2008, highlighted the alternative goal that a CRC's prime objective is survival as an organisation after the cessation of government funding, rather than the facilitation of interaction between universities and industry. Attempts at organisational survival rather than nurturing ongoing industry-university collaboration also adversely affect the Program's capacity to support innovation. This is because established CRCs crowd out new centres by re-bidding for CRC funding ([O'Kane, 2008](#)). From a

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national perspective, cross-sector specific grant funding such as the CRC Program, in addition to R&D tax concessions gained by businesses contributing to CRCs, may skew investment decisions by industries and only benefit the private sector, with 'the risk of providing support to projects with low potential spill-overs and those that would be undertaken in the absence of public subsidies' (Productivity Commission, 2007, p. 450).

In view of the above, a thorough investigation into the ability of the current CRC model to deliver longer-term collaboration between industry and academia is required. This, of course, is a problem that drives to the very core of contemporary debates relating to the role of universities in national science and technology (S&T) policy, the more so given that cross-sector collaborative research and development (R&D) has increasingly been promoted as a means to harness pre-competitive as well as mission-critical technologies by bringing together scientific and technical capacities (Boardman and Gray, 2010). Yet Australia's apparent underperformance in the intensity of collaboration between industry and universities, at least when compared to that of other developed countries (OECD, 2013), suggests that Australian businesses have been looking for research providers outside of academia, or have preferred in-house research to some extent. All this ostensibly suggests that the benefits of collaborative applied research to the entities engaging in the current CRC Program are not sufficient to cover the implicit costs to maintain ongoing relationships between academia and industry after the initial funding period has expired, at least without additional government funding. This article therefore aims to unpack the implicit costs associated with the CRC governance model using transaction cost theory (hereafter TCT). It also intends to propose a framework of broad structural prescriptions necessary for the development of genuinely sustainable research collaborations that do not rely unduly on government funding.

Of course, there are a number of studies addressing different aspects of the CRC Program on a policy as well as on an individual researcher level. For example, on a policy level, Turpin et al. (2011) provide a discussion of the genesis of the Program over time. On the individual level, studies focus on the benefits accruing to individual members of a CRC (Turpin and Garrett-Jones, 2010), industry participant experience (Couchman and Fulop, 2004), and effective incentive alignment (Garrett-Jones et al., 2005). However, to our knowledge, an organisational level of analysis has not yet been attempted. This study contributes two innovations to the literature on CRCs: (1) we peg our analysis at the CRC member organisational level, as opposed to the individual or Program level; and (2) we introduce governance attributes that would foster long-term ongoing research collaborations between industry and universities, with a particular focus on minimising transaction costs. In addition, the study makes a contribution to the research collaboration literature by extending on the policy-related lessons identified by Perkmann et al. (2013), p. 433, who suggest that 'policy should not implicitly assume that "more is better" but seek to differentiate the conditions under which engagement generates both academic and industrial benefits, so [sic] minimise the risk of failure.'

## 2. The Cooperative Research Centre (CRC) Program

Although it is difficult to pinpoint a single policy intent underpinning the foundation of the CRC Program, it is possible to position its beginning within a broader policy context. In 1982, the Australian national research centres program was launched with the objective to create linkages between university and industry, while, from the mid-1980s, university researchers were able for the first time to apply for industry-related research grants. These initiatives coincided with John Dawkins taking over the federal education

portfolio in 1987. One of his chief aims was to transform the Australian higher education sector so that it could be internationally competitive in a neo-liberal and increasingly globalised market setting, all the while allowing it to continue offering equitable and accessible education for Australian students.

Thus, the CRC Program was one of several measures that took place at the beginning of the era of mass education in Australia. In particular, the government of the day, driven by the then-popular economic rationalist agenda, aimed to direct research to meet national proprieties and to enable Australian universities to be internationally competitive with those of other OECD countries (Davey and Ware, 2009). In line with this, the Vice-Chancellors' Committee in 1988 called for an increase in collaborative research and stated that 'Industry must accept more responsibility for funding research projects and must recognise the value of funding R&D in Australia rather than buying technology from overseas' (Vice-Chancellors' Committee, 1988, p. 4). In addition, Dawkins identified a need 'to promote greater responsiveness within the university sector to both social and industrial needs' (Department of Employment, 1988, p. 90). In effect, the CRC Program was closely tied to a trend towards problem-oriented, cross-disciplinary research centres on an international scale, similar to program such as the United States' National Science Foundation Engineering Research Centres and the United Kingdom's Science and Engineering Research Council's Interdisciplinary Research Centres established in the mid-1980s (Turpin et al., 2011).

The Program's intent was to foster ongoing collaborative research between universities, government research agencies and industry partners (Davey and Ware, 2009), which is still reflected in the current CRC mission 'to undertake medium- to long-term industry-driven collaborative research' (CRC n.d.). According to Slatyer (1994), the CRC concept was designed to: (1) consolidate the disparate scientific and technological resources in Australia by creating a system of cross-sector collaborative research centres; (2) overcome the lack of large integrated research teams with targeting funding that allows members to retain separate institutional affiliation; (3) enhance the effective utilisation of research findings by involving research users and focusing on research areas that underpin existing or emerging sectors; and (4) ensure appropriate investment in future scientific and technological resources by an integrated educational program. Some of the Program-specific features include cash and in-kind contributions of CRC participants having to at least match the funds sought from the Program, and the establishment of an institution-independent intermediate management structure (Slatyer, 1994; Turpin et al., 2011).

The Program commenced by financing projects broadly affiliated with one of six industries (Manufacturing Technology, Information and Communication Technology, Mining and Energy, Agriculture and Rural-based Manufacturing, Environment; and Medical Science and Technology) with \$2 million p.a. from the Department, to be matched by an equivalent amount from university and industry partners for an initial 7 years, with a potential extension (Slatyer, 1994). By 2012, the Australian Government had committed more than \$3.4 billion to the Program. During the period 1991–2012, 190 CRCs were funded (Allen Consulting Group, 2012). Table 1 provides an overview of the contributions made over the period 1990–2006. The average size of the government investment in any CRC was \$21.5 million, while university and industry participants provided on average a total of \$6.6 million in cash and \$28.6 million in in-kind contributions (see Table 1).<sup>1</sup>

<sup>1</sup> These estimates have been made based on funding data available from O'Kane (2008) for the period 1990 until 2006. Funding data was converted into constant Australian dollars.

