

Social licence in natural resource dependent industries: Improving understanding and integrating economic perspectives

Nikki P. Dumbrell

A thesis submitted for the degree of Doctor of Philosophy
Centre for Global Food and Resources
School of Economics and Public Policy
The University of Adelaide

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Abstract

A firm with an (intangible) social licence enjoys ongoing acceptance or approval by stakeholders that: (1) are affected by the firm's activities; and (2) can influence the firm's profitability or ability to meet other objectives. However, the social licence concept has a history of practical interpretation and measurement ambiguity. This thesis attempts to bring clarity to the understanding and analysis of the social licence concept and outcomes using economics perspectives. The research crosses various disciplinary boundaries and uses qualitative and quantitative data analysis techniques to address this overarching objective, including a systematic review of the social licence literature, a qualitative comparative analysis of social licence outcomes, and multimethod analyses of case studies.

The systematic review details the origins of the social licence concept and its current uses. The review was also used to draw connections between the social licence and welfare economics literature and illustrate that affected stakeholders tend to raise social licence concerns in response to market and government failures, namely: (1) negative externalities; (2) undersupply or threats to public goods; and (3) use of socially valuable assets to generate private profits.

Natural resource case studies identified in the systematic review were used in the fuzzy-set qualitative comparative analysis to test for conditions associated with social licence outcomes and firm behaviour change. The results, based on 47 case studies from 25 countries, highlighted that the loss of a social licence was not a sufficient condition for firm behaviour change, and no single condition alone was necessary or sufficient to produce particular social licence outcomes. However, a combination of five conditions was sufficient for a social licence, namely: (1) delivery (or perception) of net economic benefits beyond the firm/project, i.e. to affected stakeholders; (2) adequate stakeholder consultation; (3) minimal media coverage; (4) minimal public protests; and/or (5) absence of well-defined and enforced private property rights. These results highlight that conditions within and beyond a firm's control influence social licence outcomes.

The key outcomes from the systematic review and qualitative comparative analysis were used to guide case study investigations, focussed on the agricultural and energy (future fuels) industries in south-eastern Australia. The case study investigations used data from three surveys (public survey, n=2,032; farmer survey, n=351; and a survey of landholders with a high-pressure natural gas transmission pipeline easement, n=126). Social licence concerns in these industries were shown to be underpinned by market and government failures. Further, econometric methods (e.g. fractional multinomial logit models) were used to identify influences on and heterogeneity in stakeholders' social licence concerns, and the trade-offs certain stakeholders were willing to make in decisions to grant a social licence in the focus industries.

This research presents a novel understanding of social licence, and describes conditions associated with social licence outcomes. It provides a starting point for greater integration of economics perspectives into social licence research and suggests pathways for this. It also reinforces the importance of interdisciplinary research to identify and overcome the challenges that are highlighted by social licence debates in natural resource dependent industries.

Thesis declaration statement

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Conference papers and seminars

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- Dumbrell, N.P.**, Adamson, D., Wheeler, S.A., Zuo, A. (2020) Is social licence a response to government and market failures?, *Australasian Agricultural and Resource Economics Society 64th Annual Conference, Perth, Australia, 10-14 February 2020*.
- Dumbrell, N.P.** (2019) Economics and the 'social licence to operate' for natural-resource-dependent industries, *Australasian Agricultural and Resource Economics Society 63rd Annual Conference, Melbourne, Australia, 12-15 February 2019*.
- Dumbrell, N.P.** "Looking at the social licence concept through an economics lens", invited public seminar for Food Values Research Group, Faculty of Arts, The University of Adelaide (December 2019).

Additional publications during candidature broadly related to this thesis

- Loch, A., Adamson, D., **Dumbrell, N.P.** (2020) The fifth stage in water management: Policy lessons for water governance, *Water Resources Research*, 56 (5), Article e2019WR026714, <https://doi.org/10.1029/2019WR026714>
- Dumbrell, N.P.** (2018) To what extent should society determine the right to farm? *Farm Policy Journal*, 15 (4), 19-26. [Runner Up in 2018 Australian Farm Institute John Ralph Essay Competition].

Chapter 1 Introduction

1.1. Context

Demand for scarce natural resources (e.g. land, water, minerals) across the globe is high, and increasing (IRP, 2017). Natural resources are used to produce food, fibre, energy and other goods. The production of these goods contributes to private and social welfare (wellbeing) and to national and regional economic development. Given society's demand for these goods, and the associated contributions to welfare, there is broad support for using natural resources for this purpose. However, this social support is neither automatic nor unconditional. Indeed, social support can be withdrawn when the environmental and social impacts of resource use or misuse become intolerable. For example, there have been cases where support was withheld or withdrawn due to: pollution (e.g. Brueckner and Eabrasu, 2018; Hoffman et al., 2015); irreversible damage to natural resource condition (e.g. Lacey and Lamont, 2014; Luke, 2017); and high inequality and conflict between the communities that disproportionately benefit and suffer from certain resource developments or uses (e.g. de Jong and Humphreys, 2016). In particular, social support for certain resource use activities tends to be withdrawn when the socially acceptable level of harm is surpassed (Coase, 1960). The withdrawal of social support can have consequences, including disruptions to operations, delivery and access to goods, and reductions in firm profits (Franks et al., 2014), creating potential incentives for resource users to alter behaviour to reflect societies' preferences.

Governments have traditionally used regulations to align firm behaviour with social expectations and maintain or improve social welfare. Where government regulations are politically unpalatable, or difficult or costly to implement, private markets have been developed and adapted to incentivise the conservation of natural resources (Khanna, 2001). With this there has been a considerable increase in private rights in environmental assets, such as tradeable private property rights for the extraction of scarce water resources, or in sequestered carbon (Grafton and Wheeler, 2018; Macintosh, 2013). However, environmental constraints or consequences of resource use have only been incorporated into prices to a limited extent (Barbier, 2021; Bleischwitz, 2010). In particular, market prices do not reflect all the opportunity costs faced by society as a consequence of particular resource use decisions (Quiggin, 2019). For example, markets tend not to capture the costs to, or the value of, environmental sustainability or public health. Consequently, voluntary, self-regulation and hybrid governance approaches have emerged at the intersection of government and markets to fill the gap left by regulations and markets (Bernstein and Cashore, 2007; Bleischwitz, 2004).

The concept of a social licence to operate (herein referred to as social licence) is used to highlight whether affected stakeholders¹ approve, or could approve of certain resource uses and management. However, the concept tends to attract most attention when used to highlight instances of resource use that are not considered sustainable or socially responsible (Cooney,

¹ The term 'stakeholders' is used throughout this thesis to refer any persons affected by and able to affect the activities of a firm or other organisation, either directly or indirectly. While other terms such as local communities or rightsholders are common in the social licence literature and may be appropriate in some scenarios or case studies presented in this thesis, they are not applicable to all and it is for this reason that the term stakeholders is adopted.

2017; Prno and Slocombe, 2012). Since the introduction of the social licence concept in the 1990's (Cooney, 2017; Moore, 1996), it has attracted increasing industry and research attention. The key reasons offered for growth in the social licence concept include: (1) a shift from public to private regulation, i.e. greater reliance on private and self-regulation; (2) growth in concern for environmental sustainability and the preservation of natural capital (Prno and Slocombe, 2012); and (3) advances in communication technology and the 24-hour news cycle, which have potentially increased the capacity for social campaigns and information about adverse events or activities to reach a broader audience (Cooney, 2017; Cullen-Knox et al., 2017a).

As demonstrated in this thesis, the social licence concept is used to highlight the contest between the private rights and incentives to use natural resources, and the social expectations and incentives to conserve resources or re-allocate resources to alternative—social welfare improving—uses. This contest also underpins a central pursuit of this thesis: to examine the overlap between the concept of a social licence and foundations of welfare economics, and further understand the conditions that influence social licence outcomes.

1.2. Social licence concept

The term 'social licence to operate' was first used in the 1990s to describe the requirements imposed by community expectations on the activities of natural resource dependent firms and industries (Cooney, 2017; Moore, 1996). Indeed, Cooney (2017, pp. 198-199) remarked that the term ascended into common use when it became clear that "*...mining companies could not ignore the concerns of ... communities and their supporters [about environmental damage and human rights issues] without risking local conflicts erupting with potential financial and reputational damage*". This observation indicates that social acceptance of a firm or industry's activities can be at least as important as legal requirements. The term social licence is commonly defined as the ongoing acceptance or approval of an activity or industry by stakeholders and the communities who are affected by it (Joyce and Thomson, 2000; Thomson and Boutilier, 2011).

A firm without a social licence, or whose social licence is under threat, is by definition not meeting societal expectations, regardless of whether these expectations are embodied in regulations. Persistent interest in the social licence status of firms since the 1990s suggests: (1) social expectations are changing or affected stakeholders have a greater capacity to express their expectations; and (2) affected stakeholders can shift a firm's activities to align with their expectations (Boutilier, 2014). This observation then suggests there is an incentive for firms to obtain and maintain a social licence. Indeed, conflicts can lead to increased costs, or threaten significant profits (Franks et al., 2014; Hanna et al., 2016). This then demands an addition to the definition provided above. The affected stakeholders who can grant or withhold/withdraw a social licence from firms can also influence the profitability of the firms (Graafland, 2002; Gunningham et al., 2004).

Despite growing interest and research attention, the social licence concept continues to be plagued by practical interpretation and measurement ambiguity.² This ambiguity has attracted

² The social licence is not unique in this sense. Other concepts describing demands on natural resources and industry-community discordance on resource use issues face questions about being buzzwords with no substance e.g. see discussion of the resource 'nexus' by Bleischwitz et al. (2018).

criticism (Boutillier, 2020a; Brueckner and Eabrasu, 2018). For example, questions remain about the functionality of the social licence concept. However, a number of research efforts have attempted to add clarity to our understanding (Boutillier, 2014; Demuijnck and Fasterling, 2016; Gehman et al., 2017; Kelly et al., 2017; Moffat and Zhang, 2014; Moffat et al., 2016; Owen and Kemp, 2013; Owen, 2016; Prno and Slocombe, 2012; Vanclay, 2017). Many of these contributions have been made from the perspectives of political science, law, psychology, business, management, and sociology, and draw on a diverse set of notions such as (corporate) social responsibility, sustainable development, legitimacy, trust, social contract theory and stakeholder management and engagement to offer models and predict configurations of the social licence among stakeholders affected by a firm or industry's activities. Notably, for the purpose of framing the research presented in this thesis, the economics discipline has made few contributions to the understanding of social licence.

1.2.1. Conceptualisation of social licence

The research in this thesis is based on the conceptualisation of social licence as permission that affected stakeholders grant or withhold from firms or industries based on their experiences or perceptions of the firm or industry's activities relative to their expectations. Essentially, affected stakeholders make a cost-benefit trade-off. Firms also make a cost-benefit trade-off in return when pursuing a social licence, based on how they perceive threats to, or a withdrawal of a social licence may affect them.

