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Managing systemic uncertainty: The role of industry-level management controls and hybrids

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ABSTRACT

We study how multiple firms voluntarily design inter-firm mechanisms to manage industry-level systemic uncertainty. Facing a threat of systemic uncertainty that cannot be addressed by any one firm, we explain how the Australian cotton industry mobilised hybrids and boundary spanners to develop an industry-level solution at the inter-firm level. We apply resource dependence theory to extend Miller, Kurunmäki and O'Leary (2008), and identify a broader range of hybrid characteristics (novel, inter-firm, public/private and open source) than currently acknowledged in accounting studies. We use these characteristics to explain how hybrid organisational forms and hybrid control processes operate at the inter-firm level to develop and share a solution to systemic uncertainty, which are subsequently applied at the firm-level. Our findings also show how boundary spanners can operate with less tension in larger industry-level collaborations, explained using our resource dependence conceptualisation. This responds to Dekker's (2016) calls for more inter-firm research clarifying how controls operate beyond the firm.

1. Introduction

We study how multiple firms voluntarily design inter-firm mechanisms to manage systemic uncertainty[1] at an industry-level. Many global challenges (e.g., the threat of pests, climate change, water quality and biodiversity) are complex (IPCC, 2014; Uetake, 2015) and create systemic uncertainty with similar effects across multiple firms within an industry (Tashman & Rivera, 2016). The management of systemic uncertainty requires coordinated actions across firms affected (Adger, 2010; Albino, Dangelico, & Pontrandolfo, 2012; Bebbington & Thomson, 2013; Chesbrough & Appleyard, 2007), with a single firm unable to tackle the effects of systemic uncertainty on their own (Tashman & Rivera, 2016). This creates a unique type of dependency between firms where collective action is taken to address systemic uncertainty. How a group of firms and individuals possessing common interests arising from systemic uncertainty reacts is not self-evident. We use Mancur Olson's treatise (Olson, 1965, 2009) to emphasise his point relating to the logic of collective action:

> It does not follow, because all of the individuals in a group would gain if they achieved their group objective, that they would act to achieve that objective, even if they were all rational and self-interested. Olson (2009:2)

The absence of collective action signalled by Olson (2009) might arise from individuals facing a multiplicity of interests, with some conflicting and therefore lowering the likelihood of collaboration in areas where alignment might otherwise have been possible (Finke, Gilchrist, & Mouzas, 2016). Alternatively, firm-level actors might struggle to perceive the longer-term financial benefits arising from broader collaboration initiatives (Håkansson & Snehota, 1995). Further, while the logical response should be for all firms to want to resolve systemic uncertainty, *how* this might be accomplished is less clear. For example, a dominant firm might pursue the task alone (Ansell & Gash, 2008), join a select group of firms and privatise a solution (Gray & Wood, 1991), or all firms may contribute to the solutions equally or unequally (Huxham, 2003). Activities might be operationally conducted at the firm-level (Miller & O'Leary, 2007), or extra-organisational entities may facilitate inter-firm endeavours (Dekker, 2016). History has shown that

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[1] Systemic uncertainty can be caused by multiple firms becoming mutually dependent on natural resources and changing environmental conditions that can disrupt access to these resources.

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whole industries have faced the threat of systemic uncertainty, owing to new technology and product obsolescence, and have failed to engage in industry-level collaborative actions to tackle these common challenges – instead relying on the individual prowess of each firm separately[2] (Easley, 2005; Sinha & Mandel, 2008). Therefore, we consider how inter-firm mechanisms might enable the tackling of systemic uncertainty at the industry-level.

Organisational research has studied inter-firm relationships examining how an individual firm manages uncertainty in its operating environment through collaboration with other firms (Faems, Janssens, Madhok, & Looy, 2008; Gulati, Lavie, & Singh, 2009), where management controls have been designed and used to coordinate activities across firms (Whitley, 1999). This research largely focuses on dyadic (Dekker, 2016) or network relationships (Håkansson & Lind, 2006), where one firm dominates and leads the design and use of management controls in search of a control solution. Few studies have examined how coordinated actions at the industry inter-firm level impact the management of uncertainty (Dekker, 2016).

One such example of an attempt to go beyond the traditional dyadic or networked inter-firm relationship is the Intel study carried out by Miller and O'Leary (2007, 2005a, 2005b). Miller and O'Leary investigate a network relationship where Intel was the single, dominant firm in the industry (having 70% share of the microprocessor market) and collectively organised its efforts with multiple partner firms. They managed uncertainty by "visualising the future" through Moore's Law and the Technology Roadmap, derived from accepted scientific principles. This enabled them to develop objectives and plan collaborative action. Intel led multiple firms to strategize and communicate their research and development (R&D) activity at the inter-firm level; however, the R&D itself was resourced and conducted individually at the firm-level for individual firm benefit. We advance Miller and O'Leary's research by examining how multiple firms collaborate to manage systemic uncertainty when there is no dominant firm directing the activity, where there is an absence of central overriding principles as a unifying mechanism, and where R&D occurs at the inter-firm (industry) level and *not* at the firm-level.

Miller, Kurunmäki, and O'Leary (2008), building upon Miller and O'Leary (2007, 2005a, 2005b), conceptualise the use of hybrid elements (organisational forms and processes) to manage industry-level uncertainty. Hybrids are a theoretical construct most generally described as novel arrangements (Miller et al., 2008) used to tackle extra-organisational uncertainty facing multiple firms in ways not limited to hierarchical or market-based information flows (Hopwood, 1996; Kurunmäki & Miller, 2011; Williamson, 1979). The hybrid construct naturally aligns to inter-organisational contexts (Miller et al., 2008), and manifests as organisational forms, processes, practices or expertise (Kurunmäki & Miller, 2006). Hybrid organisational forms have become common in many different industry settings and display characteristics that include public/private ownership arrangements, sharing of strategic and operational risks, and co-funding arrangements (Ciesielska, 2010; Thomasson, 2009).

Within management accounting research, the focus of hybrid studies has been in the context of private inter-firm collaborations (Miller et al., 2008), or regulatory inter-firm collaborations (Kurunmäki & Miller, 2011). Studies focusing on both, however, are less forthcoming in accounting literature. Further, Miller et al. (2008) did not empirically expand on hybrid control processes, or examine and explain how different hybrid elements might interrelate in the management of systemic uncertainty.

Miller et al. (2008) also refer to boundary spanning activities while discussing hybrids (Kurunmäki, 2004). They argue that hybrids can arise due to the actions of key individuals at the firm-level who take on inter-firm level responsibilities to bring about positive inter-firm level outcomes (Marchington, Grimshaw, Rubery & Willmott, 2005). Such individuals are termed *boundary spanners* (Dekker, 2016) and are key to facilitating inter-firm collaboration. They face the unenviable task of managing the tensions between their inter-firm responsibilities and their own firm-level managerial commitments (Nygaard & Dahlstrom, 2002). Few studies have clarified how boundary spanners manage this tension in the context of hybrids. Moreover, we contend that the working of inter-firm mechanisms such as hybrids are plausibly linked to the actions of boundary spanners (individuals transcending firm-level and inter-firm level work). However, the literature has had very little to say on this linkage between boundary spanners and hybrids.

We apply a resource dependence theory lens to mobilise explanations for how inter-firm collaborative activity occurs (Pfeffer & Salancik, 1978). Resource dependence theory argues that an organisation's survival hinges on its ability to obtain critical resources necessary for its survival. To this extent, organisational action is predicated on a response to an external threat (Finkelstein, 1997), with organisations seeking to absorb constraints using multiple strategies (Gargiulo, 1993). We investigate how inter-organisational hybrids are implicated in the management of systemic uncertainty by mobilising a novel and less studied resource dependence typology (low power imbalance, high mutual dependence; Casciaro & Piskorski, 2005) to explain the effects of systemic uncertainty on boundary spanner behaviour at the industry inter-firm level. This relates to the way in which different hybrids are inter-linked and mobilised within this resource dependent setting, which requires the introduction of broader conceptualisations of hybrid characteristics to those currently discussed in accounting studies (beyond *novelty* and *inter-firm*).

Our field study is in the Australian cotton industry. This industry faces systemic uncertainty[3] arising from the impact of cotton pests on cotton plants. We observed how key cotton growers, agribusiness consultants, cotton administrators and agricultural scientists acted as boundary spanners (Dekker, 2016), working beyond their firm-level tasks to tackle this threat – securing funding initially from cotton growers and then government to develop industry firms that reflect the attributes of hybrid organisational forms (Miller et al., 2008).

In our case setting, boundary spanners and industry firms (hybrid forms) enabled the design and use of three novel inter-firm hybrid control processes (environmental audits, R&D Facilitation Systems, and Best Management Practices; BMP), operating at the industry-level and firm-level. These hybrid control processes were novel (Miller et al., 2008), existed at the inter-firm level, involved *public/private* funding partnerships (Thomasson, 2009), and provided *open source* information for use by all cotton firms (Ciesielska, 2010).

[2] Consider the music industry's response to piracy, which was a systemic uncertainty that affected all firms in the industry. Multi-firm collaboration to develop solutions to the strategic challenges was not observed. Instead, the search for solutions was driven by one or two firms, with differing levels of investment by industry participants, despite all firms being affected adversely by piracy activity (Easley, 2005; Marshall, 2004; Sinha & Mandel, 2008; Van Wijk, 2002).

[3] In our setting, multiple firms commonly faced multifaceted systemic uncertainty arising from cotton pests which threaten to severely curtail the viability of the cotton growing industry in Australia. We studied how cotton growers, and a range of other related public and private stakeholders, addressed this critical challenge facing the industry over an extended period of time. We collected data covering a period of 52 years, drawing on data from 54 interviews, over 300 archival documents and extensive observations.

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Based on our findings, we provide two contributions to the accounting literature. First, the workings of hybrids within a novel resource dependence combination (high mutual dependence, low power imbalance) is theoretically explained using a broader range of attributes characterising hybrids than explored in extant accounting research (Miller et al., 2008). The stream of studies initiated by Miller, O'Leary and Kurunmäki identify hybrids as being impure combinations of usually disparate elements, which are expressed as *novel arrangements* that span the *inter-firm* divide (Miller et al., 2008). We add to these critical characteristics by also identifying the potential *public/private* nature of inter-firm arrangements (Thomasson, 2009) and the *open source dissemination* (Ciesielska, 2010) of industry-level solutions as characteristics of hybrids that are critical in explaining *how* our hybrid organisational forms (i.e., industry firms) and hybrid control processes evolved to work more effectively in our setting. The inability of individual firms to tackle the problem led to mutual dependence and low power imbalance in the industry. When coupled with the growing importance of cotton production in the economy, this led to increased government involvement in the resourcing of industry activities over time (*public/private*) – initially with financial resources and then broadening to a wider range of resources. This was instrumental to the development of an industry-wide solution to pest management. Further, the open dissemination of this solution (*open source*) to all firms and broader society, irrespective of differences in firm-level contributions to R&D, allowed for the solution to be more comprehensively implemented for the greater good of the cotton industry.