**Table 1**  
Average contributions per CRC or research participant over 1990–2006 (in constant dollars).

(in \$'000)	CRC level			Participant level		
	Cash	in-kind	Total	Cash	in-kind	Total
University contributions	2144	19,238	21,382	538	4824	5362
Industry contributions	4459	9335	13,794	719	1505	2224
Government funding	21,498		21,498	1353		1353

The most recent review conducted by the [Allen Consulting Group \(2012\)](#) revealed that some \$14.45 billion of direct economic impacts have stemmed from CRC-generated outputs, which includes nearly \$8.58 billion of impacts already materialised, together with a further \$5.87 billion of imminent impacts estimated to occur over the next five years. According to the same study, this figure understates the total benefit of the Program, as it does not include the value of collaboration and networks established, which could be leveraged for future gain. The Program's investment in R&D has reportedly created widespread benefits across all industries. These impacts have been assessed using a Computable General Equilibrium (CGE) model, which estimates a net economic benefit of \$7.5 billion over the period assessed – a contribution of around 0.03 percentage points to GDP growth per annum ([Allen Consulting Group, 2012](#)). Relative to the Australian Government's investment, the Program has reportedly generated a net economic benefit that exceeds its costs by a factor of 3:1 ([Allen Consulting Group, 2012](#)). The direct economic impact of a single CRC was, on average, \$45.6 million p.a. This compares to an average of \$5.8 p.a. of direct national contribution by US National Science Foundation Engineering Research Centers.<sup>2</sup>

Previous literature points to more specific benefits, such as the extension of research networks and the involvement of research users in the development process ([Turpin and Garrett-Jones, 2010](#)), together with the provision of training and career development paths for researchers ([Garrett-Jones et al., 2005](#)). There appear, however, to be drawbacks associated with CRC involvement, including overtly industry-driven research agendas and a resource strain on researchers who have to juggle their commitment to the CRC and to their host organisation ([Garrett-Jones et al., 2005](#)). These drawbacks could presumably be contributing to the perceived lack of financial sustainability of CRCs upon the conclusion of the initial funding period, with member organisations often not seeing the value of continuing their financial and in-kind contributions, at least at the same level. It appears that the benefits of access to a larger network, although valuable for early career researchers, increases the costs associated with coordinating negotiations on collaborative research objectives (i.e., negotiating a joint research agenda) and making choices regarding resources and resource use (i.e., time of researchers) – all of which limits the efficiency of larger structures. The following sections closely examine two important theoretical concepts relevant to this enquiry, these being the notion of collaboration in the arena of applied research and TCT.

### 3. Theoretical considerations in the context of collaborative research

There are a number of different forms of research collaborations, such as multi- ([Bordons et al., 1999](#)), trans- ([Gray, 2008](#)) or

cross-disciplinary collaborations ([Lee, 2000](#); [Jeffrey, 2003](#); [Bryson et al., 2006](#)), international scientific collaborations ([Guerrero Bote et al., 2013](#)), intra-disciplinary or disciplinary collaboration ([van Rijnsoever and Hessels, 2011](#)), and large-scale collaboration (big science, teams of teams) ([Scheirer, 2005](#); [Sonnenwald, 2007](#); [Bammer, 2008](#); [Lane and Robinson, 2009](#); [Zhao et al., 2014](#)), we are particularly concerned with defining the concept of government-funded university-industry collaboration, otherwise known as 'triple-helix structures' ([Leydesdorff and Etzkowitz, 1996, 1998](#); [Leydesdorff, 2000](#)). CRCs clearly fall within this category ([Turpin et al., 2011](#); [Garrett-Jones et al., 2013](#)).

Triple-helix structures differ from other forms of research collaborations such as international or cross-disciplinary collaborations because these university-industry collaborations involve non-academic parties. Therefore, performance of university-industry collaborations cannot only be measured on the basis of co-authorship, but also must encompass other dimensions such as the sharing and transfer of knowledge, skills and techniques and the translation of research into economically profitable output ([Katz and Martin, 1997](#)). In fact, there are a number of benefits associated with these structures, such as: (1) additional financing and access to equipment from a university perspective; and (2) access to cutting-edge research, new product and process development, new patents, and university graduates from an industry viewpoint ([Lee, 2000](#)). However, an inherently destabilising problem of triple-helix organisations is goal misalignment resulting from disparate cultures, in this case that of industry and academia ([Johnson and Johnston, 2004](#)). This can also lead to substantial lead-up costs embedded, for example, in the early negotiations for program focus and product share, which may prove prohibitive for the formation of such collaborations. This inherent instability in the nature of such structures highlights the need for a theoretical lens to explain the decision to expand, maintain or withdraw from a CRC, or a successor entity.

Such a theoretical explanation is currently missing, as most of the theories typically drawn upon only explain the decision to *enter* a collaborative relationship, and are less useful with respect to explaining why entities choose to either withdraw from or sustain the relationship. According to the literature on inter-organisational relations (IORs), for example, entities will form relationships with other entities that could assist them, with the type of relationship being dictated by its strength, from weak to tight ([Barringer and Harrison, 2000](#)). This is usually the result of resource deficiencies or a changing contextual landscape. In fact, resource dependency theory (RDT), which underpins the study of IORs, suggests that power is a resource that actors or groups of actors can use to establish a greater degree of certainty in the face of an uncertain external environment ([Benson, 1975](#); [Drees and Heugens, 2013](#)). Likewise, exchange theory posits that, when the external environment increases in complexity and there is additional uncertainty, networked relationships and collaborative practices will allow entities to enjoy benefits from reciprocity, with all parties involved recognising the interdependency of their relationships and their inability to succeed on their own ([Levine and White, 1961](#); [Oliver, 1990](#)). Yet, in the case of CRCs, industry partners have the option of choosing to collaborate with a university partner, or with a commercial research provider, such as a consultancy. In contrast,

<sup>2</sup> These estimates are based on the direct economic impact of CRCs Table C.1 of the [Allen Consulting Group \(2012\)](#) report and the [SRI International \(2008\)](#) report. Estimates for Australian CRC have been converted to constant US dollars to make them comparable to the amounts of the SRI report. Note, too, that the [Allen Consulting Group](#) report shows 18 centres, while the estimates from the SRI report are only based on 5 centres.

universities may seek collaboration in other sectors, with funding derived from collaborations with industry being essentially seen as a ‘top up’ to revenue derived from government and teaching activities. In short, both parties will generally not regard their relationship as one of genuine interdependence.