For example, Thomson and Boutillier (2011) proposed that affected stakeholders' perceptions of a firm or industry's economic legitimacy, socio-political legitimacy, trustworthiness and credibility would influence their decisions to grant/withhold a social licence. In this context, if economic benefits are modest or absent (economic legitimacy is missing), most stakeholders tend to withhold/withdraw a social licence. Alternatively, if benefits are sufficient, stakeholders tend to grant a social licence. Evidence of affected stakeholders making trade-offs between economic benefits and social and environmental costs across diverse contexts supports the Thomson and Boutillier (2011) model. There are examples of a social licence being granted in cases where economic benefits have been perceived to outweigh costs such as environmental degradation (e.g. Mason et al., 2014; Richert et al., 2015) and being withheld/withdrawn when the benefits were deemed insufficient (e.g. de Jong and Humphreys, 2016). Applications of the Thomson and Boutillier (2011) model have confirmed the relationships between these factors and different social licence outcomes (Jijelava and Vanclay, 2017; Richert et al., 2015). Others show that a lack of economic legitimacy, trust and credibility, drives the decision to withhold/withdraw a social licence from a firm or industry (Jijelava and Vanclay, 2018; Lesser et al., 2021; Luke, 2017).

Other authors have highlighted similar and additional influences on stakeholders' decisions to grant/withhold a social licence. For example, Moffat and Zhang (2014) showed impacts on social infrastructure, contact quality and quantity and procedural fairness to influence stakeholders' decisions to grant a social licence in the mining industry. The authors define social impacts to include impacts such as changes to health or education access, changes to housing availability and affordability, and changes to the cost of living that may occur when a new mine is established in a local community. Further, contact quantity and quality refer to contact between local communities and mining firms (including through formal consultation processes) and procedural fairness is concerned with decision-making processes, including the extent that

stakeholders' views are accounted for in the mining firm's decision-making. More recent research has modified and built on the initial path model of social licence by Moffat and Zhang (2014), by adding more factors such as distributive fairness, governance capacity, stakeholders' knowledge of the contested industry or firm's practices (Jartti et al., 2020; Mercer-Mapstone et al., 2018; Zhang and Moffat, 2015; Zhang et al., 2015, 2018).

Characteristics of affected stakeholders positioned to grant/withhold a social licence are also influential in social licence outcomes. In particular, Lynch-Wood and Williamson (2007) identified three characteristics of affected stakeholders as influential to a firm's social licence: (1) customer interest in the consequences of the firm's behaviour; (2) community interest in the consequences of the firm's behaviour; and (3) customer power (e.g. access to resources and ability to act collectively to influence the firm's activities). This highlights that firm or industry actions or management are less likely to be considered under threat from losing a social licence when affected stakeholders are disinterested or not empowered to affect firm or industry behaviour.

The above described models and conditions associated with a social licence outcomes demonstrate that affected stakeholders make trade-offs when deciding to grant/withhold a social licence.³ Conceptual models of social licence that consider broader system characteristics, governance and institutional arrangements also exist (e.g. Boutilier, 2020b; Prno and Slocombe, 2014). However, these tend to be complex and consequently do not offer pathways to measure a social licence or understand all of the conditions that influence stakeholders' decisions to grant a social licence. The consideration of the power of stakeholders to affect a firm's profitability (Lynch-Wood and Williamson, 2007) and the conceptualisation of economic legitimacy as critical to gaining a social licence (Thomson and Boutilier, 2011) motivates a central pursuit of this thesis: the examination of the social licence concept using perspectives from the economics discipline.

1.3. Social licence as an economic problem

The motivation to study the social licence concept through an economic lens is threefold. First, as described in Section 1.2.1, affected stakeholders make economic cost-benefit trade-offs when deciding to grant or withhold a social licence. Second, firms and industries experience costs associated with the loss of, or failure to obtain a social licence. Third, the social licence literature provides examples of market failure, i.e. evidence that markets fail to allocate resources to their most valued use. Negative externalities (costs borne by a third party as a result of an economic transaction between a producer and consumer) such as pollution or the degradation of resources from mining or energy operations are often cited as major concerns by affected stakeholders in social licence debates, and a reason for contesting industries or new developments (e.g. Gunningham et al., 2004; Hoffman et al., 2015; Lacey and Lamont, 2014).

The above three pillars of the social licence literature are also at the core of welfare economics, where welfare economics focuses on how the allocation of resources affects social welfare (wellbeing; Hovenkamp, 1990; Pigou, 1920; Stiglitz, 1991). Consequently, welfare economics

³ While a number of conditions associated with social licence have been highlighted here, the list of conditions is not exhaustive. Further conditions associated with social licence outcomes are detailed in Section 3.2 of this thesis.

may have important contributions to make toward understanding the social licence concept. For example, the welfare economics literature offers a number of approaches to address market failures, including government intervention to regulate, or implement market-based instruments to internalise externalities (as per Pigou, 1920). Alternatives to government intervention also exist. For example, Coase (1960) suggested that where property rights are clearly defined, two parties—the one that produces the externality, and the one that is affected by it—can bargain with each other to arrive at a Pareto optimum (an outcome where at least one party is better off, and no party is worse off). However, subsequent research has revealed that this bargaining solution suggested by Coase is difficult to enact in practice (Deryugina et al., 2021), due to a number of factors but particularly due to high transaction costs and coordination problems if more than two parties are involved (Ellingsen and Paltseva, 2016).

Likewise, regulatory processes can also be difficult or costly to implement, and can be captured by interested or powerful groups (Laffont and Tirole, 1991). Noting this, where regulation is absent or weak “*an array of voluntary, self-regulatory, shared governance, and private arrangements has begun to fill the policy void*” (Bernstein and Cashore, 2007, p. 347). It has been suggested that the social licence concept represents a possible alternative regulatory arrangement (Lynch-Wood and Williamson, 2007). Indeed, van Putten et al. (2018) argued that the emergence of social licence was a response to an erosion of legitimacy of regulation. That is, social licence arose where regulations designed to modify economic behaviour in the interests of social welfare were perceived to be non-existent, inadequate, or not enforced.

Additionally, to compensate for the inability to combine diverse individual preferences to create one socially preferred decision or outcome for society (Arrow, 1963), alternative decision-making metrics have been adopted for use in policy-making and other decision-making arenas. These include, majority decisions, committee decisions, social welfare judgements and normative indications (Sen, 1977), where these may be informed by multiple criteria analysis, benefit-cost analysis or other decision support metrics. The social licence concept also appears to potentially offer a way for stakeholder groups with diverse attitudes toward an industry or firm (due to an imbalance between those that experience the benefits versus the costs) to work collectively and negotiate improved outcomes for themselves.

These observations formed the basis for defining the research objectives to be tested in this research, especially Objective 1 as detailed in the next section.

1.4. Research objectives and approach

The overarching objective of this thesis is to bring clarity to the understanding and analysis of the social licence concept and social licence outcomes. Further, general thesis objectives include a greater understanding of motivations and conditions that underpin social licence debates and outcomes in natural resource dependent industries. To achieve these objectives, a number of research questions were formulated. The questions ask: what conceptual themes have emerged in the social licence literature; what conditions are associated with social licence outcomes; and what trade-offs do different stakeholder groups make in deciding to grant a social licence. The specific research questions and methods used to address them are detailed in Section 1.6.

The first part of this thesis draws on global, and multi-industry data to address the overall objectives, as well as more specific objectives (Objectives 1 and 2). This is done using a systematic review of the social licence literature and a qualitative comparative analysis of social licence outcomes. This approach was deemed important and appropriate given the rapid growth in interest in the social licence concept, and the benefit offered by research that summarises and draws together research at different scales to make clear patterns or generate new insights (Rudel 2008).

The second part of this thesis was informed by outcomes from the first part. The most obvious way this occurred was by informing the selection of case studies to focus on and use to address questions related to the trade-off that different stakeholder groups make in deciding to grant a social licence. The case studies were limited to the operation of the social licence concept in the agricultural and energy (including future fuels) industries in south-eastern Australia (Objectives 3–5). Context and motivation for selecting these industries, and therefore the context in which Objectives 3–5 were addressed, is described in the following section, Section 1.5.

Specific objectives of this research include:

- (1) Systematically review and synthesise the social licence literature to understand key research themes and how these relate to the foundations of welfare economics.
- (2) Identify whether the conditions that drive social licence outcomes differ across natural resource dependent industries and institutional settings.
- (3) Test the applicability of Thomson and Boutilier's (2011) hierarchical model of social licence for measuring the social licence of energy transmission infrastructure, particularly the social licence of a high-pressure natural gas transmission pipeline as decided by agricultural landholders sharing the landscape with the pipeline.
- (4) Conduct comparative analyses of public and farmers' concerns about issues that are reported as undermining or challenging the Australian agricultural industry's social licence and identify similarities and differences across stakeholder groups and issues.
- (5) Identify the trade-offs the public in south-eastern Australia may be willing to make in the transition to future fuels, namely, hydrogen energy.

1.5. Case study industries

There were three key reasons for focussing the case study research (Research Objectives 3–5 in Section 1.4) on agriculture and energy (future fuels). First, the research designed to address Objective 1 identified agriculture and energy as increasingly attracting attention in the social licence literature (Giurco et al., 2014; Hall et al., 2015; Hampton et al., 2020; van Wessel, 2018; Williams and Martin, 2011). Second, both industries are reliant on natural resources (e.g. land, water), and in some cases compete for access to these resources. Consequently, these industries are also positioned to impact each other's social licence. Third, they provide contrasting examples of an established industry (agriculture) with an assumed social licence

that is, in cases, coming under threat, and a transitioning industry (energy, including a transition to low carbon future fuels such as hydrogen) that is seeking a social licence to develop.

The agriculture and energy case study research was limited to south-eastern Australia (South Australia and Victoria) for five key reasons: (1) SEA Gas, the firm that owns and operates the main high-pressure natural gas transmission pipeline in the area was motivated to measure their social licence; (2) both states were relatively early movers with respect to supporting energy transitions, including to renewable energy and hydrogen (Government of South Australia, 2019; Victorian State Government, 2019); (3) more specifically, South Australia's move to adopt more renewable energy, and become a net exporter of electricity (McGreevy et al., 2021), presented an opportunity to capture the public's experiences with the transition; (4) both states have less on-shore natural gas (including unconventional gas) than most other states, and this was seen as important so results were not conflated with attitudes and experiences related to unconventional gas extraction operations (already captured elsewhere⁴); and (5) the most common agricultural industries in these states are also the most common across Australia as a whole (Australian Bureau of Statistics, 2012), so results drawn from the case studies were expected to be broadly applicable.

1.6. Thesis structure

This thesis is organised into eight chapters, including this introductory chapter. The thesis is a combination of published and unpublished works. As such, Chapters, 2, 3, 6 and 7, have each been prepared in the style of a journal article. These chapters have been published (2 and 3), or are under review (6 and 7), in international peer-reviewed journals. Noting this, the individual chapter styles vary with journal formatting requirements, and some repetition will be observed, particularly in defining and contextualising the concept of social licence. Each chapter is related to the others (by concepts, data sources or industry focus) as depicted in Figure 1.1.

Chapter 2 presents a systematic review of the social licence literature published between 1996 and 2019. More specifically, the chapter addresses Objective 1 (as detailed in Section 1.4 above), and presents and answers the following three research questions: (1) What conceptual themes have emerged in the social licence literature? (2) In what ways do these conceptual themes relate to the fundamentals of welfare economics? (3) What can be gained by making the links between social licence and welfare economics explicit?