Our second contribution is explaining how, within this less studied high mutual dependence/low power imbalance resource dependence context (Casciaro & Piskorski, 2005), boundary spanners were able to operate with less tension than would ordinarily be observed between boundary spanners at the firm-level and industry-level (Anderson & Dekker, 2014; Coletti, Sedatole, & Towry, 2005; Dekker, 2016). This low tension is less apparent in extant boundary spanner research and is critical to explaining how key cotton producers and scientists acted at the inter-firm level to tackle uncertainty. In doing so, we add to the accounting literature (Anderson & Dekker, 2014, 2005; Coletti et al., 2005; Dekker, Sakaguchi, & Kawai, 2013) by addressing the calls by Dekker (2016) for a broader understanding of boundary spanners and how they facilitate inter-firm management controls beyond the firm-level.

As an aside, the low power imbalance resource dependence attribute aligns strongly to the notion of parity-based relationships. Our findings broadly respond to Caglio and Ditillo's (2008) calls for accounting research to explain how controls manifest in a parity-based, voluntary inter-firm relationship where no single participant dominates the inter-firm relationship. Our novel resource dependence theory combination (high mutual dependence, low power imbalance) therefore aligns strongly with the notion of parity in inter-firm relations. Furthermore, this less studied resource dependence combination (high mutual dependence, low power imbalance) is increasingly prevalent in societies globally, owing to the presence of industry-level systemic uncertainties as outlined earlier (Tashman & Rivera, 2016). Our research explains how collective strategies used to manage these challenges can be implemented.

We next develop our theoretical framework based on the literature. Following this, we present our research method, discuss our case findings, and conclude with an acknowledgement of the study's limitations and suggestions for future research.

2. Literature review and theoretical framework

We develop our theoretical framework by first examining current literature on inter-firm management controls. Much of this research focuses on dyadic relationships and management controls designed and used by a focal firm to control the inter-firm relationship with another firm (Dekker, 2016). We then build an argument for how industry-level management controls are required, using resource dependence theory to develop an understanding of the challenges posed by systemic uncertainty and the need for multiple firms to carry out coordinated activities. Finally, we expand upon and theorise hybrid forms and hybrid control processes, and explain how key firm-level actors (boundary spanners) enable multi-firm coordination to manage systemic uncertainty.

2.1. Management control of inter-firm relationships

Anthony and Govindarajan (2007) broadly define management control systems (MCS) as tools that help an organisation achieve its strategic objectives. This definition encompasses the behavioural (Chenhall, 2003; Sunder & Cyert, 1997) and more technical aspects of control systems (Langfield-Smith, 1997, 2007; Merchant & Van der Stede, 2012) currently put forward in the management accounting literature. Building on these studies we define controls as processes contributing to the attainment of organisational objectives (Merchant & Van der Stede, 2012) by directly or indirectly shaping the behaviours of related individuals in organisations (Chenhall, 2003).

Inter-firm relationships (Ireland, Hitt, & Vaidyanath, 2002) have provided accounting researchers with an interesting context to examine the role of management controls (Anderson & Dekker, 2014; Argyres & Mayer, 2007; Chen, Park, & Newburry, 2009; Dekker, 2016). These relationships take many forms but the most common type is the dyadic relationship between a buyer and seller of products and services, or a firm and its outsourced supply partner (Faems et al., 2008; Gulati et al., 2009; Kumar & Seth, 1998). Inter-firm relationships provide each firm with the ability to share and access resources and competencies beyond their individual firm boundaries and consequently manage uncertainty (Ireland et al., 2002). However, these relationships also open up the firm to the possibility of opportunistic behaviour from partners who might not fully share resources and capabilities to achieve mutual gains and who may have misaligned objectives which lead to alternate actions (Anderson & Dekker, 2014). Consequently, management controls are required to align behaviour and achieve a collaborative and coordinated focus to meet the common objectives of the inter-firm relationship (Dekker, 2016).

Inter-firm management control research can be grouped into two categories (Anderson & Dekker, 2014). First, a growing stream of research has examined ex-ante management controls designed and established by a firm at the outset of the relationship (Anderson & Dekker, 2014; Argyres & Mayer, 2007; Faems et al., 2008; Ireland et al., 2002). Ex-ante management controls have been focused largely on contractual arrangements and partner selection processes (Anderson, Christ, Dekker, & Sedatole, 2015). The contractual arrangements put in place in an inter-firm relationship are classified as 'incomplete contracting' due to the information asymmetry that exists between the firms; the focus of management control research therefore has been on how these contracts can be made more complete to effect good control (Anderson & Dekker, 2014; Dekker, 2003, 2008).

A number of studies have examined the role of contracts and partner selection processes as ex-ante management controls (e.g., Anderson & Dekker, 2005; Anderson et al., 2015; Dekker, 2008;

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Dekker & Van den Abbeele, 2010; Ding, Dekker, & Groot, 2013; Krishnan, Miller, & Sedatole, 2011). Studies examining contracts have focused on examining specific clauses (Anderson & Dekker, 2005), exit arrangements (Anderson et al., 2015), level of detail (Krishnan et al., 2011), complexity (Ding et al., 2013), and the nature and type of contracts used (Dekker, 2008). Studies that have focused on partner selection processes have examined selection criteria used (Anderson et al., 2015), organisational activities employed in the selection process (Dekker et al., 2013), and prior experience and information on partners (Dekker, 2008; Dekker & Van den Abbeele, 2010; Ding et al., 2013). These studies provide an understanding that firms use contracts and partner selection processes as interrelated management controls with more detailed and tight contracts when entering into a relationship with a new partner, when operating in a highly uncertain environment, or when the transaction characteristics cannot be clearly defined and agreed upfront. When contracting with known partners from prior relationships, contracts can be more flexible and collaborative as the level of information and trust in the partner is higher. This understanding reduces the need for complex and detailed contractual conditions and terms (Gulati et al., 2009). The extent to which such controls enable voluntary participation from a range of firms beyond a dyad remains unexplored.[4]

A second and more limited stream of inter-firm management control research has focused on other forms of control choices made by managers (Caglio & Ditillo, 2008). Cooper and Slagmulder (2004) examine how cost information was shared and used by partners to control transactions and behaviours in a dyadic inter-firm relationship in the manufacturing sector in Japan. This cost information helped to reduce information asymmetry in this relationship by enabling the focal firm to guide the product development activities of the supply firm and reduce costs while developing improved cooperation and coordination of these product development activities. Similarly, Dekker (2003) shows how an activity based costing model and cost information were useful in helping to coordinate activities in a buyer-seller relationship; this enabled all parties to have a similar understanding of product costs and expectations for how these costs were to be managed to create value for all partners. Conducting coordinated inter-firm research at the firm-level has merit, but also requires flexibility to cater to individual firm-level management requirements. Wouters and Sandholzer (2018) observe how an inter-firm management accounting application of standards (cost of ownership) was used to communicate firm-level costs to other firms in the partnership, but in a way that allowed for firm specific adaptability. Firm-level choices regarding the aspects of the standard applied, and cost of ownership calculations, might be conducted in different ways to facilitate the internal versus external information needs of partners. However, when research is conducted at the inter-firm level, our understanding of how control processes might manifest is less clear (Dekker, 2016).

Langfield-Smith and Smith (2003) examine a technology outsourcing related inter-firm relationship and find that outcome and social controls were useful in controlling the relationship by placing a focus on outputs from the relationship. Finally, Anderson et al. (2015) study the relevance of intra-firm management control frameworks for inter-firm management control. Their study focused on three commonly used frameworks provided by Simons (1995), Merchant and Van der Stede (2012), and Jensen and Meckling (1992). Anderson et al. (2015) found that the Simons (1995) and Merchant and Van der Stede (2012) frameworks were useful to enable coordination of activities in value creation firms; while the Jensen and Meckling (1992) control framework, with its focus on economic performance, was useful in firms with a focus on transaction efficiency and cost minimisation.

Much of the above research examines inter-firm relationships between two (dyadic) firms, usually a buyer-seller relationship and more importantly, from the perspective of the initiating (focal) firm (Anderson & Dekker, 2014; Caglio & Ditillo, 2008; Dekker, 2016). The management controls developed and used in these inter-firm relationships are also concentrated on the needs of the focal firm (Miller & O'Leary, 2005a). There has been less interest in examining management controls from the perspective of the "other" partner in the dyadic relationship. Further still, the inter-firm management control research literature pays limited attention to multiple-firm relationships such as network relationships (Håkansson & Lind, 2006) and parity-based multi-firm relationships (Caglio & Ditillo, 2008).

Network relationships are partnerships where one firm takes on the focal firm role (Håkansson & Lind, 2006; Miller & O'Leary, 2005a, 2005b). Other firms in the network relate to this focal firm and are directed and guided by the focal firm. The characteristics of this form of inter-firm relationships have many similarities to a dyadic relationship (e.g., focal firm focus) and may be a factor in the few studies examining these forms of relationships (Dekker, 2016; Håkansson & Lind, 2006). Miller and O'Leary (2005a) provide one useful study that has examined a network form of relationship with Intel as the focal firm. In this study, the authors showed how technology roadmaps were designed as an inter-firm management control to coordinate activities related to the development of chip technology between Intel and a network of suppliers, customers and other stakeholders within the technology sector.

Parity-based multi-firm relationships are rarely studied in the inter-firm management control literature (Caglio & Ditillo, 2008). Such relationships are between multiple firms who operate largely as equals with no single firm dominating the relationship. As a consequence of focusing on the focal firm in dyadic relationships, inter-firm management control research has focused less on how firms manage the behaviour of managers and employees assigned to boundary spanning roles in the inter-firm relationship (Dekker, 2016; Taylor, 2005). Boundary spanners drive the focal firm's interest in the inter-firm relationship but are also required to consider the needs and objectives of the other partner in the relationship. This becomes more acute when the relationship involves multiple firms, and where no single firm is dominant and able to drive its own interests. While tackling a broader problem, such as systemic uncertainty, may incentivise collaboration among boundary spanners, such a parity-based relationship lacking a dominant entity may cause boundary spanners to experience more conflict as they have greater scope to seek more influence at the inter-firm level to further their own firm interests. How management controls are designed and used in this parity-based relationship to influence behaviour of firms and key actors within these firms remains an open question – this has not received much consideration in the inter-firm control literature (Dekker, 2016). This issue would seem to be even more salient if uncertainty is systemic across multiple firms in a given setting.

[4] Trust based controls have also been considered an important feature of inter-firm management controls (Dekker, 2008; Faems et al., 2008; Van der Meer-Kooistra & Vosselman, 2000). As a form of social control, trust develops through prior experience and information about the partner (Dekker & Van den Abbeele, 2010). Trust also develops through inter-firm management controls (Vosselman & van der Meer-Kooistra, 2009). Trust is seen to influence and shape other management controls (e.g., partner selection processes) and appears to be capable of operating interrelatedly with contracts and partner selection and other forms of control (Anderson et al., 2014; Dekker et al., 2013; Dekker, 2008; Ding et al., 2013, Langfield-Smith & Smith, 2003). These controls are not the focus of this study.

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2.2. Systemic uncertainty and resource dependence

Increasingly, firms face industry-wide issues related to sustainability, availability of resources, external threats (including pollution and biological pests) and other factors which pose systemic uncertainty affecting all firms within the industry in similar ways (Bebbington & Thomson, 2013). These systemic uncertainties create mutual dependence (Casciaro & Piskorski, 2005; Pfeffer & Salancik, 1978) between firms, seemingly incentivising collaboration to share resources and coordinate actions (Chesbrough & Appleyard, 2007).