One might also consider institutional theory (IT), which proposes that entities will be pressured to adopt the structures of those actors in their broader operating environment that are perceived as having the greatest legitimacy (Oliver, 1990; Scott, 2000). Organisations will therefore collaborate with those regarded as having the greatest influence with respect to improving their wellbeing, with the rules, practices and norms of the more powerful actors being imitated, either willingly or coercively, in a process known as mimetic isomorphism (DiMaggio and Powell, 1983). In the case of CRCs, universities will align themselves with industry partners, with these entities generally being seen as future funding streams post-CRC. But universities generally fail to adopt the structures of these industry partners, particularly the requirement to complete tasks by a due date and in a format that allows easy implementation. Given that the majority of a university’s funding comes from government, universities, by way of contrast, are more likely to view government as the actor with the greatest legitimacy.

The theories introduced above primarily concern organisational relationships at the inter-organisational level, rather than collaboration per se. This study, however, is not simply interested in the way in which organisations initially align themselves and coordinate their activities; rather, our interest is on how organisations assess whether these activities are worthwhile, and determine which of their relationships are worth continuing. In light of the inability of the IOR perspective, with its emphasis on individual organisations, to explain what occurs within a collective form such as a CRC, another explanation is required. Given that the CRC context offers a unique setting to test relationship continuity based on the funding arrangements, we adopt the definition of sustainability put forward by Scheirer (2005), who proposes that a research collaboration is sustainable if it is *maintained* after the initial funding or other impetus is removed. This appears to be the view privileged by recent critics of the CRC Program. Thus, after initial funding expires, it is important to determine whether institutionalisation of research collaboration within a CRC can result in a continuing knowledge exchange between industry and university members. Indeed, previous work in the context of health science has questioned whether institutionalisation should be a goal of program development and delivery (Green, 1989).

Collaborative governance, with its emphasis on variables likely to predict the success of a collaborative venture, such as previous history, stakeholder incentives to participate, imbalances of power and resources, institutional design and even leadership (Ansell and Gash, 2008), comes close to answering our questions. In particular, it emphasises the necessity to establish ‘small wins’ – or pilot projects in the case of CRCs – that will engender deeper trust and a shared understanding, together with commitment, with these factors emerging as integral to the relationship’s success. Yet collaborative governance fails to address the inherent cost element of collaboration, which is surely an important, if not overarching factor, when deciding whether to persist with funding a research partnership. In addition, it is unclear whether the primal focus of collaborative governance is the longevity of the research collaboration, as collaboration success has been defined on a case-by-case basis (Ansell and Gash, 2008), and not on the ability of partners to continue working together, with attendant funding implications. An economic explanation that looks at the relative cost of working together through IORs such as CRCs is therefore warranted.

We propose that TCT lends itself to explaining this decision to continue putting resources into a collaborative relationship. Yet only one study has explicitly examined transaction costs in a

collaborative research setting (Landry and Amara, 1998). This study, however, used the individual researcher as the unit of analysis, even though macro-level theories such as TCT do not perfectly translate into the micro level. In addition, the study is not situated in the context of university–industry partnerships. We attempt, here, to fill this gap by applying TCT to industry–university collaborations from the member organisation’s perspective. Transaction cost theory is viewed as suitable theoretical lens compared to other theoretical considerations. For example, while RDT and TCT obviously share common predictions, Williamson (1991, p. 81) warns against the over-use of dependency arguments, for, if one applies the standard assumptions of TCT, entities working together will “anticipate potential dependency conditions and organise with respect to them from the outset”. This means that dependencies will be priced out, with a contractual response being implemented to ensure that dependencies do not come as a surprise (Williamson, 1991). This is clearly the case with respect to CRCs, in which an agreement with the Commonwealth and all constituent parties is concluded at the outset, with each collaborative project also being governed by a contract, so that all parties involved understand the nature of the resources being utilised in the collaborative arrangement in question.

#### 4. Transaction cost theory applied to collaborative research

TCT, which has been applied in the past to inform public policy related issues (Graham and Scarborough, 1997; Hill and Lynn, 2003; Quinlivan et al., 2014), provides a theoretical framework to explain the formation, switch and survival of institutions such as CRCs to accommodate a given economic interaction. TCT is a quite heterogeneous body of literature, with substantial differences in model assumptions and the resultant predictions. Here, we adapt a version proposed by Hennart (1988, 1993, 1994, 2008). According to Hennart (2008), there are two important aspects to TCT: (1) economic institutions; and (2) organising methods. Economic institutions are defined as a specific set of formal rules and informal customs that are efficient in organising transactions. This set of rules can range from pure anonymous market structures to highly formalised structures such as firms. According to the classification of university–industry relations advanced by Bonaccorsi and Piccaluga (1994), institutions that organise research collaboration can range from personal informal relationships (e.g., individual consultancies) to focused structures (e.g., university–industry CRCs).