Chapter 3 presents a fuzzy-set qualitative comparative analysis that was used to identify associations between a set of ten conditions and social licence outcomes and firm behaviour change in natural resource dependent industries. The chapter draws on data from 47 case studies from 25 countries to address Objective 2 (from Section 1.4) and answer the research question: Do the conditions that drive social licence outcomes differ across natural resource dependent industries and institutional settings?

While Chapter 2 and 3 contain a dedicated methods section specific to the research question(s) analysed, **Chapter 4** provides an overview of interviews and surveys designed and

⁴ Examples include: Clarke (2021); Cronshaw and Grafton (2016); Everingham et al. (2016); Fleming and Measham (2015); Huth et al. (2018); Lacey and Lamont (2014); Luke (2017); Luke et al. (2018a); and Paragreen and Woodley (2013).

administered to collect data that is analysed in subsequent chapters. The three surveys administered include: an online survey designed to collect data from the public (n=2,032); a phone survey designed to collect data from broadacre farmers (n=351); and a mixed-mode survey of landholders with a high-pressure natural gas transmission pipeline easement (n=126), all in south-eastern Australia. The chapter also presents summary statistics from the surveys showing the survey samples are representative of the populations surveyed. The subsequent analytical chapters provide a description of the methods used to analyse the survey data.

Chapter 5 presents an exploratory factor analysis of the pipeline survey data (described in Chapter 4; n=126), to address Objective 3 (from Section 1.4) and measure the social licence status of the main high-pressure natural gas transmission pipeline south-eastern Australia. Specifically, the chapter addresses the following question: to what extent are landholders in south-eastern Australia willing to grant a social licence to the high-pressure natural gas transmission pipeline that transects their properties?

Using responses to the public (n=2,032) and farmer (n=351) surveys described in Chapter 4, **Chapter 6** presents the first study to record the concerns of both the public and farmers for a wide set of issues influencing the agricultural industry's social licence. More specifically, the chapter addresses Objective 4 (from Section 1.4), and uses principal component and seemingly unrelated regression analyses to answer the following four research questions: (1) What are the south-eastern Australian public's concerns regarding social licence issues in agriculture? (2) What are farmers' concerns regarding the same issues? (3) To what extent do the two stakeholder groups' concerns about social licence issues align? (4) What socio-demographic and attitudinal characteristics are associated with concerns about social licence issues?

Chapter 7 uses responses to the public survey as described in Chapter 4 to understand the trade-offs that individuals may—or may not be—willing to make in the transition to hydrogen energy. Fractional multinomial logit model estimates were used to identify potential influences on individuals' decisions to grant/withhold a social licence for the industry to develop. Specifically, this research addresses Objective 5 (from Section 1.4), and three specific research questions: (1) What characteristics of a future hydrogen energy system will be most important to the public? (2) What (if any) trade-offs are individuals willing to make to transition to hydrogen energy in Australia? (3) How do socio-demographic characteristics and attitudes affect individuals' hydrogen industry preferences?

This thesis concludes with **Chapter 8**. The final chapter provides a summary of each analytical chapter as aligned to the research objectives described in Section 1.4. Further, the final chapter highlights the new knowledge produced and documented, and outlines recommendations for future social licence research.

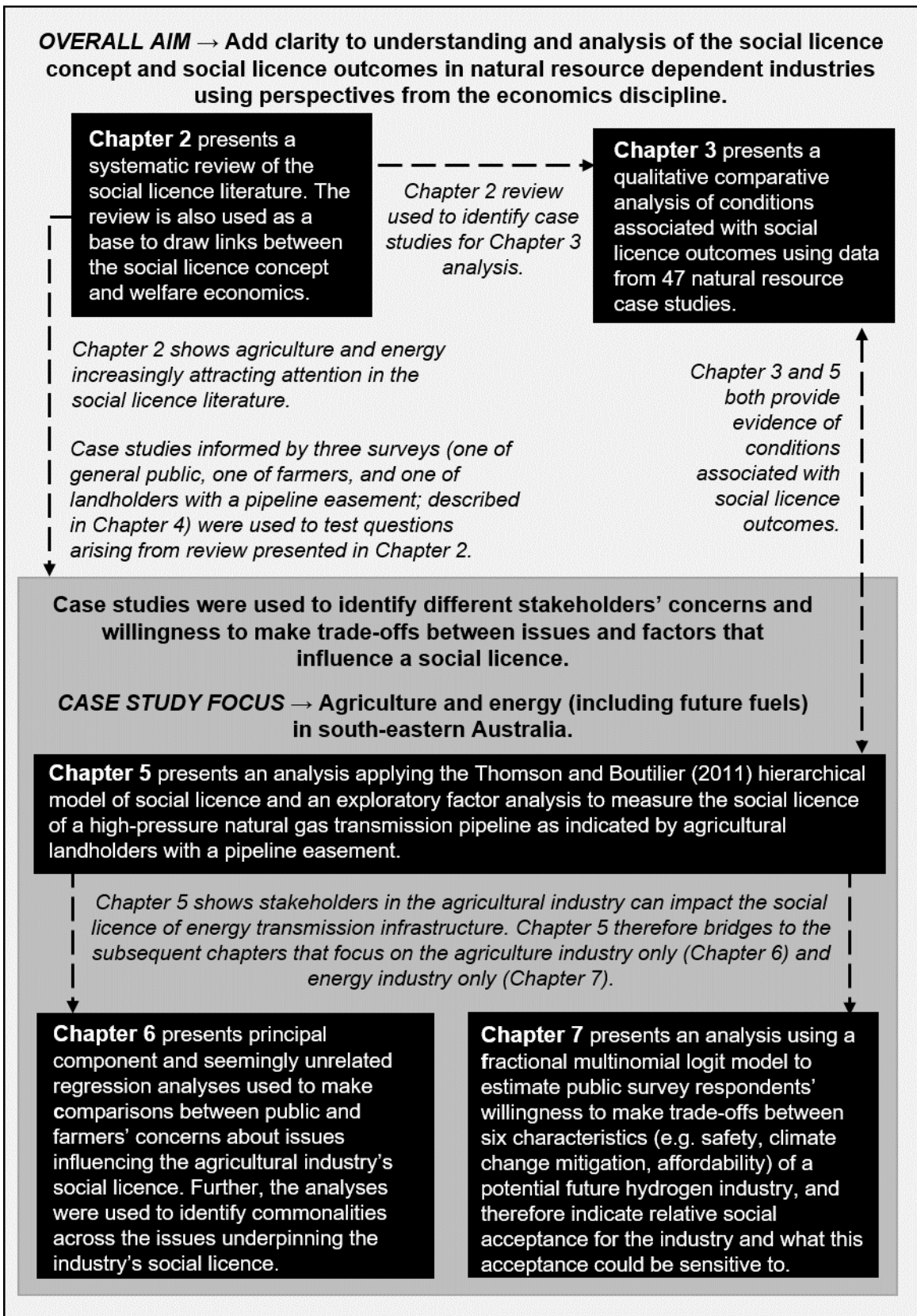


Figure 1.1. Relationships between chapters of this thesis.

Chapter 2 Statement of Authorship

Title of Paper	Is social licence a response to government and market failures? Evidence from the literature		
Publication Status	<input checked="" type="checkbox"/> Published <input type="checkbox"/> Submitted for Publication	<input type="checkbox"/> Accepted for Publication <input type="checkbox"/> Unpublished and Unsubmitted work written in manuscript style	
Publication Details	Dumbrell, N.P., Adamson, D., Wheeler, S.A. (2020) Is social licence a response to government and market failures? Evidence from the literature. <i>Resources Policy</i> , 69 (Article 101827), https://doi.org/10.1016/j.resourpol.2020.101827		

Principal Author

Name of Principal Author (Candidate)	Nikki P. Dumbrell		
Contribution to the Paper	Conceptualisation, Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing		
Overall percentage (%)	80		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	3 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

- The candidate's stated contribution to the publication is accurate (as detailed above);
- Permission is granted for the candidate to include the publication in the thesis; and
- The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	David Adamson		
Contribution to the Paper	Conceptualisation, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	Sarah Ann Wheeler		
Contribution to the Paper	Conceptualisation, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Chapter 2 Is social licence a response to government and market failures? Evidence from the literature

This chapter presents a paper published in [Resources Policy \(2020\)](#). The paper is included in its published form, with only minor changes to formatting and style to bring it in line with the overall thesis. Consequently, there is some repetition with other chapters of this thesis.

Abstract

The term ‘social licence to operate’, introduced in the 1990s, has increasingly been used to describe the social and environmental standards for firms to meet. Formally, a firm with a social licence is said to enjoy (intangible) ongoing acceptance or approval by communities and other stakeholders that: (1) are affected by the firm and/or their activities; and (2) can influence the profitability of the firm. While the mining industry was the first to identify the need to obtain a social licence to operate, other sectors also recognise its importance. Growth in the frequency and breadth of the terms use has contributed to a substantial body of research. A focus of this research has been the benefits and costs experienced by affected stakeholders as a result of a firm’s activities. This suggests that social licence is, partly at least, an economic issue. We conducted a systematic review (with a final database of 651 documents) of the social licence literature to identify what conceptual themes have emerged, and discuss how these conceptual themes relate to fundamentals of welfare economics. By introducing economic perspectives, it was found that social licence concerns stem from government and market failures, namely: (1) negative externalities; (2) undersupply of/threats to public goods; and (3) use of socially valuable assets to generate private profits. We argue that classifying social licence concerns in this way brings clarity to the social licence literature.

Keywords

Externalities; Social welfare; Welfare economics; Social acceptance; Natural resource management; Systematic literature review

2.1. Introduction

The development and use of natural resources can generate both positive economic outcomes and negative externalities (e.g. pollution). The distribution and magnitude of the positive outcomes and negative externalities produced by natural resource dependent industries such as mining, energy and agriculture, influences societal attitudes toward these industries (Marcos-Martinez et al., 2019; Richert et al., 2015). The extent to which firms in these industries are constrained to meet the societal expectations driving these attitudes and limit the social costs of their activities, has increasingly been described by the concept of a 'social licence to operate'.

The term 'social licence to operate' was first introduced in natural resource dependent industries in the 1990s (Cooney, 2017; Moore, 1996) and has since been used to describe societal expectations of firms, government, and non-government institutions (Jijelava and Vanclay, 2014). Firms that have an (intangible) social licence enjoy ongoing acceptance or approval by communities and other stakeholders (herein collectively referred to as stakeholders) who are affected by the firm or their activities, and who can affect the profitability of the firm (Gunningham et al., 2004; Thomson and Boutilier, 2011). Following this, a firm without a social licence, or whose social licence is under threat, is by definition not meeting societal expectations, regardless of whether these expectations are embodied in regulations. Persistent interest in the social licence status of firms since the 1990s suggests: (1) expectations are changing and/or stakeholders have a greater capacity to express their expectations; and (2) stakeholders may be able to shift a firm's activities to align with their expectations and improve welfare outcomes for themselves (Boutilier, 2014).