Resource dependence theory (RDT) suggests that a firm can access the resources required to manage external uncertainties from other firms, and eliminate or reduce constraints resulting from these uncertainties (Casciaro & Piskorski, 2005; Hillman, Withers, & Collins, 2009; Pfeffer & Salancik, 1978). These constraint absorption mechanisms can take the form of mergers and acquisitions (Casciaro & Piskorski, 2005), joint ventures, interlocking board directorships (Hillman & Dalziel, 2003), and other forms of inter-firm relationships (Hillman et al., 2009). A fundamental assumption in RDT is that a focal firm can absorb and manage constraints imposed by external uncertainties by accessing resources from other firms (Davis & Cobb, 2010). RDT, in its original form, offered limited guidance for managing mutual dependencies between multiple firms emerging from systemic uncertainty (Pfeffer & Salancik, 1978).

Casciaro and Piskorski (2005) extend RDT by separating resource dependency into two elements: power imbalance and mutual dependence. Power imbalance is created between two or more firms where control over resources is held by one firm (Boyd, 1990). However, the use of common suppliers, access to key personnel, technologies and other related business factors can also make firms mutually dependent (Tolbert, 1985). Systemic uncertainty across multiple firms further creates mutual dependencies (Hart, 1995). The extension of RDT by Casciaro and Piskorski (2005) provides a basis to understand how firms, faced with systemic uncertainty, become mutually dependent. However, Casciaro and Piskorski (2005) do not articulate how control mechanisms might be used to manage such mutual dependency in the absence of power imbalance, nor do they offer an empirical explication of how controls beyond the firm-level might contribute to the same. We position hybrids (Miller et al., 2008) as enablers of industry-level efforts aimed at managing systemic uncertainty.

2.3. The role of hybrids

Hybrids are "new phenomena produced out of two or more elements normally found separately" or not ordinarily thought of as being connected (Miller et al., 2008, p. 943). In the transaction cost economics literature (Williamson, 2002, 1991, 1979), studies initially identified hybrid organisational forms as an alternative to markets and hierarchies for organising transactions in efficient and effective ways. Hybrid forms were seen to enable firms to coordinate activities to manage uncertainty and risk. Early research focused on the importance of collaborative organisational forms (Eccles, 1981), emphasising the structural aspects of hybridity. The coming together of multiple firms to create new organisational forms through mergers and acquisitions, public-private partnerships (Brandsen, Karré, & Helderman, 2009; Thomasson, 2009), strategic alliances (Millar, 2012), joint ventures (Palmer, 1990), or novel contracts binding suppliers (Piore & Sabel, 1984) all reveal traits related to hybrids (Borys & Jemison, 1989).

Hybrids bring together ideas from two or more separate spaces and combine them to generate new learnings and approaches (Adler, 2001; Miller et al., 2008). Though hybrids were traditionally defined as organisational forms (Williamson, 1991), Miller et al. (2008:943) extend the construct by arguing that "… hybrids … can take the form of organisational arrangements … they can also take the form of hybrid control processes, practices or expertise". They further argue that "… the world is populated by hybrids or intermediaries that constantly mix up and link up apparently disparate and heterogeneous things … actors, entities, objects, practices, processes and bodies of expertise can all be regarded as hybrids" (Miller et al., 2008, p. 944). We apply this broader definition of hybrids introduced into the management accounting literature and focus on hybrid organisational forms and hybrid control processes, explaining the individual hybrid definitions underpinning each of these elements.[5]

2.4. Hybrid organisational forms

Hybrid organisation forms are organisation types that do not follow the constructs associated with traditional organisations, but instead combine elements that are unexpected. A hybrid form, for example, can be an organisation that is neither solely privately or publicly owned, but an entity incorporating elements of a public-private partnership (often observed in large public infrastructure projects; Mitronen & Möller, 2003; Thomasson, 2009). Alternatively, an organisation might be hybrid owing to its open source origins, leaving the rights to its output in the hands of the broader public (Ciesielska, 2010). This non-traditional sharing of arguably private intellectual property rights defines the hybridity of the organisational form from a stakeholder benefit point of view, extending the rights to organisational assets beyond shareholder/managerial control. Hybrid organisations can also manifest as extra-organisational third sector entities such as associations and co-operatives (Doherty, Haugh, & Lyon, 2014; Valentinov, 2004) that reflect the interests of firms, regulators, suppliers and broader society under the umbrella of an *industry-level* endeavour.

Miller and O'Leary (2007), for example, highlight the role of SEMATECH (the Semiconductor Industry Association) as key to allowing firm-level participants to interact and discuss their learnings regarding semiconductor technologies collaboratively. However, the actual conduct of R&D and innovation at the industry-level (as opposed to the dissemination of firm-level R&D information as observed in Miller & O'Leary, 2007) remains less studied in inter-firm research. Ménard (2004) alludes to the absence of these alternate hybrid organisational forms and laments the lack of further study of these same organisations. We address this concern in our study, but importantly also identify the possibility that collaborations might *not* form, notwithstanding the imperative to do so. For example, the music industry tackled the strategic threat of piracy in a manner that involved R&D activities within the individual firm (Van Wijk, 2002). Instead, their industry-level collaborations were loose and largely limited to the legal aspect of policing and remedying piracy behaviour as a deterrent (Marshall, 2004).

2.5. Hybrid control processes

Hybrid control processes refer to processes that transcend organisational boundaries by facilitating lateral inter-organisational information flows including, but not limited to, budgeting, planning and performance evaluation related

[5] The focus of our study does not include hybrid expertise. While we expand later on the role of boundary spanners, we examine their behaviours and activities rather than the formal skillsets of individuals (Kurunmäki, 2004) - a key attribute of hybrid expertise.

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phenomena (Hopwood, 1996). The control processes within hybrid organisational forms may not all possess hybrid properties themselves. Therefore, hybrid control processes must exhibit the qualities of a hybrid element in their day to day operationalisation. For example, these control processes might be an activity involving informational flows beyond the boundaries of any one organisation (Kurunmäki & Miller, 2011), or it might be a control process that specifically effects the open source dissemination of an output.

The extant literature generally assumes hybrid control processes will form from the deliberate actions of firms (Miller et al., 2008). However, we have little understanding of how hybrid control processes might manifest from hybrid organisational forms (Doherty et al., 2014), or are mobilised by boundary spanner behaviour. For example, hybrid control processes might express as processes that combine multifaceted elements to facilitate their execution (Kitchener, 2000), involving both public and private stakeholders (Mitronen & Möller, 2003). Alternatively, they might be the mechanism through which organisations publicly disseminate private innovations for a greater purpose (Doherty et al., 2014). Finally, control processes may be hybrid in nature owing to how they are enacted across organisations (Miller et al., 2008), or at different organisational levels (industry-level to firm-level), for purposes of achieving their control objective.

2.6. Boundary spanners

The concept of boundary spanners originates from studies that examine the coordination of interdependent work efforts between individuals at the intra-firm level (Marrone, 2010). Boundary spanning has been described and examined at the individual and team level with a focus on intra-firm and inter-firm coordination (Richter, West, Van Dick, & Dawson, 2006). Boundary spanners are identified as defining and managing activities that span the boundary between firms (Ancona, 1990). A large focus of the boundary spanner literature is on team-based boundary spanning (Druskat & Wheeler, 2003).

Research into boundary spanner activity at the individual level shows that attitudinal and behavioural moderators play a key role in the success of boundary spanning individuals (Richter et al., 2006). These include the extent the individual is identified with the organisation and the degree of contact between the individual and the inter-group members. Higher levels of identification and contact are found to lead to more effective boundary spanning. At a team level, boundary spanning contributes to improved problem-solving capabilities, increased effectiveness in uncertain settings, the ability to execute complex tasks, and increased alignment with firm strategy (Denison, Hart, & Kahn, 1996). Boundary spanning activities allow for disconnected actors to communicate, enabling information transfer, knowledge creation and innovation (Argote, McEvily, & Reagans, 2003; Marrone, 2010; Richter et al., 2006).

In an inter-firm relationship where firms remain focused on their individual strategic objectives, boundary spanners can become conflicted as they are subject to their own firm's strategic objectives but are also influenced by the strategic objectives of the inter-firm relationship and interactions with their counterparts in the other firms (Dekker, 2016). Boundary spanners might become disillusioned, insecure and/or face sanctions if they push the interests of the inter-firm relationship above their own firm's interests. However, according to Richter et al. (2006), an over-riding loyalty to the home firm will drive boundary spanners to exert influence within the inter-firm relationship, aiming to create a context which is similar to their home firm. This suggests there is a tension in the literature on the role of boundary spanners in an inter-firm relationship which has not been fully investigated and understood (Dekker, 2016). Boundary spanners can play a key unifying and engagement role in parity-based relationships, coordinating actions to manage systemic uncertainty, yet any role conflicts and tensions may adversely impact this important function.

2.7. Focus of the study

In summary, we have a developing understanding of the role of management controls in dyadic inter-firm relationships but less understanding of how management controls are used in parity-based multi-firm relationships at an industry-level where there is no single dominant firm. Furthermore, our understanding of how systemic uncertainty is managed by multiple firms in this type of parity-based relationship is limited. We argue that the absence of capability by individual firms to address industry-level systemic uncertainty creates an incentive for greater collaboration and coordination; however, a key question is not only whether firms need to collaborate but *how* they collaborate and coordinate their activities to drive a collective response.

Miller et al. (2008) provide a broader conceptualisation of hybrids as the basis for managing systemic uncertainties beyond the firm-level in a range of inter-firm relationships, including parity-based multi-firm relationships. However, they do not expand or clarify how these broader hybrid elements might interrelate, nor how collective action may be tackled by the interaction between different types of hybrids. We identify a unique resource dependence combination and study how boundary spanner activities drive the workings of hybrid organisational forms and hybrid control processes, to tackle systemic uncertainty at an inter-organisational level.

3. Research method

The analysis in this paper is based on a field study carried out in the Australian cotton industry. Australian cotton is an AUD 2 billion industry[6] with Australia being the third largest exporter of cotton in the world. Australian cotton is in high demand due to its high quality and reliable supply, with bales priced between AUD 300–600. In 2015, the Australian cotton industry produced 2.2 million bales of cotton from 196,898 ha of land. Cotton is Australia's sixth largest agricultural export, representing around 5% of total agricultural export revenues. The Australian cotton industry is located in the states of New South Wales (NSW) and Queensland. In NSW, cotton is grown in the Gwydir, Namoi and Macquarie valleys, along the Barwon and Darling Rivers in the west, and the Lachlan and Murrumbidgee Rivers in the south. The regional centre for cotton is the town of Narrabri. In Queensland (Qld), cotton is grown in the Darling Downs, St. George, Dirranbandi and Macintyre valleys (South Qld), and in the region near the towns of Emerald, Theodore and Biloela (Central Qld). The modern cotton industry started in the early 1960s, when American migrant cotton growers joined Australian farmers to grow irrigated cotton in the Narrabri area. There are now more than 1200 cotton farms almost evenly split between NSW and Qld.

Field study research enables the researcher to study phenomena in their natural setting and to make sense of his or her observations by moving between data and theory (Ahrens & Chapman, 2006; Jorgensen & Messner, 2010; Yin, 2003). As part of a research team, two of the authors spent considerable periods of time in the field, observing the activities of the participants in the cotton setting, asking questions and interacting with participants at key events

[6] Cotton Australia website (www.cottonaustralia.org.au) - accessed 30 May 2016.