##### 4.1. Underlying behavioural assumptions

Parties desirous of conducting joint research choose the economic institution that generates the greatest rent extracts from the collaboration. In this context, rents are the capitalised gains minus transaction costs. To clarify, the choice of institution is the result of the joint rather than unilateral maximisation of prospective rents by the parties *ex ante*. If rent maximisation was unilateral, no agreement would be reached *ex ante*. However, the *ex post* distribution of gains may differ from the distribution agreed upon *ex ante*. This is often the case in CRCs, where distributions are renegotiated after their formation when new parties join, which necessitates all existing parties to acquiesce and sign a new agreement.

Contrary to the assumption of no transaction costs (as found in neo-classical economics), costs associated with collaborative research, as with any particular transaction, arise as a result of three

quite different yet interrelated problems (see e.g., Williamson, 1981; Hennart, 2008; Feiock et al., 2009). These are as follows:

- Information problem: to inform parties about the existence of potential rents.
- Bargaining problem: to reduce bargaining over distribution of gains.
- Enforcement problem: to enforce terms of the bargain.

These problems are readily applicable to the broader CRC context. Explicit examples of each are: (1) the cost before lodging the CRC application (information problem); (2) the costs of negotiations and agenda-setting for projects on which the granted funds are to be spent once the CRC application is successful (bargaining problem); and (3) the cost of monitoring and performance evaluation (enforcement problem). These problems arise because the research collaboration partners are assumed to act opportunistically and are limited in their ability to make rational choices since they lack perfect foresight (see e.g., Noorderhaven et al., 1994).

#### 4.2. Economic institutions and organising methods

Transaction costs exist owing to the combination of these two behavioural assumptions. If one partner had perfect foresight, opportunism would clearly not matter as the other partner would be able to foresee opportunistic behaviour and act accordingly. Without opportunism, bounded rationality is immaterial, since the partners would not exploit the other's incomplete foresight (Hennart, 2008). Without these two assumptions, it would not matter how transactions are organised because no transaction costs would occur. These two assumptions clearly have validity in the context of collaborative research, particularly since knowledge generation offers ample room for opportunistic behaviour, which is difficult to monitor given the limited foresight of the collaborative partner.

To understand how these two behavioural assumptions lead to different structures (i.e., 'economic institutions'), it is necessary to distinguish between the two mechanisms (i.e., 'organising methods') devised to counteract the adverse effects of bounded rationality and opportunism, these being the existence of a price system and hierarchies. The price system mechanism enforces transactions by rewarding outputs, while the hierarchy mechanism enforces transactions as a result of monitoring behaviour. As a result, a price mechanism is usually found in market structures, i.e., where near-simultaneous exchanges takes place. To exemplify, a price system in a research collaboration setting context could be thought of as a research consultancy, in which a research contract specifically places a value or price on the outcome of the research activity in question. If outputs are costly to measure as a result of the interplay between bounded rationality and opportunism within a given transaction, the price system quickly becomes an inefficient mechanism, particularly if the focus is not truly long-term, given that genuinely long-term collaboration should result in lower transaction costs. In such cases, it becomes more efficient to structure transactions in the form of more formalised institutions.

Switching from informal research collaboration such as individual research consultancies to more formalised institutions initially reduces transaction costs. At first, the switch reduces the cost of measuring output ('cheating costs') as it alleviates the need to measure outcome and price *ex ante*. For example, a cost that arises owing to cheating behaviour is the cost of third-party enforcement of legally enacted research contracts in a research consultancy setting. However, the greater the behavioural constraints, i.e., the more formal the institution, the lower will be the partners' incentive to maximise output because their reward is no longer proportional to outcome ('shirking costs'). For example,

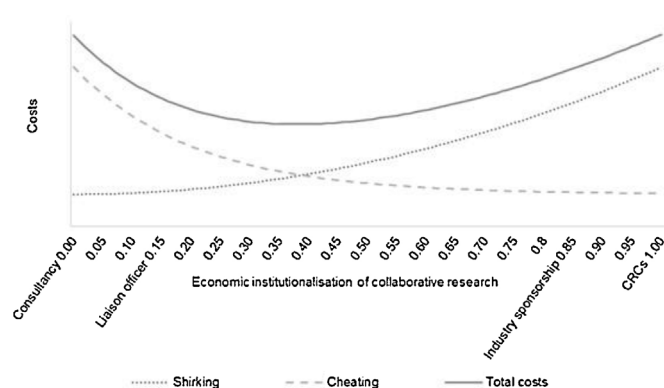


Fig. 1. Transaction costs in organising collaborative research.

researchers working for academic partners who are prevented by industry partners from publishing their research outputs in peer-reviewed media as a result of confidentiality issues are unlikely to give the project their greatest attention. With fewer behavioural constraints, and thus less hierarchy, academic researchers may be more likely to do quality work as their efforts are more likely to be rewarded through enhanced publishing opportunities, which are in themselves intrinsically linked to reward through career development.

Fig. 1, which is adapted from Hennart (1993) and uses the university–industry relationship forms suggested by Bonaccorsi and Piccaluga (1994), shows how transaction costs determine the choice of economic institution in the context of collaborative research. In CRCs, transaction costs consist mainly of 'shirking costs'; that is, underperformance, as researchers may devote less effort to assigned projects, especially if these do not align well with their respective research areas, or if these projects are accorded minimal priority in the researcher's actual (as opposed to official) workload. However, some residual cheating costs push total enforcement costs further up, as a result of the enforcer's inability to measure project output with perfect accuracy. Note that the curvilinear function of the shirking and cheating cost curves represent cost acceleration and, thus, diminishing returns the more loosely or more strictly the collaboration is structured. For example, the substantial increase in shirking costs in fully institutionalised collaboration such as in CRCs is met by only a marginal decrease in cheating costs.