To date, the social licence literature has been underpinned by concepts such as legitimacy, trust, (corporate) social responsibility, sustainable development and, stakeholder management (Prno, 2013; Thomson and Boutilier, 2011). In addition, governance perspectives point to social licence as a form of governance operating at the intersection of public (i.e. government) regulations and markets (Prno and Slocombe, 2012; Vince and Haward, 2017). Conceptualising social licence in this way suggests that it is compensating for – or exploiting – weaknesses in traditional forms of regulation. Public regulations have been criticised for the extent to which interest groups can influence outcomes in their favour (i.e. the regulatory process can be 'captured'; Laffont and Tirole, 1991), and for being costly to design and implement (Khanna, 2001). At the same time, a firm's decision to adopt voluntary initiatives is often underpinned by their economic self-interest to, among other things, improve their reputation, minimise compliance costs, or improve market access, rather than an interest in maximising social welfare (Gunningham et al., 2004). As a result, the outcomes for social welfare can be mixed (e.g. Khanna, 2001; Thornton et al., 2009).

Given this background, applied social licence research has followed two main paths of inquiry. First, social licence as a risk management issue for firms (Cooney, 2017; Falck, 2016; Wilburn and Wilburn, 2014). For example, failure to meet social licence standards can negatively affect the profitability of firms (representing a risk) if they must divert resources from productive uses to other uses, e.g. dispute resolution (Henisz et al., 2014; Jijelava and Vanclay, 2018). Another risk to firms is that social licence standards that exceed regulations can also motivate changes to public regulations or other policy settings (e.g. Chailleux et al., 2018; Gentzoglani, 2019), creating additional costs. The second pathway has focussed on identifying attitudes and

perceptions that drive decisions to grant, withhold or withdraw a social licence (Luke, 2017; Moffat and Zhang, 2014).

Social licence research detailed above suggests that social licence is, partly at least, an economic issue. In particular, social licence concerns appear to arise in cases where the first theorem of welfare economics is violated, i.e., markets, alone, do not allocate resources to their most valued use and thus do not lead to efficient or socially optimal outcomes. This apparent relationship between social licence and welfare economics motivated us to examine the actual relationship between social licence and economics and ask the following questions: (1) what conceptual themes have emerged in the social licence literature; (2) in what ways do these conceptual themes relate to fundamentals of welfare economics; and (3) what can be gained by making the links between social licence and welfare economics explicit?

To address these questions, we undertook a systematic review of the social licence literature with the aim to understand key research themes and how these relate to the foundations of welfare economics. We anticipate that this approach and the outcomes will lead to two key benefits. First, a thorough investigation of the use and growth of social licence as it relates to established ideas in the welfare economics literature could contribute to an improved understanding of the social licence concept. Second, by understanding the drivers and potential responses to social licence concerns using economics we can then also draw on economic frameworks to understand and design solutions to issues (i.e. resource uses that generate both positive and negative impacts) that attract social licence attention.

2.2. Methods

We used a systematic review of the social licence literature to identify key research themes and central concepts underpinning social licence research. Where links to key concepts of welfare economics were apparent, we then reviewed relevant aspects of that literature to explore the links in more detail. This article therefore reports on research from the systematic review of social licence literature and discusses findings with reference to the welfare economics literature. We highlight welfare economics⁵ because, as stated in the introduction, social licence concerns appear to arise in cases where the first theorem of welfare economics is violated. Public economics is also incorporated in our discussion as it focuses on the role of instruments such as regulation, suasive measures, economic instruments such as financial (dis)incentives, property rights and market creation/design, used by public decision-makers to encourage or prevent particular behaviours or outcomes, to maximise social welfare⁶.

This systematic review of social licence literature was guided the checklist of Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA; Moher et al., 2009). The PRISMA checklist was developed in an attempt to address suboptimal reporting of systematic reviews, and has subsequently become widely adopted as best-practice for conducting and reporting systematic reviews across different research areas (Siddaway et al., 2019). Additionally, methods and suggestions developed by Tranfield et al. (2003) were used to translate the methods developed for systematic reviews in medical sciences (e.g. PRISMA checklist) for use in social science disciplines. Table A1.1 in Appendix 1 reports the information

⁵ Theorems, their origins and modern reassessment of them are well summarised by Stiglitz (1991).

⁶ Major contributions and themes of public economics are well summarised by Boadway (1997).

recorded from each document captured in the review as guided by the PRISMA checklist and accounting for the challenges in developing an appropriate methodology for a systematic review of management literature as outlined by Tranfield et al. (2003). To draw on a wider body of literature, in this case the welfare and public economics literature, not captured in the standard systematic review approach we followed the approach of Karakaya and Nuur (2018). That is, to both reduce bias (see Section 2.2.2) and to enhance our discussion and ability to draw conclusions, like Karakaya and Nuur (2018), we drew on documents additional to those captured in the review to discuss and interpret themes captured in the systematic review. This strategy was adopted as it was identified as the most appropriate means to identify key themes in the social licence literature and then to identify how they related (or not) to key concepts and themes in welfare and public economics.

2.2.1. Data

The data source for the systematic review was documents indexed in Web of Science Core Collection, Scopus, and Google Scholar (Table 2.1). Search terms used to identify relevant research were “social licence” or “social license”, and the search time-frame included all documents published between 1 January 1996 and 31 December 2019. The selected time-frame captured the early writings on the social licence (e.g. Moore, 1996) as a way to describe societal or community opinion or approval of an activity and the development and breadth of the research since. The term ‘social licence’ had been used earlier than this to refer to taking liberties within prevailing social norms. However, the more recent meaning and use of the term, and the use of interest in this research, is social licence as a metaphorical parallel to a legal licence that is, approval to conduct an activity that affects a community or society (Cooney, 2017; Gehman et al., 2017).

The search across the three databases returned 2,574 documents (Figure 2.1). The initial database was refined based on criteria listed in Figure 2.1 to create a final dataset of 651 documents (including both peer-reviewed literature, such as 487 journal publications, and grey literature such as book chapters and theses). Documents were excluded from the final database if the full-text was unavailable or the document was not written in English. If a document was indexed in more than one of the databases searched for the review, only one record was kept in the final database (others were considered duplicates; Figure 2.1).

Corrections to published articles were considered together with the original document and, where conference papers and journal articles were deemed to be reporting the same research, only the journal article was kept in the final dataset. Documents were also excluded if they did not mention “social licence” or “social license” in the body of the text. This scenario arose in two ways. First, beyond the first 300 results produced by a Google Scholar search, the results tend to be less relevant to the original search (Haddaway et al., 2015). Second, when an article was included in the raw dataset because “social licence” or “social license” were included in the KeyWords Plus® (Web of Science KeyWords Plus® consist of words and phrases harvested from the titles of the cited articles), yet, were not included in the body of the document. Despite this, the Keywords Plus® feature was used because it “is considered as effective as Author Keywords in terms of bibliometric analysis investigating the knowledge structure of scientific fields” (Zhang et al., 2016, p. 967).

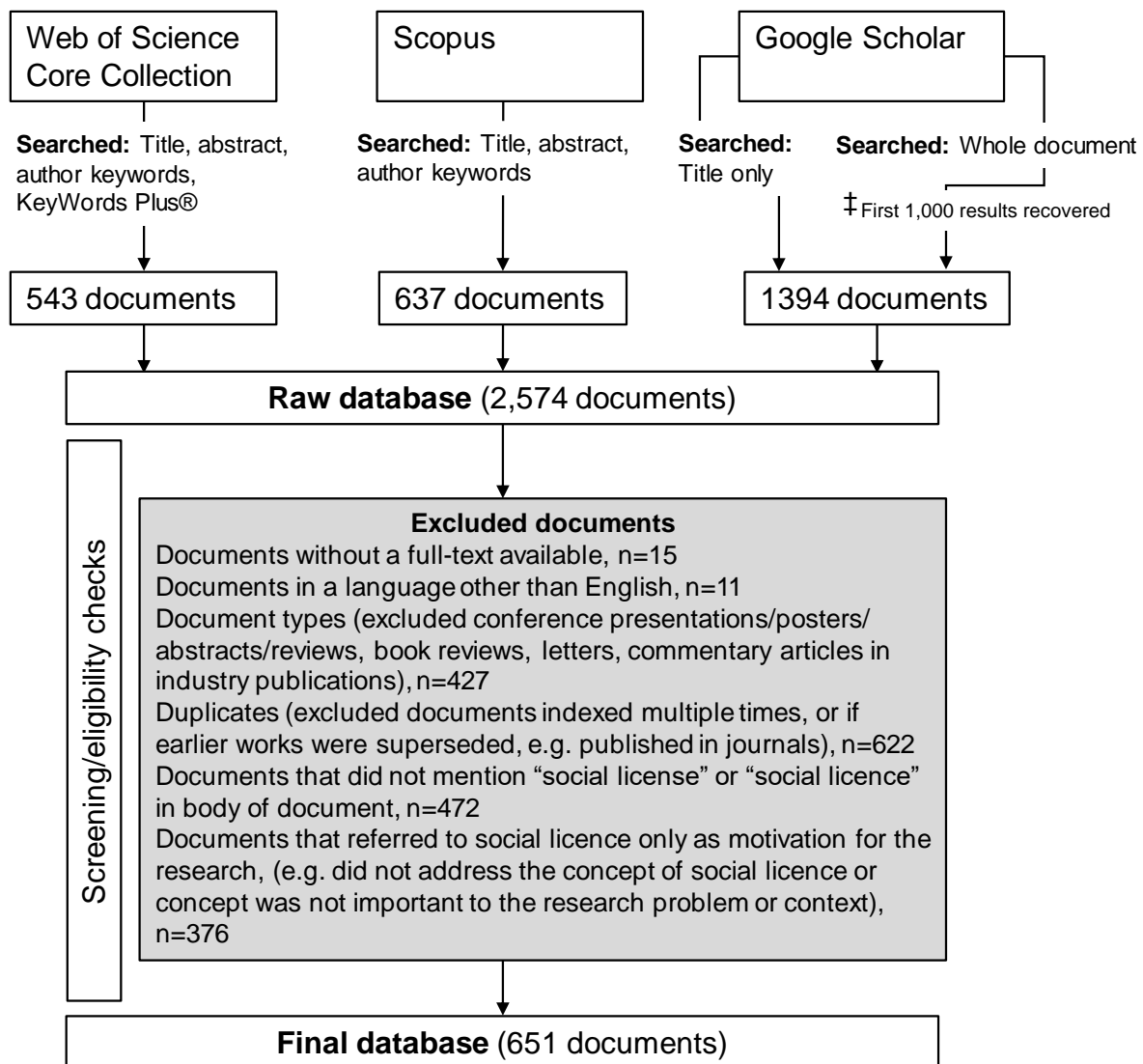


Figure 2.1. Systematic review process to identify documents published between 1 January 1996 and 31 December 2019.

Note: ‡ Methodology to download first 1,000 results from Google Scholar followed Haddaway et al. (2017).

2.2.2. Limitations

The methods used to establish the database, and the consequent size of the database affected both the scale and scope of the analysis. First, search terms were not extended to use relatives of social licence such as ‘social acceptability’ because we were specifically interested in the use, growth and application of the social licence concept. Unlike social acceptability (or variations of), social licence is focused on the activities of firms or governments (not individuals), and the impact of stakeholder expectations on the decision-making of each actor (firms, governments and stakeholders). Second, a thematic analysis, rather than an in-depth analysis, was adopted in order to manage the large number of documents. Other publications provide in-depth analyses of aspects of or applications of social licence (e.g. Kelly et al., 2017; Luke et al., 2018a; Moffat et al., 2016; Owen and Kemp, 2013). The implications of these decisions are such that some documents and topics may not be captured in this review. In addition, relevant articles may also be excluded because the search terms were not included in the titles, abstracts or keywords sections. However, this was partly

overcome by widening the search to the whole document in Google Scholar. Despite the limitations of our methodology, we expect that the documents included represent an important and representative share of the social licence literature.