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(e.g., cotton conferences, meetings and workshops). As the field study formed part of an industry funded project, we are satisfied that we were provided with good access to participants and data in order to form our findings.

The fieldwork was carried out over a period of 24 months, from January 2012 to December 2013.[7] During this period, the research team carried out five field trips to the main cotton growing regions in NSW and Queensland to collect data. Two of the authors formed part of the research team on these trips. On each trip, the researchers spent between 2 and 5 days collecting data. Semi-structured interviews provided the primary source of data for the study: 54 interviews were carried out with 48 participants, with interviews averaging around 70 min (Appendix 1). The interviews were conducted with a range of industry participants including cotton growers and cotton researchers, managers from industry firms, and cotton agribusiness consultants. The interviews were recorded and transcribed.

Archival documents (Appendix 2) provided extensive data on the cotton industry, its hybrids and industry-level management controls. These documents related to the four industry firms and included their annual reports, strategic plans, minutes of board and other committee meetings, industry reports commissioned by the industry firms, books written on the development of the industry, papers and proceedings of the Australian cotton conference, websites, and other social media data. The lead author reviewed and drafted notes on these archival documents to gather data subsequently used in the study.

Formal observational data (Appendix 3) was collected by the lead author as part of the research team attending committee meetings arranged by the industry firms and was supplemented by informal observations during discussions at lunch and coffee breaks. Two of the authors, as part of the research team, also attended conferences and workshops arranged by the industry firms to observe interactions between participants. The bi-annual cotton conference provided an important opportunity to observe the interactions between cotton growers and cotton researchers, particularly at breakout workshop sessions where researchers presented their project findings and received feedback from growers.

The approach to data analysis was based on primary pattern matching supplemented by explanation building (Patton, 2002) related to important theoretical concepts: systemic uncertainties, hybrid expertise, organisational forms, and industry-level control processes (Dubois & Gadde, 2002; Yin, 2003). Empirical data was used to assess, refine and develop the theoretical framework taken to the field and to build an understanding of different hybrid elements. Data was coded using NVivo software (version 10) and followed a manifest coding approach where the visible content in the text is coded (Neuman, 2000). Data coding was carried out by the lead author and was reviewed by another author. The analysed data was written up as “thick narratives” (Patton, 2002; Yin, 2003) to develop an empirically based theoretical understanding of systemic uncertainties and the different hybrid elements.

4. Case findings and analysis

Owing to the broad range of themes covered in our findings, we intersperse our findings with occasional analyses of their meaning in relation to our broader theoretical arguments. These relate to hybrids and boundary spanners brought about by resource dependence. We then supplement these points of analyses with a discussion of their theoretical importance in our discussion section. A summary of our explanations concerning the three hybrid elements and their flow is provided in Table 1.

We also include a timeline of key events discussed in this section as Table 2.

4.1. Systemic uncertainty leading to resource dependence: the challenge from cotton pests

A systemic uncertainty is an externality that indiscriminately impacts all firms in an industry (Tashman & Rivera, 2016). By virtue of its ubiquitous impact on all players, the uncertainty is of such a magnitude that it poses multifaceted and interdisciplinary challenges to those affected. Resolving it therefore requires effort from those with the capacity to capture the different facets of the uncertainty – thematically and structurally.

Thematically, the cotton pest *Helicoverpa armigera* (cotton bollworm) created systemic uncertainty from different perspectives for cotton growers in the Australian cotton industry. Cotton pests are indifferent to farm boundaries and this necessitated cotton growers to carry out similar and coordinated operational activities to combat this pest. A key activity to minimise the adverse effects of the cotton pest was the use of pesticides (e.g., Endosulfan). Pesticides reduce damage caused by the cotton pest and thereby minimise yield reduction. However, over time the cotton pest began to develop biological resistance[8] to Endosulfan and yields began to decline (McHugh, 1996).

Biological resistance to pesticides poses a scientific, agricultural and economic challenge. Scientifically, the research required to understand the base elements upon which pesticides might effectively eradicate pests is significantly difficult. Pesticides need to be developed in a manner that minimises the occurrence and magnitude of adverse second and third order effects on the broader agricultural industry, such as on livestock, waterways and people. Such research serves to manage these trade-offs while also being cost effective.

The presence of cotton pests created systemic uncertainty as individual firms lacked the capabilities and resources to manage this challenge individually. This created resource dependence between firms due to mutual dependence, and therefore reduced any power imbalance that might otherwise exist (Casciaro & Piskorski, 2005). Firms therefore had some incentive to engage with each other in a parity-based multi-firm relationship (Caglio & Ditillo, 2008) as all were equally concerned with finding a solution. Still, systems to incentivise participation and involvement in these different areas required leadership from key individuals, especially at the early stages of the industry.

Systemic uncertainty made cotton growing firms interdependent. In the early periods of the cotton industry (1960's & 1970's), each cotton firm attempted to coordinate its operational activities to combat the cotton pest with other cotton growing firms; however, this coordination was often limited and consequently unsuccessful (e.g., aerial spraying of pesticides was done independently by firms and created challenges for the industry through contamination of waterways). Cotton growing firms in Australia therefore became mutually dependent (Casciaro & Piskorski, 2005). Coordination mechanisms were needed at the industry-level to enable cotton growing firms to strategically manage cotton pests, to develop improved pest management techniques, and to execute

[7] The data for this study were collected as part of a five-year industry study.

[8] Pesticide resistance management remains a major challenge in agriculture: ‘I can think of few problems in evolutionary biology that are more important than controlling resistance, a problem that is serious enough now, and certain to become more so. Despite significant advances in our knowledge of the genetics, physiology and biochemistry of resistance, little progress has been achieved in formulating practical countermeasures against the inexorable march of resistance’ (Prof Taylor, CE, 1985, Address to the Linnean Society of London, as reported in Forrester, 1993).

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Table 1
Boundary spanners, hybrid organisational forms and hybrid industry-level management controls.

Element	Classification	Focus	Examples
Boundary spanner			
Pioneer cotton growers and researchers	Boundary spanners – founders simultaneously owned farms and allotted significant personal time/resources to the advancement of the Australian cotton industry	Enablers of other hybrids and industry-level management controls	• Lobbying government and regulatory agencies for funding and support • Enrolling other cotton growers and researchers as boundary spanners • Taking on leadership roles within the industry firms and committees • Making strategic appointments to key roles on industry committees • Encouraging co-location of growers, researchers and industry policy specialists
Hybrid organisational forms – industry bodies			
Cotton Australia (CA)	Industry-level association – membership (ownership) by cotton growers	Advocacy, policy and strategy development for cotton growers Public-private organising mechanism	Industry firms • Cooperative structure, grower members drive firm's agenda • Work with government to design infrastructure and policy arrangements for the sector
Australian Cotton Growers Research Association (ACGRA)	Industry-level association – membership (ownership) by cotton growers	Flexible organisational arrangement tasked with developing an agenda for industry-level R&D Executive committee with diverse skills Public-private funding mechanism	• Cooperative structure, growers part of executive committee driving research agenda • Active involvement by a wide range of stakeholders, including researchers and consultants, in decision making • Private cotton grower levy contribution per bale of cotton, with government matching levy contribution
Cotton Research and Development Corporation (CRDC)	Industry-level government owned corporation for R&D funding	Bring cotton growers, researchers and consultants together, to conduct projects endorsed by ACGRA Public-private project approval and funding process	• Program management of research projects with government and private industry endorsement • Funding of approved projects using taxpayer funds for cotton grower benefit
Cotton Cooperative Research Centre (Cotton CRC)	Industry-level government owned research partner firm	Building research capacity for running projects funded by CRDC Public-private research connector and capability building hub	•Convene 11 core and 36 affiliate research partners to conduct research funded by CRDC and approved by ACGRA
Hybrid control processes			
Environmental Audit	Industry-level control process Assessing the operational performance of farms in relation to pesticides and preventive activities	Multifaceted coordination of different skillsets to appraise performance Conducted with private and public sector respondents Novel, unexpected process	• Speaking to farmers, government officials, scientific researchers, other industry representative • Hailed as first of its kind in cotton industry globally
R&D facilitation – Project Management System (PMS)	Industry-level management control (knowledge development)	Multifaceted coordination of different skillsets to identify solution Involved public and private parties	• Multiple R&D projects to develop new information • Involved government staff, farmers, consultants and researchers
Best Management Practices (BMP)	Industry-level management control (knowledge application)	Multifaceted coordination of solution transfer from industry-level to firm-level Open dissemination of privately developed knowledge	• Optimal processes developed out of R&D disseminated to cotton growers for implementation • BMP guidelines openly disseminated in a non-proprietary manner

Table 2
Timeline to support case findings and analysis.

Time period	Key events
1960s to mid-2000s	Transformation of the modern cotton industry to combat the systemic uncertainty posed by cotton pests.
1960s	Arrival of the three pioneer boundary spanners (Derera, Kahl and Hadley) into the cotton industry. Progressively other boundary spanners were added to the group of boundary spanners.
1972 to date	Establishment and ongoing operations of Cotton Australia and ACGRA as industry firms focused respectively on strategy and advocacy, and research direction and funding (respectively). ACGRA was absorbed into Cotton Australia in 2008.
1960–1990	Cotton Research Council was the key Australian Government funding agency for cotton research projects.
1990 to date	Establishment and operation of CRDC as an Australian Government business entity with responsibility for government funding of cotton research projects. Replaced Cotton Research Council.
1991	Design and implementation of the Environmental Audit to survey cotton growers and other relevant stakeholders to assess understanding of the impact of cotton pests and current cotton growing activities, and to gather information on changes needed to manage the systemic uncertainty.
1993–2012	Establishment and operation of the Cotton CRC which provided research skills and capabilities through partners to the cotton industry.
1993–1998	Intensive use of R&D projects and programs to develop new information to design improved cotton growing activities.
1998 to date	Design and implementation of BMP, incorporating information from R&D to improve cotton growing activities to manage systemic uncertainty.

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them in a coordinated manner across landscapes (not just properties). This was needed to ensure the survival of the cotton industry. To this end, the rise of individuals thinking beyond their own farms and investments in broader uniform approaches to tackling such problems at the industry-level were key to facilitating such responses.

4.2. Boundary spanner inter-firm behaviours – lower levels of tension

In our field setting, a new and evolving group of cotton growers and researchers acted to develop the industry in the belief that doing so would further the operations of their own firms and research interests. We class them as boundary spanners consistent with Dekker (2016). The boundary spanner, as an actor with expertise, operates beyond firm boundaries while holding an initial affiliation with a firm-level entity (Dekker, 2016). While it may be reasonable to argue that it is impossible to study all the potential boundary spanners who played a role in the development of the cotton industry, the boundary spanners discussed below represent an important and dominant set of individuals who exerted great influence on the cotton industry. In doing so, we illustrate the motivating factors underpinning their drive to contribute at the industry-level, and the manner by which they exerted their efforts to shape the industry response to the cotton pest challenge.

To this extent, three immigrant cotton researchers and farmers are noteworthy (McHugh, 1996). Nick Derera was a Hungarian and Soviet Union refugee, agricultural scientist and cotton grower who carried out research into cotton growing in the Narrabri region, discovering favourable growing conditions for large-scale cotton farms. Though a scientist by trade, he foresaw tremendous commercial opportunities inherent in the land and advocated for farmers to consider the region for cotton growing.