In CRCs, cheating costs are assumed to be small as formal enforcement mechanisms are replaced by behavioural constraints, such as incomplete private contracts (i.e., contracts at the project level are said to be incomplete in the sense that the nature of research can be altered without violating the contract), or personal or network sanctions (Klijn and Koppenjan, 2000; Buskens, 2002). This means that there is less room for opportunistic exploitation of a price mechanism. One ramification is that, for most research collaborations, the optimal institutional solution will be a mix of price and behavioural constraints. It follows that government funding may distort a more efficient choice of organisational structure. This distortion effect is illustrated in Fig. 2, which compares the benefits of collaborative research organised within CRCs (solid line), with the transaction costs fully borne by CRC members (dashed line) and partially offset by government funding (dotted line). For simplicity's sake, costs are assumed to be fixed over time. In reality, transaction costs may vary over time, but only marginally so owing to the stationary nature of the cost driver ('shirking behaviour'). It is also expected that the benefits of CRC research collaborations (e.g., research publications, licenses, patents, etc.) will take time to build up and will reach saturation at some point. This is best reflected in a bounded growth function, as shown in Fig. 2. Here, the

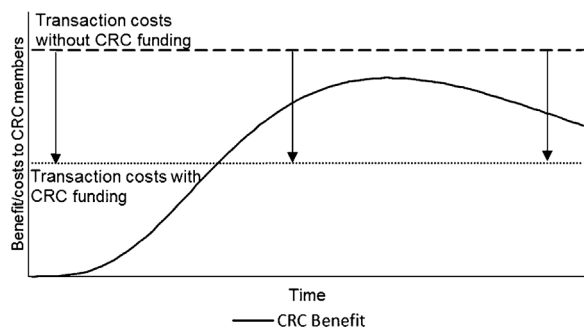


Fig. 2. Effect of government funding on perceived transaction costs.

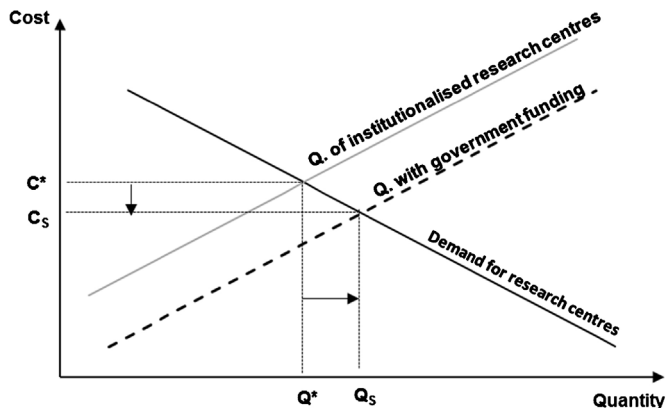


Fig. 3. Macroeconomic effect of CR funding.

benefits of institutionalising collaborative research within a CRC only exceeds the cost hurdle when government funding subsidises the overarching administrative and organising architecture imposed on collaborative research in CRCs.

From a policy perspective, the effect of ‘subsidised’ research collaboration becomes evident in Fig. 3, which shows that there may be a greater number of these Triple-Helix organisations than is socially beneficial as a result of the distortion effect of government funding on transaction costs. The government-sponsored funds therefore artificially depress the perceived ‘cost of a CRC’ from a macroeconomic perspective, which leads to an oversupply of these research entities.<sup>3</sup> In fact, Boeing Australia, in its submission to the NIS review (O’Kane, 2008, p. 54), noted that ‘CRCs are not the most efficient organisation for certain types of research charging far more for their work than it would cost if it were contracted out to a dedicated R&D organisation like CSIRO’. In addition, a member of the CRC committee described CRCs ‘as government-subsidised semi-commercial entities, aiming to eventually generate income for themselves and become self-sustaining’ (O’Kane 2008, p. 54).

The economic intuition presented above demonstrates the need to consider these implicit transaction costs when discussing the benefits of conducting collaborative research to determine the true value of highly formalised structures such as CRCs. In the following section, we use joint ventures, characterised within the TCT literature as highly formalised partnerships between private sector organisations, as an analogy to determine the nature of transaction costs likely to occur within the CRC landscape.

## 5. CRCs as joint ventures

In essence, a CRC is a member-owned research entity comprised of organisations from the private or public sectors, together with higher education institutions or affiliated research institutes. A board of governance composed of directors from the various, although in some cases not all, member entities of the CRC is usually headed by an independent chair, with the CRC’s CEO reporting directly to this board.<sup>4</sup> In effect, a CRC is a cooperative entity. In 2014–15, the majority of the 36 CRCs (31 CRCs or 81%) were incorporated as a separate entity (Cooperative Research Centres Program, 2014).

Within the CRC, private and public sector members are tasked with conducting collaborative research with the aim of pooling resources, and tacit knowledge in particular. In short, CRCs are comparable to companies creating joint ventures (JVs) to enter new markets. Like CRCs, JVs are established by two or more firms that organise their interdependencies through common ownership of an entity, with the overall aim of pooling resources. Again like CRCs, JVs are established because of difficulties in defining the boundaries of tacit resources, such as knowledge, which prevents the formation of enforceable contracts in an arm’s-length exchange (Gordon, 1992; Salanie, 2005). Yet, unlike JVs, CRCs require the formulation of contracts at the individual project level, once a project has been approved by the CRC’s board of governance. These contracts then have to be approved by the member entities participating in the project. This problem is bypassed in JVs as transactions are completely institutionalised in the relationship. In JVs, knowledge can therefore be shared without specifying a contract for each project. Despite this difference, CRCs can be regarded as constituting a joint hierarchical form, i.e., ‘a joint firm’, with the O’Kane review (2008, p. 36) even referring to them as ‘end-user focused research joint ventures’. Given this precursory evidence, CRCs might be expected to share most of the transactions costs associated with JVs, in addition to the costs that arise owing to some of the market-like features (such as project contracts) that differentiate CRCs from JVs. This suggests *prima facie* that implications drawn from research on JV transaction costs have a direct applicability to our understanding of transaction costs within CRCs.