2.3. Results and discussion

Overarching themes in the social licence literature include corporate-community relations (transactional vs relational) and the benefits and costs experienced by affected stakeholders as a result of a firm's activities (Lacey and Lamont, 2014). Benefit and cost trade-offs central to social licence concerns are equally important in the economics literature. However, the review of the social licence literature revealed little to no explicit links to economics. The following sections integrate descriptions of: (1) the emergence and use of the social licence concept; (2) industries and activities attracting social licence attention; and (3) the key concepts in the social licence literature, paired with developments in the welfare and public economics literatures.

2.3.1. Emergence and growth of social licence

Since the introduction of social licence terminology in the 1990's (Cooney, 2017; Moore, 1996), the concept has continued to attract industry and research attention (Figure 2.2). The key reasons offered for growth in the social licence concept captured in this review included: (1) a shift from public to private regulation, i.e. greater reliance on private and self-regulation; (2) growth in concern for environmental sustainability and the preservation of natural capital (Prno and Slocumbe, 2012); and (3) advances in communication technology and the 24-hour news cycle, which have potentially increased the capacity for social campaigns and information about adverse events or activities to reach a broader audience (Cooney, 2017; Cullen-Knox et al., 2017a).

Though not identified by Cooney (2017) or other writers on social licence in natural resource dependent industries, the above listed factors are inextricably linked to economic factors. For example, van Putten et al. (2018) argued that the emergence of social licence was a response to an erosion of legitimacy of environmental regulation. That is, regulations designed to modify economic behaviour in the interests of social welfare were perceived to be non-existent or inadequate. In addition, simultaneous to the introduction of 'social licence,' new themes were appearing in the economics and management literatures. For example, Vogel (2005) noted that the 1990s saw a revival of corporate social responsibility and increasing reliance on markets as a form of governance. The 1990s was also when the first empirical evidence of higher incomes being linked to good outcomes for at least some measures of environmental quality was published (Arrow et al., 1995; Stern et al., 1996). Early adoption of social licence terminology in developed countries such as the United States, Canada and Australia, could then be interpreted as a signal that these societies reached a level of development, where trade-offs between public goods such as the environment and economic growth were no longer considered acceptable or necessary by affected stakeholders (we return to this point in Section 2.3.2).

With increasing use there has also been increasing criticism of the social licence concept and terminology. Leading criticisms suggest that it can be difficult to know when a firm has a social

licence (Lacey et al., 2012). Despite a growing effort to measure the social licence (Boutillier and Thomson, 2011; Moffat and Zhang, 2014), there is debate about the identification of the tipping points or level of action (or inaction) required to repeal a social licence, i.e. the intangible nature of social licence is troublesome to its useability. In addition, critiques highlight that a firm can leverage social licence to create the appearance that they are engaging with stakeholders to claim credibility and avoid investing in new (higher cost) production practices to meet societal expectations (Owen and Kemp, 2013). For example, investments made in the name of gaining or maintaining a social licence, such as offering local employment opportunities, can be made very public, but activities contradictory to this guise can be kept very private (Miller, 2016).

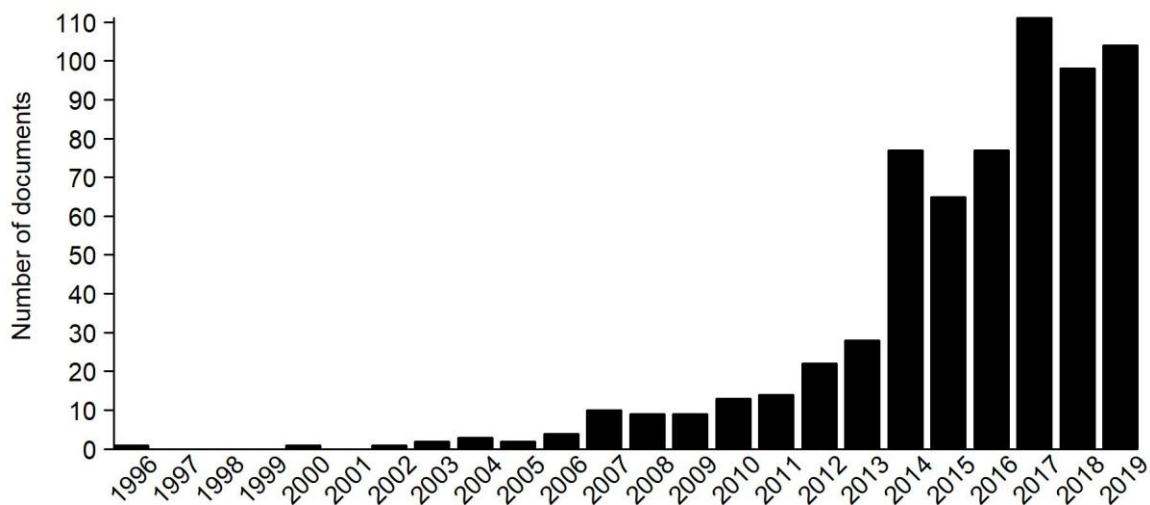


Figure 2.2. Number of documents in the final database (n=651) as drawn from the Web of Science Core Collection, Scopus and Google Scholar Databases using search terms: “social licence” or “social license” in the title, keywords or abstract in the period 1 January 1996 to 31 December 2019.

2.3.2. Industries and activities attracting social licence attention

Extractive industries such as mining, energy, forestry, agriculture and fisheries are the focus of the applied social licence literature (Table 2.1). A number of theoretical and conceptual advancements have also been illustrated with mining industry case studies. Journals publishing social licence research also reflect the industries/applications attracting social licence attention (Table 2.2).

Some characteristics of extractive industries make them relatively more susceptible to social licence concerns. First, the supply of minerals, energy, food and fibre is critical to global and localised economies, and livelihoods. Second, decisions about how and when to extract/use renewable and non-renewable resources underpinning the natural resource sector can impose inter and intra-generational costs on society (directly or indirectly). Consequently, concerns about the extent of environmental and social costs of natural resource use and what stakeholders are willing to accept or forego dominates the literature (i.e. the economic concepts of willingness to pay and accept). For example, stakeholders are willing to accept some environmental costs in order to access employment opportunities or economic growth

(e.g. Bastian et al., 2015; Marcos-Martinez et al., 2019; Richert et al., 2015). In other cases, there is evidence that affected stakeholders are not willing to make trade-offs of a similar nature (e.g. de Jong and Humphreys, 2016; Westoby and Lyons, 2016). From this we propose that it is when this threshold (of what stakeholders are willing to accept) is met that threats to a firm's social licence emerge.

Table 2.1. Ten most common industry applications in the social licence literature 1996–2019 (n=651).

Industry application[^]	Number	Percent
Mining	340	52.2
<i>Oil and gas</i>	114	17.5
<i>Coal seam gas</i>	29	4.5
<i>Shale gas</i>	27	4.2
<i>Gold</i>	25	3.8
<i>Copper</i>	12	1.8
<i>Other mining (including associated activities & products)</i>	133	20.4
Energy (including nuclear, renewable and associated infrastructure)	49	7.5
<i>Renewable energy</i>	14	2.1
<i>Energy infrastructure (pipelines)</i>	9	1.4
<i>Nuclear energy</i>	6	0.9
<i>Bioenergy</i>	5	0.8
<i>Other energy</i>	15	2.2
Forestry and forest management, pulp and paper mills	31	4.8
Agriculture and food	31	4.8
Research and technology	25	3.8
Fisheries and aquaculture	22	3.4
Marine/coastal management	16	2.5
Transport (including shipping and ports)	10	1.7
Infrastructure/construction	10	1.5
Tourism and recreation activities/events	9	1.4
No specific industry focus	88	13.5

Note: [^]Documents with multiple industry applications were included in all relevant categories, i.e. categories are not mutually exclusive.

Considering the focus on mining and other extractive industry applications, it is not surprising that resource-rich countries such as Australia and Canada feature heavily in the social licence literature (Figure 2.3). Of the 76 percent of documents classified to have a defined geographic focus (based on case study location or data collection), approximately one-quarter focused on Australia (Figure 2.3). These studies highlight the trade-offs between objectives that are considered (un)acceptable, and concerns about the distribution of benefits and costs associated with decisions to reallocate resources to more sustainable uses, or to improve equity between resource users (e.g. Martin and Shephard, 2011).

Alternatively, research from resource-rich developing countries, including those in Southern and West Africa and Latin America (Figure 2.3), highlights scenarios where governments have relied on the private-sector to provide the foundation for a country's (or region's) economic development (e.g. de Jong and Humphreys, 2016; Gqada, 2011). In addition, case studies from developing countries often explore issues with accountability and transparency in decisions to grant initial or re-allocate property rights (e.g. mining licences), and the

negotiation or delivery of compensation for local communities and traditional rights owners (e.g. Matebesi and Marais, 2018).

Table 2.2. The 10 journals with the most (or equal most) articles reporting social licence related research 1996–2019 (n=487).

Journal	Number	Percent
Resources Policy	41	8.4
Extractive Industries and Society	30	6.1
Journal of Cleaner Production	25	5.1
Impact Assessment and Project Appraisal [^]	15	3.1
Marine Policy	12	2.5
Social Epistemology [^]	10	2.2
Forestry [^]	9	1.8
Energy Policy	9	1.8
Journal of Business Ethics [^]	8	1.6
Energy Research & Social Science	6	1.2
Environmental Impact Assessment Review	6	1.2
Sustainability	6	1.2

Note: [^]Denotes journals that include special issues on the topic.

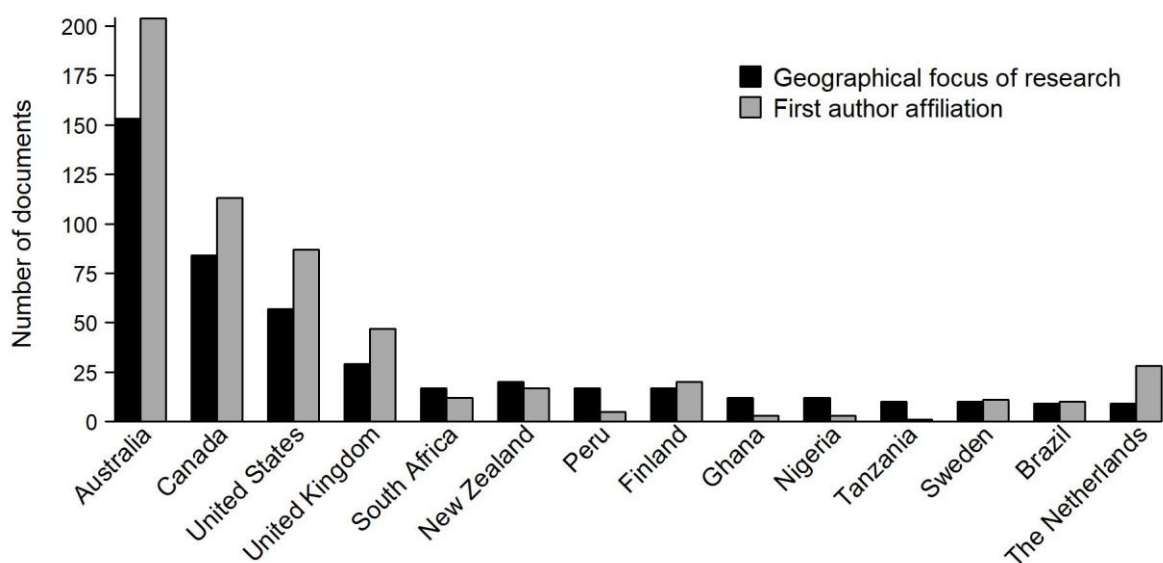


Figure 2.3. Geography of social licence research included in final database, published 1996–2019 (n=651). Based on geographical focus of research presented in documents (grey bars) and affiliation of first author (black bars) based on data collection or location of case study. Countries with more than 10 documents in either category are included.