Paul Kahl and Frank Hadley were two American cotton growers struggling to grow cotton in Southern California. They saw the potential to be foundational partners in a developing cotton industry in Australia, and sought out Derera to explore the opportunity further. Derera, simultaneously acting as a researcher and industry advocate for the development of the cotton industry in Narrabri, actively encouraged Kahl and Hadley to come and grow cotton in Australia:

> Cotton growing in Australia has a great future … I wish to assure you that the climatic and environmental conditions desirable is available in NSW and especially in the Naomi Valley … …most of the present farmers are not accustomed to intensive farming … therefore this industry must depend on new young farmers or on migrant farmers who have experience with any type of intensive farming. (letter from Derera to Kahl and Hadley; McHugh, 1996:6–7).

In 1961, Kahl and Hadley established a small cotton farm in Wee Waa, near Narrabri and began to grow natural cotton on 60 acres of land. They were soon joined by other cotton growers, in particular Australians Frank Boyle and Vic Melbourne, who also started small cotton farms in adjoining areas around Narrabri. In 1962, these growers had their first successful cotton harvest (McHugh, 1996) but yields were hampered by pests. To commercialise and maximise their returns, these growers needed to improve cotton growing activities and technologies to combat cotton pests (McHugh, 1996), and also address other ancillary concerns such as the development of infrastructure to support the industry.

These early participants fully appreciated the need for collaboration and coordination across the cotton industry, between cotton growing firms and other stakeholders such as cotton research firms and cotton agribusiness consulting firms:

> I think some of the early leaders in the industry basically identified that the only way that they could make progress was to work together. So, there was that collaborative aspect right from the outset. (Cotton Agribusiness Consultant 2)

They understood the strategic importance of continually developing new cotton cultivars or varieties that were more resistant to cotton pests, requiring less use of harmful pesticides and less water but able to provide higher yields. They also understood the importance of new operational activities for growing cotton sustainably, protecting the natural ecosystems around cotton plants:

> My father was just absolutely committed to the value of research and the importance of research. It could have been just the fact that there was enough people around that saw that it was important enough to invest voluntarily in to make the industry work. (Cotton Agribusiness Consultant 3)

The three foundational pioneers of the cotton industry – Derera, Kahl and Hadley – exhibited related but different strategic business and leadership skills and used their skills collectively to go beyond the firm-level and play an industry leading role for cotton. They adapted their skills, from personal and professional experience, as individual managers, cotton growers and agricultural scientists. To these skills, the boundary spanners added soft skills (e.g., communication skills, negotiation skills) to provide leadership to the developing group of cotton growers and cotton researchers as they collaborated to develop the cotton industry and face the strategic challenge arising from cotton pests, a key source of systemic uncertainty. These foundational boundary spanners were joined by other actors in the industry who were prepared to operate as boundary spanners themselves, exhibiting multifaceted skills to develop coordinated actions to manage the systemic uncertainty arising from the cotton pest:

> In the old days, the industry was really governed by Auscott, Namoi Cotton and Queensland Cotton (large cotton firms). So, they would have more representatives on all the industry bodies like Cotton Australia, ACGRA [Australian Cotton Growers Research Association]. To their credit, they also would support their staff. But they would send growers, now people that are members of the co-op … to their gins to represent ACGRA, to sit on ACGRA and discuss these things. (Cotton Agribusiness Consultant 3)

The role of the boundary spanner in our setting appeared to be less contested and relatively free of conflict arising from their industry-level and firm-level roles (Anderson & Dekker, 2014; Luo, 2005; Richter et al., 2006). Boundary spanners ordinarily grapple for authority at the industry-level, seeking benefit for their own firm over broader inter-firm industry-level interests (Dekker, 2016; Richter et al., 2006). In our setting, boundary spanners seemed to be operating in an environment with low conflict between their firm-level and industry-level roles. As discussed by Casciaro and Piskorski (2005), inter-firm relationships become more parity-based relationships when all firms in the relationship face a common systemic uncertainty, reducing the power imbalance between collaborating firms. Our evidence indicates that boundary spanners need each other from two perspectives – to provide resources so that the industry can tackle the problem, and ensure the partaking of all boundary spanner firm-level entities in the solutions prescribed by industry-level innovations.

Boundary spanners therefore enter their interactions with

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others at the industry-level with less tension between their individual firm and broader industry-level roles. While prior boundary spanner studies have long identified uncertainty and environmental dynamism as adversely affecting the functioning of boundary spanners (Aldrich & Herker, 1977), contributing specifically to boundary spanner perceived stress and consequently impacting outcomes (Stamper & Johlke, 2003), we found that systemic uncertainty created a more enabling and supportive context for boundary spanning, leading to lower levels of tension in their roles as firm-level actors and inter-firm collaborators. Our findings on the role of boundary spanners provides an alternative insight into the role of boundary spanners; we next discuss the industry-level control implications of this cooperative theme underlying boundary spanner interactions.

4.3. Boundary spanner behaviours and hybrid organisational forms

In our field setting, in the absence of any dominant firm driving the collaboration as observed in Miller and O'Leary (2007, 2005a, 2005b), alternate mechanisms were developed to provide a platform to bring multiple firms together, to collaborate, develop coordinated activities, and identify solutions that enabled the management of systemic uncertainty to the industry. Boundary spanners realised that industry bodies (hybrid organisational forms) needed to be formed to provide a platform for multiple firms to connect, collaborate and develop coordinated activities to address the common challenges faced.

We consider these industry bodies as hybrid organisational forms as they represent a mix of industry-level entities with an ultimate profit driven motive at a firm-level, whose strategic direction and funding decisions were shaped by private actors comprising their foundational client base (cotton growers) as well as cotton researchers and other actors (e.g., government) pursuing the security of the cotton resource from a macroeconomic perspective. This conjoint influence of the public and private sectors is aligned to the stakeholder breadth element of hybrid organisations put forward in Thomasson (2009). Also, while there was a level of government involvement, the ultimate intention of these industry firms was to protect the cotton industry from systemic uncertainty arising from the cotton pest, directly facilitating the profit motive of private farmers (Valentinov, 2004).

The development of industry bodies, however, presented a costly endeavour requiring significant resources. The boundary spanners therefore initially established smaller, more narrowly focused industry firms that were managed by private cotton growers who strongly lobbied and advocated for strategic shifts in relation to regulation and policy process in the Australian cotton industry. We specifically identify four industry firms established over a period of time: Cotton Australia (CA), the Australian Cotton Growers Research Association (ACGRA), the Cotton Research Development Corporation (CRDC), and the Cotton Cooperative Research Centre (Cotton CRC). These industry firms were developed by key boundary spanners (e.g., Kahl, Hadley, etc.) who saw the need for a structured response to tackle systemic uncertainty, and who mobilised a wide range of skillsets themselves and in others to do so. They also focused on the industry's advancement with as much (if not more) focus than their own farms. Marshall (2015) cites James, son of Paul Kahl, explaining that his father invested more time into the development of hybrid organisational forms than his own cotton growing firm:

> James Kahl said his father's recognition of cotton farming's need for infrastructure and support services saw him focus more energy and time on helping build the industry in the 1960s and 1970s than building his family's own farming business interests. (Marshall, 2015) [9]

The first industry firm, established in 1972, was Cotton Australia (CA). Its purpose was to pool the views of cotton growers in the Narrabri region, acting as the entity driving advocacy, policy and strategy development for cotton growers. CA lobbied the Australian Government for investment in capital infrastructure (e.g., roads, rail, water) to support the development of the cotton industry. Unsurprisingly, cotton growers actively participated in activities organised by CA. Regional cotton grower associations (CGA) were set up to organise cotton growers by region and these CGAs became members of CA. CA was formally governed through a Board of Directors comprised of cotton growers. CA employed staff who were based in regions and worked closely with CGAs and cotton growers more generally.

Understanding the importance of R&D to improve cotton growing operational activities and new cotton technologies, the boundary spanners developed a second industry firm – the Australian Cotton Growers Research Association (ACGRA).[10] ACGRA provided strategic direction and funding for R&D projects, and importantly organised an accounting mechanism around which individual farmers implicitly contributed to tackling uncertainty through R&D. ACGRA raised funds from cotton growers through a voluntary levy on each cotton bale (paid by all cotton growers, though not compulsory). In doing so, the levy subsequently increased their vested interests in implementing the recommendations of the resulting cotton R&D projects.

ACGRA also lobbied the Australian Government for tax payer funds to support R&D within the industry. Research projects were funded by an Australian Government agency called the Cotton Research Council. As an example, at its meeting on 12 April 1988, the ACGRA Executive Committee reviewed progress on 32 projects which had received $1.2 m in funding from the Cotton Research Council. A further 43 new projects were approved and submitted to the Cotton Research Council with a requested funding amount of $1.5 m in total.

Our field data demonstrates the expansion of the remit of the industry firms. CA initially pooled the views of all firm-level members, and engaged in regulatory advocacy regarding industry infrastructure development. The research required to tackle systemic uncertainty drove it to then create a second industry firm, tasked with performing a strategic research function by identifying the longer-term systemic uncertainties facing the cotton industry, driving an agenda of key areas for research to address.

The third industry firm, the Cotton Research and Development Corporation (CRDC), was created by the Australian Government in 1990 under the *Primary Industries and Energy Research and Development Act 1989 (Cth).* Boundary spanners (founders and other individuals brought on by the founders to contribute to the industry firms) and their supporters within the cotton industry lobbied to establish this organisation. The minutes of the ACGRA Executive Committee held on 9 April 1990 document the role played by boundary spanners and their partners in lobbying:

> … meeting be organised at an early date with the Minister for Primary Industries and Energy to discuss both the role of ACGRA being the responsible industry firm to which the new R&D

[9] http://www.smh.com.au/comment/obituaries/paul-kahl-cofounder-of-modern-australian-cotton-industry-20150220-13k5cb.html (accessed 24 March 2017).

[10] ACGRA and Cotton Australia worked closely together in setting the strategic direction for R&D across the industry. In 2008, ACGRA was absorbed into Cotton Australia.

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Corporation (CRDC) would report to and also the eligibility of ACGRA members nominating as directors of the new corporation.

The CRDC was mandated to fund cotton R&D projects using tax payer funds and to take strategic direction on research from the ACGRA (and later, CA). We observed an expansion in the breadth of expertise within this body with the addition of a third industry-level firm (CRDC) reporting to the second (ACGRA), specifically sourcing revenue from the government (as opposed to growers) with a view to broadening the scope of funding for purposes of tackling systemic uncertainty. We also observed the expansion of individual cotton grower expertise as they, through ACGRA, reviewed and assessed R&D proposals which were of a scientific nature. Further, non-cotton industry stakeholders began to take a more formal and active role in the resourcing of the cotton industry, in this instance the Australian Government. We therefore witnessed a gradually wider net of stakeholders adopting an interest in the cotton industry, incorporating both public (government) and private (cotton grower) elements.

Finally, the Cotton Cooperative Research Centre (Cotton CRC) was established in 1993. This was a specialist research partner firm with responsibility for providing research skills to carry out the R&D projects funded by the CRDC and approved by ACGRA. The Cotton CRC brought together 11 core and 36 affiliate research partners to provide a strong research capability for the cotton industry. These partners included university-based research teams, private research firms, and government owned research organisations. The Cotton CRC conducted its research, development and extension programme through five streams: farm, catchment, community, product and adoption.