Hennart (1988) argues that, within formal hierarchies such as CRCs, information costs may arise on account of their centralised information structure. A centralised information structure is required, since it is not possible for individual actors to reach a coordinated response given the amount of uncertainty involved. Centralised information structures, however, may result in sub-optimal decisions taking place as a result of: (1) separation of information collection and use, which impacts on the level of diligence and accuracy in information sourcing; (2) asymmetric information and information distortion; and (3) information overload for individuals making decisions (Hennart, 2008). Thus, it could be argued – leaving aside the *ex ante* costs for now – that CRCs, once established, are insufficiently flexible to exploit opportunities that may arise on account of their rigid information structures. These opportunities might have implications for the entity’s long-term financial sustainability. In fact, a significant proportion of the funds underpinning their establishment and operation are devoted to central administrative staff, which normally includes a CEO, a business manager and a research director, together with staff responsible for overseeing adoption and commercialisation, higher degree research (HDR) candidates supported by CRC funding, and intellectual property emanating from projects. All these features reflect the CRC’s centralised information structure. In addition,

<sup>3</sup> The term ‘cost’, as shown in Fig. 3, refers to the entirety of costs (incl. transaction costs) associated with CRCs from a macroeconomic or system-wide perspective.

<sup>4</sup> Board positions may rotate between the constituent members.

costs associated with holding dissemination events or workshops and publishing research outcomes can be viewed as information costs.

In hierarchies such as CRCs, the bargaining (i.e., the renegotiation of tasks and expectations) is mainly solved by authority. This is because, in hierarchies, agents are rewarded based on behaviour (Hennart, 1993), so they are more likely to accept directives in allocating tasks, thus accepting the authority of the supervisor or manager. Operating costs, which normally include arranging meetings between industry and researchers, as well as holding workshops, can be classified as such. When it comes to enforcement and monitoring, insights are gained by contrasting the mechanism of hierarchies against the price mechanism of less-rigid structures, such as research consultancies. Here, actors are rewarded in proportion to output, which means that the output must be easily measurable and verifiable (Hennart, 2008). When this is not the case, it will be possible for agents to ‘cheat’, i.e., to overcharge the buyer or underperform on the dimensions of the transaction that are difficult to measure (Hennart, 1993). In CRCs, however, the enforcement problem is addressed by behavioural constraints such as personal supervision, bureaucratic rules, indoctrination, or socialisation. The O’Kane (2008) review, for example, found that the conduct of CRCs is regulated by complex rules. If monitoring behaviour is costly because of a weak correlation of behaviour with performance or geographic distance, agents may underperform or ‘shirk’. ‘Shirking’ is defined as the failure to provide full effort on a given task (Kidwell and Nygaard, 2011), such as a research assistant paid a fixed salary may not actively seek out opportunities (i.e., new research projects) that generate additional rents. Instead, the researcher simply performs the assigned duties (e.g., collecting data), whereas a research consultant, whose reward is determined by performance, may actively pursue new opportunities.

Within a CRC, researchers working for an academic partner might not put the same effort into a CRC project as they might do for a scholarly peer-reviewed output, or else they might not complete agreed tasks in a sufficiently timely manner, as per the expectations of industry partners. Conversely, those working for industry partners might prove unwilling to provide appropriate or complete data for a project (often owing to risk aversion), or might be too engrossed in day-to-day business matters to attend to researcher requests for guidance or information. Personnel changes within the entities collaborating on a project might also result in project members with less interest, or less technical proficiency – all of which can compromise the project’s success. In addition, owing to bounded rationality, complete and perfect enforcement is impossible (Hennart, 2008). Within CRCs, industry partners, or even an independent industry reviewer, might not have the technical skills to verify the quality of the output, at least in its entirety.

If CRCs indeed possess a JV-like structure as per TCT, the hidden transaction costs introduced above are quite substantial and therefore may result in even higher fail rates compared to the 50–60 percent fail rates of JVs (Büchel, 2003). A possible underlying cause for the proliferation of these hidden costs is the failure of CRCs to harness genuine collaboration (Keast, 2011). According to the US Agency for International Development (1988), program sustainability is the ability to deliver outcomes after external major financial, managerial and technical assistance is terminated. By adopting this definition to our context, we can suggest that failure occurs when a CRC fails to promote collaboration between the member organisations beyond the initial funding period, which implies a failure to demonstrate to its member organisations the benefits of providing commitment to collaborative research through ongoing cash and in-kind resources. This is not surprising, since Turpin and Garrett-Jones (2010) reported that some CRC members felt a degree of ‘lock-in’ to the CRC projects, which might restrict an appropriate change of direction by participants.

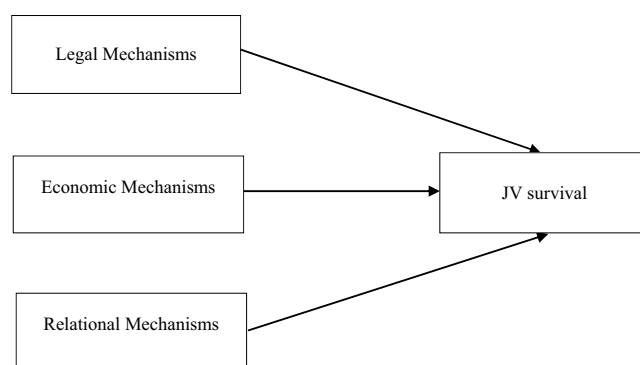


Fig. 4. Structural factors of JV survival (Kaufmann et al. 2006).

Likewise, Garrett-Jones et al. (2005, pp. 541–542) report on the reflection of a CRC participant, who referred to a ‘mismatch of expectations of industry on the one hand and the academic research community on the other’.

The lesson to be learned, then, is that complete and perfect enforcement within a CRC structure is impossible as a result of bounded rationality. We therefore need to examine other structural factors that may prove effective in establishing long-lasting collaborative research endeavours.

## 6. Towards a framework for sustainable research collaboration

It emerges that different mechanisms are needed to reduce transaction costs to ensure the sustainability of research collaboration. Successful research collaborations will therefore encompass one or more of these factors. In addition, their presence or absence may allow for examination of how government can target research collaborations that pay off in the long-run, as member organisations will have an active interest in maintaining the relationship in a financially sustainable manner.