The economics literature tends to describe the same issues albeit with different terminology. Countries reliant on the development of natural resources for economic growth but who do not necessarily achieve it are described as suffering from the ‘resource curse’ (Mehlum et al., 2006; Sachs and Warner, 2001). The intersection of the resource curse and social licence in the Nigerian context is discussed by Ezirigwe (2017). The willingness of stakeholders to trade-off future environmental degradation (for example) and accept developments such as mines in the present day in order to access essential services or employment is described in the

economics literature through the concepts of discounting (e.g. Baumol, 1968) and willingness to pay or accept (Coase, 1960). In reality, if there are few alternative employment opportunities or no alternative providers of essential services e.g. government (more often the case in developing countries than developed countries) then the affected stakeholders may not be in a position to withhold a social licence. Rather the gains (real or perceived) from access to jobs or other forms of compensation may be considered essential to help them meet their basic needs. Applying economic perspectives to understand the social licence literature therefore highlights that the decision to grant or not grant a social licence has opportunity costs.

2.3.3. Conceptual themes in the social licence literature

Common concepts in the social licence literature, irrespective of industry applications discussed above, are listed in Table 2.3. The most pertinent of these are discussed and related to concepts in the welfare economics literature in the following sections. Trust and legitimacy are frequently cited as critical elements of a social licence (Demuijnck and Fasterling, 2016; Jijelava and Vanclay, 2017; Moffat and Zhang, 2014). However, this research suggests that these factors may only recently be coming to the fore in the social licence literature. This may be a consequence of the research captured in this review (dating back to the 1990s) focussing on social licence as a risk management issue and therefore focussed on responses firms can make through (for example) corporate social responsibility which is founded on the need to gain and maintain legitimacy, ahead of highlighting issues such as legitimacy in their own right (Table 2.3). In addition, we suggest (in Section 2.3.3.6) that rent-seeking and regulatory capture could be useful frameworks for thinking about the role and erosion of trust as related to social licence. In addition, procedural and distributional fairness are attracting interest in the social licence literature (e.g. Moffat and Zhang, 2014). While these concepts are not listed in Table 2.3 in their own right, they are closely tied to and therefore included in the groupings of community and stakeholder attitudes and governance.

Table 2.3. Number of documents in social licence literature published 1996–2019 (n=651) with non-mutually exclusive key concepts (listed) in titles or keywords.

Keywords	Number	Percent
Social licence; Social licence to operate [^]	416	63.9
Community/ies (or public) attitudes/opinions/acceptance	131	20.1
Corporate social responsibility/social responsibility	123	18.9
Sustainability; sustainable development	78	12.0
Stakeholder(s); stakeholder relationships/theory/engagement	68	10.5
Governance	53	8.1
Risk; Risk management/perception	49	7.5
Regulation; Regulatory compliance; Legislation	47	7.2
Social/environmental/human rights impact assessment	37	5.7
Human rights; Indigenous rights	34	5.2
Trust	32	4.9
Legitimacy; Legitimacy theory	32	4.9
Conflict; Protest; Activism	31	4.8
Communication; Reporting; Dialogue; Disclosure	29	4.5

Note: [^]alternative spelling “social license” included.

2.3.3.1. Community and stakeholder attitudes

By definition, affected communities and stakeholders are the agents positioned to grant, withhold, withdraw, design (methods of compliance) and benefit from a social licence according to what they consider acceptable. Therefore, stakeholders' attitudes or perceptions influence their decision to grant a social licence. However, one of the key criticisms of social licence is that it is easier to know when a firm does not have a social licence compared to when it does (Lacey et al., 2012). Clarity around the drivers of social licence concerns and the way social licence is used by affected stakeholders, particularly influential or powerful groups, as a mechanism to incentivise particular behaviours could contribute to both improved understanding of the concept and the factors that influence its effectiveness as a form of governance. By exploring the social licence and economics literature simultaneously, we argue that social licence concerns are underpinned by market and government failures. More specifically, upon reading and classifying the literature, we suggest social licence concerns are motivated by: (1) concern about real or perceived negative externalities (45 percent of documents in final database); (2) concern regarding a real or perceived undersupply on public goods (18 percent of documents in final database); and/or (3) concern regarding the use of socially valuable assets to generate private profits (13 percent of documents in final database). Each of these is discussed in turn below.

Negative externalities

Selected examples of negative externalities (costs imposed on third parties) motivating social licence concern include: contamination of ground water and soil from coal seam gas extraction (Lacey and Lamont, 2014; Luke, 2017) water contamination and atmospheric pollution from pulp and paper manufacturing (Gunningham et al., 2004; Hoffman et al., 2015) and ocean plastics (Vince and Hardesty, 2018). Other negative externalities include inequitable experiences of benefits and costs. For example, property damage for neighbours of extractive industry operations (van der Voort and Vanclay, 2015) creates costs for locals while a substantial proportion of benefits can be exported or experienced outside the local community (Lacey and Lamont, 2014). Opposition from host communities, who experience costs from a development such as a mine or installation of energy infrastructure, have on occasion, been characterised as NIMBY (not in my backyard) problems (van der Horst, 2007). Characterising these issues as such may overshadow the real issue of negative externalities. Following this, we argue there is value in reorienting the understanding of social licence as a mechanism through which stakeholders attempt to highlight the social costs of negative externalities they experience, and demand firms and public decision-makers address these externalities and/or reduce their supply back to the socially desirable level. This level is rarely zero given demand for benefits (e.g. jobs, goods and services) associated with activities that create negative externalities. The negotiation of a social licence therefore represents a trade-off in individual welfare (for producers of negative externalities, forced to internalise the external costs) and social welfare.

Undersupply or threats to public goods

The social licence literature features stakeholder concerns regarding the undersupply (in quality or quantity) of public goods such as animal welfare (Coleman et al., 2018), ecosystem services or aesthetic values provided by natural resources (Langbroek and Vanclay, 2012; Ranacher et al., 2017), public safety (Eyles and Fried, 2012) and human rights (Buhmann, 2016; Cragg, 2012; Wheeler, 2015). Without a market or price for these goods there is no incentive for private firms to supply or protect them, contributing to their undersupply i.e. they

are often supplied (in quality or quantity) below the socially optimal or desirable level (Samuelson, 1954, 1967). Following this, supply is often regulated or provided directly by governments.

Withholding or withdrawing a social licence then appears to be a mechanism used by stakeholders to highlight the importance of public goods and demand firms ensure their continued supply or protection (e.g. Koivurova et al., 2015; Langbroek and Vanclay, 2012). In response, firms can voluntarily adopt environmental/safety/welfare standards beyond current regulations. Incentives for firms to do this exist in the form of market opportunities, such as market access or greater consumer willingness to pay for goods with credence attributes they value. A community or stakeholder group that decides to withhold or withdraw a social licence could also do so as a means to indicate to public-decision makers that they are unwilling to trade-off the quantity or quality of public goods supplied in order to achieve other objectives, such as access to jobs or economic development.

Use of socially valuable assets to earn private profits

Property rights include ownership and use rights in a resource. Assigning private property rights, or access rights, in previously open access resources such as fisheries or water, allows the holder of the right to manage the resource for the generation of profits. However, this only holds when rights reflect the reliability of resources, and the rights are excludable and enforceable. This is relevant here because *“formal property rights, by their nature, supersede expectations and social judgements about who has the right to use a socially valuable asset ... and how they use it”* (Quiggin, 2019, p. 106). However, social licence concerns indicate that we continue to hold onto judgements about how certain socially valuable assets, such as land, water and minerals, can be used. This is demonstrated in debates about the acceptability of land clearing on private property (Martin and Shephard, 2011), and the granting of permits and licenses which give holders the right to beneficially use common-pool resources such as water (Shephard and Martin, 2008). Granting new rights over former rights, e.g. access to public lands or culturally significant lands for extractive purposes, is another source of much community resistance of both public decisions to grant rights and the activities for which the rights were granted (Gqada, 2011; Pedersen and Kweka, 2017). We suggest that societal expectations of resource users (and therefore the requirements for a social licence) are grounded in the (re)allocation, specification, or perception, of resource users' property rights. Following this, we suggest that either a lack of understanding of rights and responsibilities (by firms and affected stakeholders), or a lack of enforcement (by governments) of responsibilities associated with particular property rights, or discontentment with the allocation of property rights in socially valuable assets sits at the foundation of some social licence concerns.

2.3.3.2. Corporate social responsibility

Corporate social responsibility and social licence are related concepts. Both are concerned with a firm's ability to maintain legitimacy and meet important social objectives, e.g. social, cultural, economic and environmental. However, few authors differentiate the concepts clearly. Gehman et al. (2016) differentiate social licence and corporate social responsibility by arguing that corporate social responsibility is a firm-driven policy (i.e. extends beyond one project or activity), and not a response to regulation (current or expected). In other words, it is a form of self-regulation. In comparison, gaining and maintaining a social licence is not within the firm's control. Analysis for this research indicates that investing in corporate social responsibility (including, for example, adopting best management practices or investing in community health

or infrastructure projects as compensation for affected stakeholders) is a common strategy of choice to appeal to stakeholders who will ultimately decide whether to grant or withhold a social licence (e.g. Roeder, 2016; Saenz, 2018).

The most effective corporate social responsibility programs represent beyond compliance behaviour, address a negative externality or undersupply of/threats to public goods, or adequately compensate stakeholders experiencing negative impacts. In addition, it was found that when firms only invest in their corporate social responsibility for the short-term (Browne et al., 2011) or superficially (Miller, 2016), the social licence and associated gains can be short-lived and superficial. The social licence decision for stakeholders then draws attention to whether these social 'responsibilities' of firms should be considered beyond compliance or whether firms should be required (by regulation or other means) to adopt best management practices or provide compensation to affected stakeholders. The social licence issue here is also related to whether affected stakeholders consider it acceptable for the firm to offset their negative impacts via compensation. We return to this question in Section 2.3.3.3.

Applying economics perspectives again, we are reminded that as with the costs and benefits of the firm's activities, compensation can be distributed unequally. Investments in community infrastructure or social programs to offset business-as-usual activities, or the adoption of best management practices or other practices to reduce negative externalities, may create new or emphasise existing inequalities between stakeholders. Following from Section 2.3.2, these inequalities, prevailing governance arrangements, access to employment opportunities or essential services (Goldstuck and Hughes, 2010; Matebesi and Marais, 2018) will interact with the firm's corporate social responsibility business model to influence stakeholders' willingness to accept the firm's activities.