The industry firms provided a platform for inviting multiple firms within the cotton industry to collaborate and engage. The role of committees within the industry firms help to explain how this collaboration was enabled. The boundary spanners established a range of *industry* committees. For example, ACGRA deployed *internal* governance committees to bring multiple cotton firms, cotton research firms and other stakeholders together to strategize, develop strategic activities, assess current performance, and develop new cotton growing operational activities. A good example of this internal governance committee and how it was used is encapsulated by the ACGRA Executive Committee and its related sub-committees. The Executive Committee was established as the senior decision-making body of ACGRA; while formal membership was restricted to cotton growers, other actors (e.g., cotton researchers, agribusiness consultants, etc.) were regularly invited to attend and contribute to the discussions and decisions. This intermingling of individuals from a diverse range of skillsets allowed for the "mixing in" of apparently disparate skillsets, rendering complexity and "impurity" to the pursuit of a solution relating to the control of cotton pests. In this sense, the industry firm revealed itself as a hybrid form. The hybrid industry firms were also funded both publicly by the Government, as well as privately by cotton growers (based on a levy per bale of cotton). The simultaneous public-private resourcing of the activities of industry firms strongly aligns with the notion of a hybrid organisational form.

To specifically evidence the plurality in skillsets marshalled to achieve its core purpose around managing cotton pests, we explain the activities of the Transgenic and Insect Management Strategy (TIMS) Committee and the subsequent introduction of transgenic cotton.[11] Formed in 1995, three key strategic objectives were established for TIMS Committee were: to design a management strategy to preserve current and future insect management systems; to correct/change the insect resistance management strategy in accordance with conditions such as chemical shortages or exceptional *Heliothis* problems; and to "police" the application of the strategy and provide approvals for deviations it.

The committee membership was broad and multifaceted, comprising individuals from a highly diverse set of professional backgrounds which was ultimately key to the attainment of their objectives. It comprised five cotton growers from ACGRA, three cotton researchers, one representative from a global biotechnology firm, two representatives from Cotton Seed Distributors (CSD), a specialist provider of cotton seed, one representative from the Queensland Department of Primary Industry, one cotton agribusiness consultant, and one chemical company representative. The committee was chaired by a cotton grower who was also a member of the ACGRA Executive Committee. From its inception, the focus of the TIMS Committee was on a collaborative, interdisciplinary pursuit towards the development of transgenic cotton, involving a "negotiated consensus":

> It took a couple of meetings convened by ACGRA, and the organisational membership of the committee was determined, what its scope would be and what it would do and off it went … That was a pretty big thing for the industry to do but it needed broad support. So that's where the kind of industry committee evolved, so it wasn't Cotton Australia or CRDC telling everyone what to do, it was broad – so the committee tries to operate through negotiated consensus. (Cotton Agribusiness Consultant 1)

The industry firms and related committees (internal and industry) therefore provided cotton growers within CA and ACGRA the ability to draw upon a wide array of skills from stakeholders to address the multifaceted challenges posed by the systemic uncertainty, fundamentally requiring a hybrid form (Miller et al., 2008). The membership driven, not-for-profit cooperative ownership structure of CA and ACGRA in pursuit of solutions for profit-seeking firm-level participant members (cotton growers) also reveal the central tenets of a hybrid form (Doherty et al., 2014; Ménard, 2004; Valentinov, 2004). Finally, the simultaneous role of government ownership and private sector influence in the CRDC and the Cotton CRC, alongside the public dissemination of R&D innovations (Ciesielska, 2010), provide additional characteristics of hybrids.

We emphasise the critical nature of these hybrid elements for addressing the systemic uncertainty concerns. First, tackling systemic uncertainty from multiple perspectives required multifaceted skills (boundary spanners) and governance structures to embrace this diversity in skills that are non-traditional. Second, the "buying in" and voluntary participation of members at the industry-level required accounting systems (voluntary levy) that encouraged the resourcing of activities within the hybrid forms while simultaneously raising the likelihood that all firm-level participants will implement the R&D resulting from these investments. The R&D outcomes were made publicly available in an open source manner to further the likelihood that all participants will implement them. This is highly characteristic of a hybrid form (Thomasson, 2009).

Finally, industry firms afforded opportunities to cotton growers that were not involved in their governance structures to identify with the issues and challenges arising from the systemic uncertainty through another internal interaction mechanism – the bi-annual cotton conference. This conference provided a forum for all cotton growers and researchers to share information on research project findings, discuss specific ecological challenges, and operationalise research outcomes, enabling collaboration between

[11] Transgenic cotton is genetically modified cotton which has higher resistance to cotton pests and is now used widely within the industry.

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researchers and growers.

> Cotton conferences in Australia have been an instrument used to overcome geographical and social challenges by bringing communities together, sharing ideas and research, and uniting growers. Conferences became a showcase for local research and became a key resource for both early adopters and prospective growers. It was also used to address industry-wide matters. (A historical geography of cotton farming in NSW and QLD: Adaptation and adoption:15)

4.4. Hybrid industry control processes

The unique resource dependence we observed in our setting drove the conduct of boundary spanners (key founders), who saw benefit in acting beyond their own firm-level in order to maximise their own outcomes. This led to low tension between their firm-level and inter-firm level pursuits. Having formed the hybrid organisational forms, activities needed to be organised and conducted in order to tackle the systemic uncertainty. These activities by the four industry firms yielded a range of industry-level control processes. For the purposes of our study, we focus on three hybrid control processes that significantly shaped the design and implementation of a solution to the systemic uncertainty posed by cotton pests. In doing so, we speak to a broader theoretical significance of the study – explaining the role of boundary spanners in yielding hybrid organisational forms that release hybrid control processes for purposes of solving a systemic uncertainty.

We investigate how hybrid control processes contributed to the appraisal, resolution and communication of solutions to firm-level participants. Specifically, the Environmental Audit was designed to appraise the extent of the systemic uncertainty from the activities of the cotton pests and related cotton growing activities of cotton growers; the R&D facilitation activities labelled "The Program" contributed to resolving the problem by offering a system for mobilising the development of new information and resulting cotton growing processes. Finally, from the program, "Best Management Practices" (BMP) guidelines were publicly disseminated from the inter-firm level to the firm-level in order to improve cotton growing across the industry and better manage the systemic uncertainty.

4.5. Hybrid industry control processes: the environmental audit

A key activity undertaken by CA was the development of an industry-wide performance appraisal mechanism, known as the Environmental Audit (the audit), to assess the current cotton growing performance in greater detail. The audit was designed to "identify major environmental issues relating to the Australian cotton industry and to assess the overall performance of the industry with respect to these issues" (Gibb, 1991, p. 1).

The audit surveyed all cotton growers, cotton researchers and other relevant stakeholders. Archival records and interviews with growers, researchers and other stakeholders were used to collect data on cotton growing processes and their impacts on the environment and on the economic performance of cotton growing firms. The audit led to 69 key recommendations covering a range of cotton growing activities including the use and storage of pesticides, the management of land, the use and conservation of water, as well as the growing, harvesting and processing of cotton.

The audit was a voluntary survey of all key stakeholders and widely considered the first of its kind globally. Further, it was developed by multiple public and private stakeholders. CA, with the assistance of private agri-business consultants and researchers from the Australian Government's Commonwealth Scientific and Industrial Research Organisation (CSIRO), developed the survey to be administered to all target participants industry-wide. Second, it was administered not only to cotton growers, but also to researchers and consultants, to capture the breadth of challenges inherent in managing the issues related to the systemic uncertainty. Finally, the audit was administered voluntarily by participants, which is uncharacteristic of an "audit", and was completed by the majority of target participants owing to its criticality.

In the early 1990's, around the time of the audit and prior to developing new information for improved cotton growing, the extensive use of pesticides was directly contributing to the creation of systemic uncertainty – the growth of more pesticide resistant pests. Understanding how the problem might be tackled required an appraisal of current grower and researcher/consultant activities, and all stakeholders appreciated its importance.

> Cotton's response to mounting pressure in the late 1980s and early 1990s was to commission the now historical Environmental Audit in 1991. Addressing its findings … provides a focus for solid foundation for best practice. The means by which the cotton industry will steer itself through the increasing political and environmental pressures is by adhering strictly to an industry code of practice or best practice guidelines (CA Annual Report, 1992: p5-refer Appendix 2).

CA lacked knowledge and information on the specific impacts of chemicals on the cotton farming environment and on surrounding riverine and other ecosystems, including their impact on beneficial insects. This information had to be developed collaboratively and with the active involvement of cotton growers, researchers and consultants. The in-depth analysis of audit data revealed that in many instances the actual effects of current cotton growing activities on the external environment were not known and more information through R&D was needed to understand these effects. Theoretically, the attributes of hybrids are observed in the workings of the audit. Through its novelty, unexpected methodology and presence of a diversified public/private stakeholder base, the audit exhibited the characteristics of a hybrid control process.

4.6. Hybrid industry control processes: project management system – 'the program'

Armed with information on knowledge gaps, boundary spanners turned to R&D facilitation processes to develop new knowledge that could improve cotton growing. This necessitated the implementation of control processes to facilitate the conduct of R&D. Accounting research has documented the role of R&D facilitation processes in "controlling" the conduct of R&D and innovation pursuits of different types of firms (Abernethy & Brownell, 1997; Bisbe & Otley, 2004; Chenhall, Kallunki, & Silvola, 2011; Revellino & Mouritsen, 2009). These studies identify a range of control processes such as personnel controls, planning, performance measurement, budgeting and other administrative functions as enabling and facilitating R&D processes to develop new information. However, settings such as Intel (Miller et al., 2008; Miller & O'Leary, 2007) were characterised by the conduct of R&D at the firm-level. We explain how the project management system in our setting acted as a hybrid control process, driving an approach to tackling R&D at the inter-firm level, subsequently leading to the identification of systemic uncertainty solutions.

An example of a structured R&D facilitation process was the project management system implemented to facilitate the planning and development of processes surrounding the *Helicoverpa* pesticide resistance R&D Program, known simply as 'The Program'.

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Developed by ACGRA, The Program served to organise the behaviours of key individuals partaking in the R&D process through a series of program objectives, key activities and monitoring of activities against these objectives (Revellino & Mouritsen, 2009). The Program became a key focus of ACGRA's efforts to use R&D to develop new information for improved pesticide resistant cotton growing. Structured as a 5-year process with multiple smaller projects, The Program brought together cotton researchers and cotton growers to collaborate and develop new knowledge and information that yielded improved cotton growing processes.

A sophisticated project management system (PMS) was developed and implemented to facilitate all aspects of The Program. This PMS had a number of important features. First, a committee was established to manage The Program. The committee were responsible for setting the objectives of The Program, agreeing on R&D priorities, designing the research program (including phases and research projects), and the financial and operational management of The Program. Strategic direction was established based on three objectives:

1. Assess the impact, if any, of current pesticide use on the riverine environment.
2. Develop practical and economic methods to minimise the transport of pesticides from application sites (i.e., cotton farms) and to minimise their effects on the riverine environment.
3. Provide a sound scientific basis for the development of management guidelines and regulatory codes for cotton growers.