As stated in Section 5, the direct comparability of JVs and CRCs allows us to draw parallels from the JV literature and apply them to the CRC context. Against this background, TCT suggests a range of structural determinants for a JV’s survival and, hence, a CRC’s long-term financial sustainability.<sup>5</sup> These determinants result in lower transaction costs for maintaining the collaboration compared to exiting from it. As shown in Fig. 4, these mechanisms can be clustered into three categories: legal, economic and relational. Kaufmann et al. (2006) suggests measuring the stringency of contractual safeguards to assess the effectiveness of legal mechanisms. Such safeguards can take the form of written reports, audit rights, confidentiality provisions, and termination clauses, etc. Some of these constraints can also be found in the CRC governance model: the CRC partnership agreement constitutes a legal constraint, while the member investments in CRCs form economic constraints. If we follow the approach taken by Buckley and Chapman (1997) to measure the extent of economic constraints present in CRCs, members could be asked to rate the potential or actual loss in investment if they were to terminate their engagement with the CRC. Relational constraints can be related to issues such as trust and reputational concerns arising from pre-existing relationships between CRC members such as research consultancies or industry-research linkages via project-specific grants. This classification allows us to identify a number of structural

<sup>5</sup> Following the terminology used in the strategic alliance literature (see e.g. Kaufmann et al., 2006; Parkhe, 1993), structural prescriptions or determinants describe the features or characteristics of an organisational structure.

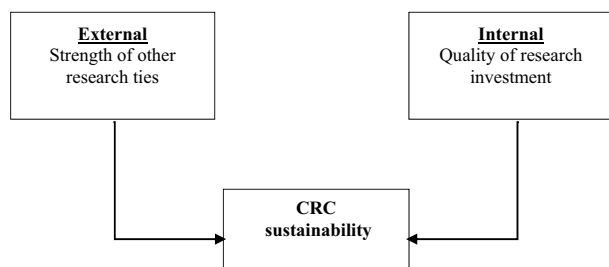


Fig. 5. Framework of sustainable research collaboration.

prescriptions in the context of CRCs. Kaufmann et al. (2006) highlighted previous research examining factors associated with the establishment of JVs (Parkhe, 1993; Chen and Chen, 2003). Yet they failed to examine whether these factors lead to their long-term viability. Likewise, there is evidence of the factors that lead to the establishment of different forms of research collaboration (see, e.g., Landry and Amara, 1998). That said, exactly what results in a 'lasting collaboration' remains unclear. Future research therefore needs to extend Kaufmann et al.'s (2006) study by examining the specific factors that can result in a JV's 'survival'.

We propose the following framework model to assess the viability of research collaborations derived from TCT (see Fig. 5). In this adaption of Kaufmann et al.'s (2006) analysis, we identify two factors that determine long-term sustainable collaborative research: suitability of external environment (i.e., strength of external research ties) and internal collaboration traits (i.e., strength of collaborative research commitment). The dynamic interaction of the two elements is required to ensure that the CRC emerges as financially sustainable.

We acknowledge that other factors can be categorised as internal or external determinants of research collaboration sustainability. For example, while the financial health of the CRC members can be regarded as an external determinant, other factors, such as the commercialisability of the CRC's outputs, can be classified as CRC-internal factors that can have an effect on the sustainability of research collaboration. But these factors are not necessarily unique to CRCs, which are assumed to operate mainly via behavioural constraints. Indeed, these factors can also apply to other forms of research collaborations that operate using the price system (i.e., a research consultancy). In the following section, we turn to the research implications that can be gleaned from the proposed framework.

## 7. Directions for future research

As Büchel (2003) suggests, the main source of JV failure is the lack of clearly articulated resources and responsibilities. From a transaction cost perspective, this relates to the fact that the contracting of intangible assets such as knowledge and relationship building is difficult to formulate, let alone measure. The potential deviation in the *ex post* distribution of rents from the *ex ante* agreement provides further aggravation. Indeed, Parkhe (1993) found that the loss resulting from opportunistic behaviour in JVs is positively related to the completeness of the JV agreement. Therefore, the first structural prescription identified relates to legal mechanisms that support ongoing research collaboration. According to Parkhe (1993), contractual completeness relates to the level of stringency of the clauses included in the partnership agreement. Contractual completeness, however, seems to come at the cost of flexibility with respect to exploiting opportunities arising 'on the go', which is often an outcome of collaboration. Thus, there appears to be a trade-off between limiting opportunistic behaviour and encouraging the right conditions for genuine innovation. In fact,

Kaufmann et al. (2006) results show a non-significant association of contractual completeness with JV survival. This ostensibly supports the view that contracts are ineffective in reducing opportunism in transactions such as research collaborations, which cannot be measured efficiently in the first place. It is unclear whether contractual completeness can be applied to the case of CRCs, since all contracts are essentially incomplete for CRCs. Yet, the initial CRC partnership agreement, although incomplete, may turn out to be more or less articulated from one CRC to another. On account of the mixed evidence presented in the JV literature on legal mechanisms, however, there remains some doubt that the 'stringency' of the partnership agreement may be a relevant structural prescription for CRC sustainability. Therefore, we argue that:

P1: Research collaboration sustainability bears no relationship to contractual completeness of the initial CRC partnership agreement.

Furthermore, the JV literature suggests that credibility threats in the form of relationships between CRC members outside the formal CRC structure, such as industry sponsorship of university departments or participation in student placement programs, can lower transaction costs by setting up a potential cross-hostage scenario (Zhang and Rajagopalan, 2002). For example, if the university partner decides to exit the CRC, the industry partner may retaliate by terminating other existing collaborations. In effect, this shifts the decision to continue from singular benefit cost considerations to aggregate benefit and cost considerations. Extra-CRC dealings therefore inhibit the motivation to leave the collaboration. Viewed differently, existing research relationships may help with the continuance of collaboration within a CRC framework, as the costs associated with establishing these relationships have already been made before engaging within the CRC (Keast and Hampson, 2007). Therefore, extra-CRC dealings may function as structural prescriptions, as highlighted in P2:

P2: Research collaboration sustainability is a positive function of the extra-CRC relationship strength between CRC members.