2.3.3.3. Sustainable development

In the social licence literature, the term 'sustainable development' is used to refer to attempts and challenges to simultaneously promote social, environmental and economic outcomes (de Jong and Humphreys, 2016; Kelly et al., 2017; Prno and Slocombe, 2012). From a welfare economics perspective, to achieve sustainable development is to achieve a non-declining level of social welfare. Simply, welfare is derived from the combined stock (and quality) of social, human, natural and produced capital (Solow, 1974; Stiglitz, 1974). Social licence concerns about sustainability are then related to trade-offs between the maintenance, promotion, and quality of different capital types. For example, the questions often being asked in the negotiation of a social licence include: is it acceptable to trade-off natural capital (or cultural capital) for produced capital without a loss in social welfare? If one group or individual is set to gain from the trade-off, will they gain sufficiently to compensate the group that does not? Is the provision of compensation able to offset the loss of natural capital and create an acceptable outcome? The same questions are posed by welfare economists.

Welfare economics is concerned with the impact on individual (private) and social welfare if different types of capital are treated as interchangeable. In other words, economists debate the appropriateness of this and whether it is necessary (Arrow et al., 2004; Pezzey, 1992) or not (Beckerman, 1994) to add environmental sustainability constraints to traditional formulations of social welfare and approaches to maximising welfare. The social licence literature highlights a number of scenarios where trade-offs are made between economic objectives (or produced capital) and natural/cultural capital. In some cases, but not all,

compensation is deemed appropriate to offset the loss of natural capital. However, it must be noted that it is not possible to interpret consent to mean that affected stakeholders perceive the trade-off to represent an improvement to social welfare. This is especially so in political or cultural setting where affected stakeholders can be persuaded or forced to give consent, or have their opinions silenced (e.g. Rosyida and Sasaoka, 2018).

Essentially, the same debates about sustainability are occurring in both the social licence literature and the welfare economics literature. By way of drawing the two bodies of thought together, we reinterpret the definition of social licence such that a firm with a social licence, must be making positive contributions to the welfare of a community or society. That is, by either the core activities or through compensation (including corporate social responsibility activities), firms with a social licence are making a net contribution to welfare as perceived by the stakeholders (at least a majority or influential group) affected by the firm.

2.3.3.4. Governance and private regulation

The effectiveness of social licence as a tool to improve social welfare is both a consequence of, and dependent on, prevailing governance and institutional arrangements. Prno and Slocombe (2012) and Lynch-Wood and Williamson (2007) suggest that social licences have emerged to offset the failures inherent in relinquishing the design and enforcement of regulation from public to private institutions. Governance arrangements can also determine the capacity of stakeholders to exert power over the decisions of firms and governments (by granting or withdrawing a social licence). For example, open, democratic decision-making processes allow for—and attach value to—stakeholders acting as regulators of activities or behaviours that affect them (Whitton et al., 2017). In contrast, technocratic decision-making following a Decide-Announce-Defend strategy tends to dismiss the preferences of affected stakeholders (Whitton et al., 2017). Prevailing governance and institutional arrangements also determine whether the intended impact of social licence pressure is to highlight/correct poor compliance with existing regulations or enforcement of regulations (i.e. government failures), or to demand behaviour that exceeds current regulations (Gunningham et al., 2004).

Private regulation relies on firms voluntarily aligning management with broader social objectives. The incentive for firms to do this, when their traditional goals may have been to maximise profitability, is contingent on market-based and social pressure creating demand for the adoption of voluntary changes. Lynch-Wood and Williamson (2007) noted that consumer power is important to the capacity of social licence to act as a form of regulation of firm activities. For example, consumers can create signals about the behaviours or production practices, used at any point in the production of a good, they consider acceptable through their decisions about what to consume. Consumers' preferences, and where possible, subsequent purchase decisions, can create signals about the practices they consider acceptable and consequently convey social licence concerns (Coleman, 2017; van Wessel, 2018). If sufficient consumers behave the same way and shift market demand (especially quickly, e.g. in response to a particular event), producers may be forced to respond in order to maintain market access, market share or profitability.

Interest in third party certification and/or accreditation in the social licence literature is also a reflection of consumer power to influence firm activities. For example, third party certification is often used by firms or industries to signal the use of technologies or management practices that meet or exceed social expectations and allay social licence concerns (Lee et al., 2019;

Vince and Haward, 2019). In this context certification schemes are often used to highlight a firm's provision of public goods, or activities to minimise the production of negative externalities such as biologically sustainable harvest practices within the forestry and fisheries industries. Indeed, in a case study from Australian aquaculture, Vince and Haward (2019) note that third party certification indicating sustainable practices is a necessary but insufficient condition to earn a social licence. The authors also note that firms decide to change management and invest in certification for a number of reasons, including strategic interests, and to improve their reputation and market competitiveness. This is critical as other actors in the value chain between the primary producer (often the focus of social licence concern) and the consumer, can also play a private regulatory role. For example, depending on the level of market power, these actors can manipulate producers' market access opportunities to be contingent on particular production methods (e.g. Olynk Widmar, 2018).

Overwhelmingly the social licence literature is concerned with the regulatory function of social licence rather than the role of societal expectations in influencing public regulations. As noted in Section 2.3.3.1, we identified negative externalities and undersupply of/threats to public goods as drivers of social licence concerns, and by definition, these are experienced by stakeholders that do not have the capacity to influence firm behaviour through the market mechanism. Following this, public regulation has an important role to play.

2.3.3.5. Public regulation

Governments intervene in markets/industries with regulations and policy to encourage behaviours and outcomes that reflect current social expectations, correct market failures (e.g. negative externalities, missing markets), transition society along new development paths, and/or protect against uncertainty and unknowns (Laffont and Tirole, 1990). When a decision is taken to implement or change regulations there will be trade-offs in private and social welfare. A decision to implement regulations is therefore a decision between firms (or individuals) being allowed to harm society for private gain through, for example, producing negative externalities, or whether society is allowed to harm the firm by restricting their feasible choice set (Coase, 1960). The decision to implement regulations following social licence concern is then the same. We detail this dynamic with respect to a firm's production choice set below.

For a rational decision-maker, the feasible production choice set will be a subset of the complete production choice set. Assuming monitoring and enforcement of regulations (whether this assumption holds in reality is another matter), a rational decision-maker that pursues the maximisation of self-interest (e.g. profit) and exhibits consistent, planned and sensible behaviour, will not use technologies or inputs, or produce outputs that are illegal or unprofitable. As such the feasible choice set will be a complement of the complete production set, excluding the subset that is illegal, and not profitable or perceived to be unprofitable. To impose regulations to follow social licence concerns would be to further constrain the feasible set. If regulations are not imposed in this way, it will be the choice of the firm as to whether they further constrain their feasible choice set by avoiding the use of technologies and/or inputs that do not meet societal expectations. This decision will reflect the firm's understanding of the likelihood and impact of: (1) unabated social licence concerns on their objectives (e.g. maximise profit); (2) the industry in which they operate implementing changes to standards or certifications; and/or (3) governments moving to implement regulations that follow future social licence concerns. There are examples of these scenarios in the social licence literature.

In some cases, social licence pressure can achieve a similar outcome as regulations. For example, the Enbridge Northern Gateway pipeline in Canada and the Khudoni Hydroelectric Power Plant in Georgia did not proceed because they were unable to obtain a social licence (see Jijelava and Vanclay, 2018; Wood and Thistlethwaite, 2018). There are fewer examples of public regulations being introduced following social licence concerns, e.g. hydraulic fracturing in France (Chailleux et al., 2018). A more common form of public intervention has been the repeal of legal licences for projects such as mining developments that faced significant resistance from host communities (e.g. Faruque, 2018; Gqada, 2011). The removal of legal licences in these cases indicates that stakeholders with concerns about the use of socially valuable assets for private profits, can use the social licence mechanism to demand governments remove or adjust legal rights and licences to access/use the resources (Gqada, 2011).

To implement regulations or redistribute property rights as per the examples above would affect the firms' feasible production choice sets. Other policy and regulatory tools at the disposal of public decision-makers, such as taxes on the production of negative externalities, can have a similar effect. However, rather than making a subset of options infeasible, a tax would shrink the feasible choice set by making some combinations of technologies or inputs unprofitable. Stakeholders withholding or withdrawing a social licence can be seen as signalling their expectations of public decision-makers to create disincentives for the production of negative externalities, or, demand the use of any tax or royalty revenue be used to deliver benefits back to the affected community. Following this, we argue there is potentially much to gain from extending existing social licence analyses to include economic theories of regulation (Peltzman, 1976; Stigler, 1971) and how different actors contribute to outcomes such as self-regulation or the need for public regulation. There could also be value in extending work such as that conducted by Cronshaw and Grafton (2016), exploring the impact of different regulatory settings across jurisdictions that face similar social licence issues in order to understand the relevant economic, environmental and social outcomes of different governance approaches.

2.3.3.6. Rent-seeking and regulatory capture

Despite the arguments made in the preceding sections, it must be noted that stakeholders can withhold or withdraw a social licence as a rent-seeking strategy to, for example, demand more than adequate compensation. Formally, rent-seeking is the 'demand for' decision-making to benefit private interests ahead of the public interest (i.e. ahead of the social welfare maximising decision). Also, firms may attempt to capture the regulatory process to prevent regulations, or limit the extent of regulations, that follow social licence concerns. This would be in the interests of the firm if they deem the costs of unabated social licence concern to be lower than the cost of complying with new regulations. Following this, the economic concepts of rent-seeking and regulatory capture are important to any discussion of the relationship between the social licence concept and governance and regulation.

Social licence issues are subject to rent-seeking and regulatory capture because any negotiation of a social licence will involve trade-offs between private and social welfare outcomes. They are also subject to rent-seeking and regulatory capture because it is, in many cases, legal to lobby decision-making agencies to make decisions that favour a particular outcome, or groups, e.g. those better able to express their preferences (high-income groups). Private interests also have greater capacity to influence public decision-making if the

transparency surrounding decision-making is poor (Grafton and Williams, 2020). Private interests also have greater capacity to influence public decision-making if the transparency surrounding decision-making is poor. Different governance arrangements can then have a significant influence on the prevalence of rent-seeking and regulatory capture.

Importantly, rent-seeking and regulatory capture can lower the quality of public decision-making and create welfare distorting outcomes. Consequently, it can lead to the erosion of trust in public institutions and firms. As mentioned earlier, trust and legitimacy are commonly referred to as central issues in the social licence literature (Table 2.3). However, the reason for the lack of trust is rarely tied back to the root causes described here. A lack of trust could be symptomatic of poor governance and/or rent-seeking and regulatory capture. The use of economics perspectives, in particular, the framework provided by the concepts of rent-seeking and regulatory capture could make important contributions to understanding the role of trust in social licence issues.