Second, the committee comprised a wide range of stakeholders, including public bodies such as the government owned CRDC and other stakeholders both within and outside of the cotton industry, including sectors such as water resources and irrigation. A cotton grower who was involved with a number of firms and forums within the cotton industry described The Program as a:

> … huge cooperative venture involving research funders, a range of research providers and the cotton industry. Progress is usually achieved through cooperative effort and this program has highlighted such benefit.

Third, the committee established the direction which was embedded in the three strategic objectives set for The Program. Highlighting the importance of systemic uncertainty and related issues (e.g., pesticide resistance) and prior industry-wide inadequacies in responding to this threat, a cotton grower from a major private cotton grower firm described it as follows:

> The Australian cotton industry, perhaps more than any other agricultural enterprise, has been at the epicentre of tension over agricultural practice. Clearly, the use of chemicals and concern for the riverine environment has been key pressure triggers.

Fourth, the PMS established specific performance outcomes that were communicated to all stakeholders and operated as a measurement control to manage the performance of The Program. These performance outcomes were developed for The Program as a whole and for each Phase, used to focus and influence managerial behaviour to achieve the strategic direction. The performance outcomes for The Program overall included the identification of all impacts of operational activities in relation to pesticides on the riverine and aquatic ecosystems, and the development of improved operational activities to reduce the environmental footprint of cotton growers. These performance outcomes helped to focus the behaviour of managers towards meeting the strategic direction by helping to change operating processes, as described by one cotton grower:

> … best practices provide a process for benchmarking and where necessary methodical and rational change in management systems. It also provides a vehicle for cultural change.

Finally, the R&D facilitation efforts were largely considered successful, as they led to the conduct of research that was integrative and collaborative, strongly involving cotton growers in the process:

> … we were blessed by researchers that didn't just sit at the research station and do their research and publish papers … These were guys that went out into the fields and spoke to farmers (cotton growers), got feedback … there was always very much a working relationship, certainly a core of the really respected researchers … they have these relationships with growers where they will just ring them direct and say, I have got this bug (cotton pest), what is it or how do I manage it or whatever … the industry was also very blessed in having very, very good researchers … it had a very positive sense about the value of research … there was real tangible successes … from investing in the research. (CC3)

Theoretically, the Program revealed attributes aligning it to a hybrid control process. More generally, it was developed to regulate industry-level knowledge development at the inter-firm (industry-level), and required the coordination of multi-faceted skillsets to develop an inter-firm solution. These two attributes of hybrids reveal themselves through this control process.

4.7. Hybrid industry control processes: best management practice (BMP)

Best Management Practice (BMP) is best described as an industry-level management control process.[12] Theoretically, BMP might also be regarded as a hybrid process (Miller et al., 2008) as it represents the universal and public dissemination of a set of activities from the inter-firm level to the firm-level, and was also developed from R&D projects identified and funded by the CRDC and CRC (government bodies) for a profit motive (the continuing profitability of individual cotton grower operations). Its transcending from inter-firm to firm-level as well as its public funding links to private industry benefits characterises it as a hybrid control process. All cotton growers were afforded access to the BMP, and indeed, they were made public in broader research forums to maximise their reach, though funded in part by the private contributions of cotton growers through the cotton bale levy ($2.00 per bale).

BMP is a solutions implementation tool deployed by CA to directly influence the behaviours of farmers with a view to overcoming a key systemic uncertainty (pest resistance), thereby attaining the longer-term objectives of the industry. BMP relies on a set of management accounting activities (benchmarking and target

[12] We note our use of the term "**process**", in explaining "Best Management **Practices**" (BMP). Consistent with Paroutis and Pettigrew (2007), we argue that practice and process are similar in their focus and activities, especially within organisational settings. More generally, process is defined as a "series of actions or steps taken in order to achieve an outcome" (Oxford Dictionary). This definition aligns closely with BMP as it is applied in the cotton industry, causing us to term it a "process", though it was labelled as a "Practice" by the relevant cotton industry decision maker(s).

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setting), communicated as a set of policies and procedures (Malmi & Brown, 2008; Merchant & Van der Stede, 2012) that provide information on improved aspects of cotton growing to tackle pesticides. In our setting, it enabled individual firms to benchmark their current operational activities and identify the improvements required, providing a:

> … process for benchmarking and where necessary methodical and rational change in management systems and a basis for cultural change. (Boundary Spanner, Pesticide Conference address, 1998)

This approach was recommended by external consultants who reviewed the work undertaken by the industry research projects (e.g., The Program):

> Emphasis should be shifted to supporting Phase 2 of the research program, i.e., to identify and test potential methods for ameliorating problems by supporting proposals for … development of a comprehensive Best Management Research Project … a Best Management Practices Manual should be developed for use by growers and consultants (CR Harris, University of Guelph, Ontario, Canada, Independent Program Review, Jan 1996:4).

The adoption of BMP was organised by managers at CA who helped train and communicate them to growers, helped them with the assessment of their current activities, and helped them plan for changes to activities not in line with BMP. A cotton agribusiness consultant who was involved in this process described how these teams from CA helped growers:

> Cotton Australia had a team of people trying to get them to adopt it … So, the sorts of things that happened, from memory back then, were Cotton Australia people getting the growers to do the rankings and self-assessments and do things. (Cotton Agribusiness Consultant)

The first version of the BMP was released as a 70-page, hard copy manual in 1996 grouped under four major headings: farm design and management, pesticide application, integrated pest management (IPM), and pesticide storage and handling. The focus of the BMP manual was on three key issues: how the BMP should be used, how growers should be engaged to enable adoption of best practices, and how compliance to best practices should be monitored. The focus was to ensure that the:

> Manual really is a manual … that is something that is used (not just read), as the word manual implies. (Cotton Consultant 3, Pesticide conference presentation, 1998)

The BMP manual first required growers to conduct a self-assessment of their individual operational activities. Self-assessment worksheets with a series of questions were included for each category, which allowed the grower to assess their practices and identify risks. The use of risk ratings (from 1 – low risk, to 4 – extreme risk) allowed the grower to identify high priority areas within their activities that required action plans to enable improvements to be made.

Second, for critical issues identified in high risk (3–4 rating) categories, the BMP Manual provided another framework. This framework took the form of hazard identification and analysis, and led to a specific set of activities tailored for a farm that could be implemented incrementally by the grower. Rather than design a prescriptive set of processes, the grower is able to develop:

> … their own best management practices and to check them against some standard issues included in the Manual … [This process] alerts people to key issues and potential problems while allowing them to develop a set of practices with accompanying monitoring systems which suit their specific circumstances and operations. (Cotton Consultant 3-Pesticide conference presentation, 1998)

On-farm environmental outcomes have been significantly improved by the adoption of BMP, directly improving grower management of the systemic uncertainty – the threat of pests and pest resistance:

> [They] have played a role in the reduction in the use of pesticides on-farm and the significant increase in the level of professionalism in pesticide application … the result has been a reduction in total sprays, a reduction in the occasions when sprays have not reached the target pest and/or weed, and a reduction in the number of odour and spray drift complaints about spraying practices on-farm. (Macarthur Agribusiness, 2004:1)

5. Discussion

Global challenges can be multifaceted and complex (IPCC, 2014; Uetake, 2015), creating systemic uncertainty impacting many if not all firms in an industry (Tashman & Rivera, 2016). The antecedents to and operation of management control systems at the interfirm-level to address systemic uncertainty remain less understood in accounting research (Caglio & Ditillo, 2008; Dekker, 2016).

Cotton pests pose a critical strategic threat to the cotton industry in Australia (Fitt, 1994), and indirectly, the broader Australian economy through its impacts on other cotton dependent industries. In our case, cotton firms and cotton growers were also faced with the reality that no single grower possessed the requisite financial resources or intellectual capital or know-how to construct a durable solution to the cotton pest problem. Further, even if one did (and none could), the execution of the solution required universal implementation by cotton firms to prevent a recurrence of the systemic uncertainty (cotton pests).

The lack of a dominant partner and the inability of any individual firm to resource and subsequently solve the problem alone are key differentiating aspects in our context – this provides the basis for novel explanations regarding our development of inter-firm relationships when compared to other inter-firm control studies, such as the Intel studies by Miller and O'Leary (2005a, 2005b, 2007). The important consideration subsequently for cotton firms was not *if* they needed to collaborate but *how* they coordinated their activities to develop new industry-level structures and processes to manage the multifaceted, systemic uncertainty created by cotton pests. We observed key individuals transcending their firm-level responsibilities to develop industry bodies (hybrid forms) and a series of novel, industry-level activities (hybrid control processes) to effect a control solution, disseminated to firms who wholly implemented the solution.

While organisations may respond as a collective in a number of different ways, we offer a novel explanation of multi-firm collaboration not discussed to date in the accounting literature. We use a theoretical lens relating to a less investigated resource dependence form (low power imbalance, high mutual dependence) described by Casciaro and Piskorski (2005), that is becoming increasingly prevalent in the face of industry-wide challenges faced by different sectors. Using this theoretical lens, we explain how hybrid forms

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and hybrid control processes developed to respond to systemic uncertainty, and the importance of the low tension among boundary spanners driving the development of hybrids at the inter-firm level. These will be expanded upon to clarify our two primary contributions.

Using this novel resource dependence combination, our first contribution is to theoretically broaden the range of characteristics encapsulating hybrids in order to explain how hybrid organisational forms and hybrid control processes interact. Hybrids are dominantly regarded as possessing *novel arrangements* existing at an *inter-firm* level in management accounting research (Miller et al., 2008). How different hybrids interact with one another remain less explored in extant accounting studies. We explain how, by mobilising a broader conceptualisation of hybrids in accounting literature to acknowledge the potential *public/private* (Thomasson, 2009) and *open source* (Ciesielska, 2010) attributes of hybrids, previously not discussed in accounting studies. These broader conceptualisations were crucial to enabling the working of our hybrid relationships. The public/private hybrid attribute clarifies *how* hybrid forms were resourced, with public sector involvement necessitated by the economic importance of the cotton industry and driving government support financially, then gradually expanding to include a wider range of resources and subsequent ownership of some hybrid organisational forms. This gradual widening of participation by government across a series of hybrid forms at the industry-level to support firm-level outcomes in the industry is less documented in the literature. From an industry perspective, the substantial investment put forward by cotton farms (firms), via the cotton bale levy, is a considerable investment into R&D, whose solutions are not privatised by the industry but made open to all (*open source*) owing to the industry-wide implementation required to counter systemic uncertainty.

Our second contribution is to mobilise the resource dependence view to explain how the less cited inverse relation between boundary spanner tension and inter-firm collaboration (Anderson & Dekker, 2014; Coletti et al., 2005; Dekker, 2016) arises in our setting. We note that the lack of tension between the firm-level and inter-firm activities of key individuals (boundary spanners) as a result of the unique resource dependence combination drove their efforts to work together and mobilise inter-firm activities that were beneficial to all participants beyond their own firms. When faced with systemic uncertainty that no individual firm could overcome, key individuals in firms transcended to conduct industry-level work to mobilise the industry, required to resolve firm-level problems. There is therefore little tension between their industry-level work and their firm-level work. The lower tension observed in our setting has been discussed less in the literature, as the dominant dyadic inter-firm research (Dekker, 2016) is characterised by adversarial relations between partners, leading to boundary spanner tension (Levina & Vaast, 2005). Our findings contrast Levina and Vaast (2005), explaining the capacity for boundary spanners to mobilise inter-firm behaviours constructively in ways that reinforce all participants in the collaboration. In doing so, we provide valuable evidence advancing Dekker's (2016) call for studies clarifying how inter-firm management controls operate beyond dyadic relationships, in parity-based (low power imbalance) environments. Parity-based relationships, such as that observed in this setting, have been called for more concertedly in extant accounting research (Caglio & Ditillo, 2008).