Yet an active interest to continue the collaboration on account of extra-CRC relationships may lead to suboptimal collaborations. This is because such relationships may encourage members to continue the collaboration, even when the expected benefit is negative (Keast, 2011). Other mechanisms that could be more effective in lowering transaction costs are economic constraints in the form of specific fiscal investments. The JV literature shows that the larger the specific investments requirements, the more likely the partners will choose a JV structure (Chen and Chen, 2003; Parkhe, 1993). The underlying assumption is that, while a larger investment by collaborators is likely to make it more costly to terminate the collaboration, larger investments also signal greater commitment, which should be related inversely to CRC members acting opportunistically. Using only quantity (i.e., cash and in-kind contributions) as a proxy for investment, however, may fall short in addressing possibly the most significant aspect of CRC investment. As a consequence, we propose that the *quality* of investments should be examined as a credible commitment by research collaboration members. For example, a genuine commitment by a leading academic expert in the respective field shows greater investment by the university partner than an ad hoc placement of an early career researcher with little or no field expertise. Alternatively, the extent of research activity on the part of the non-academic CRC members would allow the operationalisation of this concept across different sectors. Regardless of the sector background of the respective CRC member, the quality of the investment in research collaborations, as per Kaufmann et al. (2006), could be measured



as the perceived loss to CRC members if the collaboration was to terminate. Kaufmann et al. (2006) found that JV survival is associated with the qualitative aspect of investment loss rather than the quantitative aspect. Indeed, Perkmann et al. (2011) found that departmental staff quality is related positively to industry involvement for technology-related disciplines such as medical and biological research. Therefore, the final prescription relates to the subjective dimension of CRC-specific investment:

P3: Research collaboration sustainability is a positive function of the specific investment quality by collaboration partners.

In summary, if we had a better understanding of the different transaction costs to different parties in CRCs, we would have a better capacity to predict which CRCs would lead to long-term relationships between their constituent members. This understanding would allow the detection of viable structural features that could mitigate some of the transaction costs inherently present in CRC structures, an undertaking which would, in turn, lead to more informed policy and governance mechanisms. Given that transaction costs may be perceived differently by different parties, such an understanding would also allow a more considered assessment of whether the initial investment – be it in-kind or cash – by the various CRC members would be worthwhile, or whether another form of relationship would be more appropriate. From our screening of the relevant literature, the CRC Program as it stands does not always seem to be a good match maker of sustainable research collaborations; rather, it is more successful in acting as a facilitator for medium-term co-operations of a finite lifespan.

## 8. Concluding remarks

To extrapolate from the literature on TCT, government funding seems to play an important role in minimising the governance costs that would otherwise have to be borne by industry and academia in the context of a highly formalised and hierarchical applied research centre, such as a CRC. As a result, the initial hope that an initial injection of government funding would normally translate into a longer-term, financially sustainable relationship between CRC members, as per O’Kane (2008), emerges as inherently questionable. Government funding, which enables a coordinating umbrella-like governance structure to sit over an oftentimes extensive collection of collaborative projects, therefore allows the existence of a mechanism such as a dedicated and non-aligned central CRC management team to address costs associated with monitoring and enforcement, which the theoretical literature associates with hierarchical structures.

Such costs, it emerges, are unlikely to be borne by industry and academia in truly collaborative successor entities, unless, of course, the benefits of the relationship greatly overarch such costs. Where this is not the case, ‘collaboration’, contrary to the hopes of Slatyer (1994), who envisaged that CRCs would lead to more cross-sector team-based approaches to research, shifts back to more traditional principle-agent relationships between research user and research provider, and the collaborative structures forged thanks to the initial government funding have a tendency to unwind. The implications of this from a taxpayer perspective hardly need to be elucidated. That is not to say that productive relationships between academia and industry do not occur. In fact, we establish that relational and economic factors in the form of strength of collaboration-external research ties and the quality of collaboration-internal investments exist that allow for such relationships to thrive, with these productive characteristics emerging as determinants of relationships between industry and academia that lower transaction costs and thereby allow value to be created

for both parties. While research has yet to show that these factors can lead to sustainable research collaborations, it is probable that economic determinants, such as commitment signalling via investments, are the most effective mechanism to achieve this end.

So, there is reasonable theoretical justification, from our introduction of TCT into the arena of policy relating to collaborative research, to suggest that CRCs, at least as currently formulated, might not be particularly well placed to deliver the Australian Government’s hope of fostering ongoing research collaboration between industry and academia beyond the CRC’s life. This observation, derived from our application of TCT to the case of CRCs, drives to the very core of the historical rationale underpinning the creation of CRCs, which spoke more to ‘seed funding’ long-term collaboration between industry and academia, rather than subsidising transaction costs between these parties so as to provide an economic justification for research collaboration that would otherwise not occur. The main point is that, if research collaboration began in a CRC-like structure, it is difficult for the collaboration to continue under precisely the same conditions as those that existed within that structure, especially once government funding expires, and in the absence of factors that minimise transaction costs. We therefore propose a number of structural prescriptions that allow the governance model to shift to one in which less hierarchy and thus fewer behavioural constraints are in effect from the outset.

The theoretical contribution of this paper is two-fold. First, we position TCT against other theoretical constructs such as Resource Dependency Theory, Inter-Organisational Relations, Institutional Theory, and Collaborative Governance. From this, we conclude that the real-world phenomenon under investigation in this study, i.e., the ability or otherwise of CRCs to lead to financially sustainable successor entities and research partnerships, is best explained by TCT. Second, we formulate a theoretical basis that can lead to new research questions that draw on the core concepts of TCT, and which offer the promise of new empirical contributions to the literature on collaborative research and how to sustain it.

One limitation of this study is that it examines research collaboration sustainability from a specific theoretical lens. We leave it to future research to apply other theories to examine the viability of long-term research relationships in the CRC context, a course of action which will potentially lead to a more comprehensive picture of the problem area.

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