Over time, the Australian cotton industry collectively managed the systemic uncertainty arising from the activities of cotton pests. This transformation is eloquently captured in the comments of a cotton agribusiness consultant:

> If I was to be able to take us to a field of cotton, even in 1992, let alone 1982, really only the plants would be recognisable today. The way we grow the crops changed, the way it's protected from insects has changed. The way it is watered has sort of changed to a large degree. The way it is picked has changed. It is amazing really and yet I don't know that anyone necessarily stood there in '92 or '82 and said, this is what we want to see, this is what we'd like.

An outline of the boundary spanners, hybrid organisational forms and hybrid control processes that emerged in our setting is provided in Table 1.

Finally, and more empirically, we also provide insights into the operations of management controls in an agricultural setting, a setting which has received less attention in the management accounting and control literature (Argilés & Slof, 2001; Jack, 2005) but which is widely expected to grow in importance as broader factors surrounding population growth and food security intensify. Contextually, the continual threat of pests and pesticide resistance to all agricultural producers, not just cotton, will require industry-level responses beyond that which can be tackled by any one producer or other stakeholder. To this extent, our findings add to industry specific understanding of the role of inter-firm controls to address these threats (Messner, 2016).

6. Conclusion

Understanding how multiple firms (beyond a dyad) collaborate and carry out industry-level collaborations to manage systemic uncertainty remains less studied in the inter-firm management control literature (Caglio & Ditillo, 2008; Dekker, 2016). We develop knowledge on how multiple firms coordinate activities to manage systemic uncertainty. We do this by highlighting the importance of boundary spanner behaviour in the absence of tensions, and its consequent effects on hybrid forms and hybrid control processes in this industry-level venture. First, we explain how boundary spanners engage in industry-level efforts to mobilise private and public resourcing of hybrid organisational forms as a platform from which to deploy hybrid industry-level management control processes. These control processes appraise, solve and distribute solutions so that systemic uncertainty at the firm-level is managed while achieving broader industry-level objectives. These industry-level management controls (Environmental Audit, R&D facilitation initiatives, and BMP) were developed to function as coordinating mechanisms to enable collaboration between firms and to develop information which firms can use to manage systemic uncertainty.

Moving forward, our study might be extended to the observation of other types of hybrid elements. We did not observe hybrid practices in our study, but only hybrid organisational forms and hybrid control processes. Indeed, the distinction between hybrid practices and hybrid control processes (Miller et al., 2008) remains less understood, and we explained that our data related more closely to processes than practices. Studies that elaborate on these and their inter-linkage to the operation of controls in other industries will further add to our understanding in this space (Messner, 2016). What types of controls exist, and how they are developed and used, will help build a more coherent understanding of strategic responses by firms faced with systemic uncertainty beyond the cotton agricultural setting.

As previously stated, we also found and analysed a particular combination of hybrid elements. Perhaps such interactions manifest differently in other settings, when influenced by theoretical impetus other than resource dependence borne from systemic

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uncertainty. These alternative hybrid element interactions across firm and industry-levels will aid in shedding greater light on how hybrids impact the mobilisation of controls in inter-firm settings.

We acknowledge limitations in our field study. First, the findings from a single industry-level case may be less relevant to other settings. The characteristics of industry-level management controls and hybrid organisational forms examined might manifest differently in other settings and further research on these issues in different settings will prove useful. More research on how firms manage systemic uncertainties and what different strategic responses are usefully made to manage these uncertainties in alternative settings will build a more coherent understanding of the hybrid-control interrelation. Second, studies applying more aggregated data from a wider range of firm settings will supplement the in-depth findings from a single case that our study has provided. Third, our in-depth case could not consider the evidence of every single individual exhibiting boundary spanner behaviour and we also concede that other management control processes not highlighted to us in the field may exist, which might exhibit hybrid attributes. Despite these limitations, our study makes an important contribution to our understanding of how hybrids interrelate to drive the management of systemic uncertainty at the industry-level (Dekker, 2016).

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Appendix 1. List of interviews.

Stage	Interviewee	Type	Method	Duration
Familiarisation/preparation	Policy officer, Cotton Australia	Face to face	Taped	1 h
	Independent Consultant	Face to face	Notes	2 h (two interviews)
	Senior Executive, CRDC (CC2)	Face to face	Notes	1 h
	Senior Executive, Cotton Australia	Face to face	Notes	1 h
	Research Manager, Cotton Australia (CC1)	Face to face	Notes	1 h
Primary data collection	Senior Manager Cotton Firm	Face to face	Taped	1 h
	Senior Manager CRDC	Face to face	Taped	2 h
	BMP Officer, CMA/CRDC	Face to face	Taped	40 min
	Cotton Consultant	Face to face	Notes	1 h
	Senior Executive & Senior Manager, Cotton Firm	Face to face -group interview	Taped	1.5 h
	Marketing Manager, Cotton Firm	Face to face	Taped	2 h
	Human Geographer/Researcher, UNSW	Face to face	Notes	1 h
	Program Manager, CRDC	Face to face	Notes	2 h
	Regional Executives 1 & 2, Cotton Australia	Face to face -group interview	Notes	2 h
	Regional Executives 3 & 4, Darling Downs, Cotton Australia	Face to face -group interview	Notes	1 h
	Senior Marketing Executive, QLD Cotton Firm	Face to face	Taped	1 h
	Program Manager, Cotton CRC	Face to face	Taped	1 h
	Senior Executive (CC2), CRDC	Face to face	Taped	2 h (2 interviews)
	Senior Operations Executive, Cotton CRC	Face to face	Taped	2 h
	Senior Executive, Cotton CRC	Face to face	Taped	2.5 h (three interviews)
	Education & Extension Program Leader, Cotton CRC	Face to face	Taped	1 h
	Project Management Officer, Cotton CRC	Face to face	Taped	1 h
	Board member 1, Cotton CRC	Face to face	Taped	1 h
	Board member 2, Cotton CRC	Face to face	Taped	1 h
	Managers 1 & 2, Cotton CRC	Face to face – group interview	Taped	1 h
	Program Leader, Cotton CRC	Face to face	Taped	1 h
	Board member (DA), Cotton CRC	Face to face	Taped	1 h
	Research Manager, Cotton Australia (CC1)	Face to face (over 2 days)	Taped	4 h (two separate interviews)
	Ex-Senior Executive, Cotton Australia	Face to face	Taped	2 h
	Senior Executive, Cotton Australia	Face to face	Taped	1 h
	Senior Executive, CRDC	Face to face	Taped	1 h
	Program Manager (CC3), CRDC	Face to face	Taped	2 h
	Directors (1&2), Public Accounting Practice	Face to face – group interview	Taped	1.5 h
	Senior Manager, CRDC	Face to face	Taped	1 h
	Senior Executive, Cotton Seed Firm	Face to face	Taped	1 h
	Research Scientist, CSIRO	Face to face	Taped	1 h
	Principal Research Scientist, CSIRO	Face to face	Taped	1 h
	Project Officer, NSW Dept of Primary Industry (DPI)	Face to face	Taped	1 h
	Senior Research Scientist, NSW DPI	Face to face	Taped	1 h
	Research Program Leader, CSIRO	Face to face	Taped	1 h
	Director & Principal Research Scientist, NSW DPI	Face to face	Taped	1 h
	Research Agronomist, NSW DPI	Face to face	Taped	1 h
	Team Leader, CSIRO	Face to face	Taped	1 h
	Retired Research Scientist, CSIRO	Face to face	Taped	2 h
	Total Interviews & hours	54		59 h 10 min

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Appendix 2

List of archival records examined.
Industry reports/publications/news articles

1. Cotton Pest Control in Australia Before and After Bt Cotton: Economic, Ecologic and Social Aspects, David Murray, Department of Primary Industries, Toowoomba
2. Management of pyrethroid and endosulfan resistance in *Helicoverpa armigera* in Australia, *Bulletin of Entomological Research*, Supplement Series, September 1998
3. Impacts of Bt transgenic cotton on integrated pest management, Steven Naranjo, *Journal of Agricultural and Food Chemistry*, 2010
4. Review of Insecticide Resistance Management Principles in the Australian Cotton Industry, NSW Department of Primary Industries and Australian Cotton CRC
5. Prevention and Management of Insecticide Resistance in Vectors of Public Health Importance, Insecticide Resistance Action Committee, 2011
6. *Communication Plan*, Discussion Paper, TransFact, April 1994
7. Economic, Environmental and Social Sustainability Indicators of the Australian Cotton Industry, Guy Roth, 2010
8. The Australian Cotton Water Story: A Decade of Research & Development 2002–12, Cotton Catchment Communities CRC Limited
9. A Historical Geography of Cotton Farming in NSW and QLD: Adaptation and Adoption, Wendy Shaw, UNSW, 2012
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Appendix 3. Field observation data.

Date/Duration/ Location	Group	Purpose	Data collected
17 April 2012 2 Hours 50 min CRDC office, Narrabri, NSW	Project Steering committee-3rd Environmental Audit	The role of the committee was to manage the audit process and to review the preliminary findings Participants on the committee included managers from Cotton Australia, CRDC, Cotton CRC, cotton consultants and cotton growers	Audit process Coverage of cotton growers Audit questions Audit responses Emerging issues and trends Problems with the audit process
5–7 August 2012 24 h Broadbeach, Gold Coast, Australia	Australian Cotton Conference	Bi-Annual industry conference providing a forum for cotton growers, cotton researchers and other industry stakeholders to meet, discuss and share information	R&D projects and outcomes Industry information and knowledge Contacts for further interviews and data access
20 November 2012 2.5 h Swiss Grand Hotel, Bondi	Cotton Australia Research Panel: Human Capacity	The panel is one of four research panels set up to request, review and approve R&D projects for the cotton industry Membership on the panel included cotton growers, cotton researchers and managers from Cotton Australia and CRDC	R&D approval & monitoring process Details on specific R&D projects Links between R&D projects and strategy process Problems with R&D projects New R&D project ideas
20 November 2012 2 h Swiss Grand Hotel, Bondi Junction	Cotton Australia Research Panel: Bio Security	The panel is one of four research panels set up to request, review and approve R&D projects for the cotton industry Membership on the panel included cotton growers, cotton researchers and managers from Cotton Australia and CRDC	R&D approval and monitoring process Details on specific R&D projects Links between R&D projects and strategy process Regulatory issues Problems with R&D projects New R&D project ideas
21 November 2012 2 h Swiss Grand Hotel, Bondi	Cotton Australia General Members meeting	General meeting of cotton grower members of Cotton Australia Forum for updating members on key strategic and operational issues Participants included cotton growers, managers from CRDC and Cotton CRC, cotton consultants and cotton researchers	Strategy process update including key strategic issues and challenges R&D project approval and monitoring updates Information and ideas on new issues and challenges Regulatory and stakeholder issues Marketing and value chain issues

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