2.4. Future research agenda

Up to this point, we have detailed the social licence literature and related aspects of the welfare economics literature. While the disciplinary approaches that have been prominent to date will continue to have value, it is argued that framing social licence concerns in terms of welfare and public economics opens new pathways for understanding motivations for social licence concerns, i.e. as a consequence of: (1) concern about real or perceived negative externalities; (2) concern regarding a real or perceived undersupply on public goods; and/or (3) concern regarding the use of socially valuable assets to generate private profits. Using economic perspectives, it was possible to identify these three ‘types’ of motivations for social licence concerns allowing us to bring clarity to the drivers of social licence concerns. However, beyond questions about motivations for social licence concerns, loom larger issues. Namely, as natural resource industries (in particular) face increasing social licence pressures, there is a need to better understand the influence of social licence pressure on firm and public decision-making and the consequences for social welfare. For example, can social licence pressure be represented as costs to firms? At what point do these costs inhibit firms from continuing with business-as-usual behaviour? Do firms voluntarily change behaviour to minimise or avoid the costs that social licence pressures impose on them?

To address questions such as these, it is suggested researchers draw upon methods typically used by welfare economists, such as cost-benefit analysis (with careful considerations of appropriate discounting of future benefits and costs expected from any decision and extensive sensitivity analysis); multi-criteria analysis; or constrained welfare maximisation. Each of these methods can also be integrated with non-market valuation techniques in order to capture the costs and benefits experienced outside of the market system, such as externalities which we have established as a source of social licence concerns. Without diminishing the value of site-specific negotiations, we argue there is value in introducing structured economic-based methods to identify the quantifiable and non-quantifiable costs and benefits of different scenarios through time and how these can interact to inform the decisions of firms and stakeholders. Behavioural economics research should also become increasingly important to understand the influence of social factors on the decisions firms and stakeholders take when in possession of complete or incomplete cost and benefit information, and the responses that

may be induced by the introduction of regulatory changes or disincentives for activities or behaviours that attract social licence concern.

2.5. Conclusion

This article details the origins of social licence and current uses of the term as identified in a systematic literature review, and then builds on the current literature by detailing social licence as an economics issue. Growth in attention paid to the social licence status of firms and industries has been attributed to: changes in public regulation and governance arrangements; public access to information about firms' activities; and growth in awareness of and related action in the global sustainability movement.

We argue that as the social licence phenomenon continues to grow in economic importance for firms, stakeholders, and governments, it is becoming increasingly important to understand the motivations of social licence concerns. Across industries and sectors, we identified the motivations for social licence concern as responses to market and/or government failures. This contribution brings much needed clarity to the understanding of drivers of social licence concerns. In addition, by drawing on ideas established in the welfare economics literature, the definition of social licence can be reinterpreted to understand that a firm with a social licence is making positive contributions to the welfare of a community or society. However, it remains easier and potentially more accurate to identify the firms without a social licence than those with a social licence.

It is also important to note that any negotiation/withdrawal of a social licence involves trade-offs between individual and social welfare outcomes. For example, to contest and withhold a social licence from a firm in the interest of social welfare, will have a negative impact on the firm (e.g. reduce profitability). It may also deny some stakeholders opportunities (e.g. employment) associated with the firm's operations. However, to grant a social licence in order to access these benefits may invite continued production of negative externalities, an undersupply of/threats to public goods or unabated concern about the extent to which natural resources are exploited for private gain. The consequence of this is that incentives exist for both firms and community groups/stakeholders to capture the regulatory process and engage in rent-seeking behaviour. There are then ramifications for social welfare outcomes when social licence is relied on as a form of private regulation but also ramifications if public regulations follow social licence. With this, we suggest future research directions employ economics to understand the potential responses to social licence concerns from both social welfare and firm-level perspectives.

Chapter 3 Statement of Authorship

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Principal Author

Name of Principal Author (Candidate)	Nikki P. Dumbrell		
Contribution to the Paper	Conceptualisation, Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing		
Overall percentage (%)	80		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	3 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

The candidate's stated contribution to the publication is accurate (as detailed above);
 Permission is granted for the candidate to include the publication in the thesis; and
 The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	David Adamson		
Contribution to the Paper	Conceptualisation, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	Alec Zuo		
Contribution to the Paper	Conceptualisation, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	Sarah Ann Wheeler		
Contribution to the Paper	Conceptualisation, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Chapter 3 How do natural resource dependent firms gain and lose a social licence?

This chapter presents a paper published in [Global Environmental Change \(2021\)](#). The paper is included in its published form, with only minor changes to formatting to bring it in line with the overall thesis. Consequently, there is some repetition with other chapters of this thesis.

Abstract

A project, firm or industry whose activities are accepted by communities and stakeholders is said to have a social licence to operate. The importance of a social licence is increasingly being realised in natural resource industries where a project or firm can impose more environmental and social costs, e.g. pollution, or strain on service delivery and housing, on communities than they are willing to accept. However, the conditions that are necessary and/or sufficient to obtain/maintain a social licence are unclear. To rectify this gap, a global literature review paired with a fuzzy-set qualitative comparative analysis of 47 natural resource case studies from 25 countries was used to identify the conditions necessary and/or sufficient to: (1) obtain or lose a social licence; (2) result in voluntary practice change by firms; and/or (3) create regulatory change. No single condition out of the ten conditions tested was found to be necessary to obtain or lose a social licence or to change firm behaviour. However, a combination of five conditions created a robust pathway for maintaining a social licence, including: (1) delivery (or perception) of net *economic benefits* beyond the firm; (2) adequate stakeholder *consultation*; (3) minimal *media coverage*; (4) minimal *public protests*; and/or (5) absence of *well-defined and enforced private property rights*. These results contribute to an understanding of the somewhat limited effectiveness of social licence as a form of governance, and suggest that social licence outcomes are determined by the expectations of stakeholders, decisions and behaviours of firms, and broader institutional governance factors.

Keywords

Qualitative comparative analysis (QCA); Case study analysis; Net benefit; Firm behaviour change; Social licence to operate

3.1. Introduction

Natural resource dependent industries, such as mining, energy, agriculture and forestry, are central to local economies across the globe. Whilst producing desirable consumption goods, these industries can have undesirable external impacts, including pollution, biodiversity loss and land degradation. A relatively new form of governance, playing out at the intersection of markets and government regulations, that seeks to moderate these external impacts, is the concept of ‘a social licence to operate’. A project, firm, or industry with a social licence to operate (herein social licence) is one that experiences ongoing acceptance or approval by affected stakeholders and communities who have the power to affect the profitability of the project, firm or industry (Cooney, 2017; Gunningham et al., 2004; Raufflet et al., 2013). Herein the term stakeholders is used to refer to local or broader communities and other parties that may be affected by and/or able to affect the activities of firms.

The emergence of the social licence concept has been attributed to: (1) growth in awareness and concern about environmental degradation; (2) changing governance arrangements, especially a shift from ‘government-push’ regulation to greater reliance on market incentives or self and private regulation (Prno and Slocombe, 2012); and (3) increased public access to information about firms’ activities, especially natural resource exploitation activities in remote locations (Cooney, 2017; Cullen-Knox et al., 2017a). Ongoing interest in the social licence concept, from its original emergence (largely) in relation to environmental impacts of mining in the 1990s, reflects the power that stakeholders have to affect a firm’s profitability if it is perceived to not meet minimum regulatory requirements; or comply with minimum regulatory requirements that are considered too lax or not aligned with stakeholders’ expectations (Boutilier, 2014).

With growing reliance on social licence as a form of governance, research has sought to identify: (1) how and why affected stakeholders withdraw or withhold a social licence; and (2) how projects, firms or industries can obtain a social licence (Cooney, 2017; Thomson and Boutilier, 2011). Stakeholder attitudes and perceptions are critical as they are the actors positioned to grant, withhold/withdraw a social licence, as per their environmental and social expectations (Luke, 2017; Moffat and Zhang, 2014; Thomson and Boutilier, 2011). In the most general sense, the decision to grant or withdraw a social licence has been found to be a function of the distribution (inequalities) of the monetary and non-monetary costs and benefits of a firm’s activities (Dumbrell et al., 2020; Lacey and Lamont, 2014). At the same time, stakeholders’ decisions to withdraw a social licence can affect the operational feasibility of projects, firms or industries (Henisz et al., 2014; Jijelava and Vanclay, 2018). For example, stakeholders may boycott projects or firms, or may force firms to divert resources to non-productive uses such as dispute resolution. As a result, social licence has been conceptualised as a risk management issue for firms (Falck, 2016) and research has sought to identify ways to mediate this risk such as consultation or compensation (Mercer-Mapstone et al., 2017; van Putten et al., 2018; Walsh et al., 2017).

Case study research allows in-depth examination of the complex environments in which social licence issues arise and—as Conde and Le Billon (2017) identified—the different objectives, narratives and intensity with which stakeholders may resist or accept an activity. With this, a growing body of research has characterised the local (Koivurova et al., 2015; Luke, 2017); or national (Jartti et al., 2020; Zhang et al., 2015); or international (Lehtonen et al., 2020; Lesser

et al., 2021) social licence status of firms or industries based on a set of criteria. In the analysis presented in this article, qualitative comparative analysis (QCA; Ragin, 1987) was used to identify patterns across cases in different countries as well as different industries. The QCA method is underpinned by Boolean logic (rather than commonly used correlation methods) to test a range of conditions for particular outcomes to occur or not occur (Roig-Tierno et al., 2017). The method can be employed to identify the conditions that are necessary and/or sufficient to achieve the outcome of interest. A condition is deemed necessary, if, whenever the outcome is present, the condition is also present, and a condition is deemed sufficient if, whenever it is present, the outcome is also present (Ragin, 2008a).

In this article QCA is used to identify the conditions present/absent across natural resource case studies where: (1) a social licence was reported as granted/withheld/withdrawn; and (2) social licence pressure led to a change in firm activities or regulations. The analysis draws on a global literature review that identified 47 published case studies describing social licence outcomes for firms and/or specific projects in natural resource industries (e.g. mining, energy and agriculture) across 25 countries. This is the first analysis to identify the necessary and/or sufficient conditions for social licence outcomes and firm behaviour change across contexts. Specifically, the objective is to identify whether the conditions that drive social licence outcomes differ across natural resource dependent industries and institutional settings. This is important because the social licence concept is growing in prominence in multiple natural resource industries while the majority of research underpinning and testing models of social licence use mining industry examples.

There are three key benefits of this research for stakeholders reliant on, or positioned to influence social licence outcomes across the world. First, identifying the factors that underpin a social licence will be invaluable for industries that recognise their future success/profitability is contingent on maintaining a social licence (e.g. Future IQ, 2019; Mitchell et al., 2020). Second, understanding the necessary and or sufficient conditions to gain or lose a social licence may be critical for stakeholders that are reliant on the social licence mechanism to mediate future firm behaviour. Third, as Rudel (2008) noted, policy-makers can benefit from research that summarises and draws together research at different scales to make clear patterns or generate new insights. The QCA method adopted in this research is advantageous in this respect. In particular, as social licence concerns are most likely to increase in prominence with continued global environmental degradation, policy-makers will benefit from understanding the effectiveness of social licence as a form of governance and the role of policy-makers and overarching institutional arrangements in supporting alternative forms of governance.

3.2. Conditions associated with social licence outcomes

In the absence of a unifying theory of social licence, this section synthesises a series of frameworks and theoretical advancements that describe a social licence. Relationships between these frameworks and the broader literature, show several conditions associated with different social licence outcomes. Ten interrelated conditions were identified to be tested in the QCA analysis, as described below.

A systematic review of the social licence literature (reported in Dumbrell et al., 2020) was used as a first basis to identify frameworks and theories of social licence, and influences associated with social licence outcomes. The review captured documents published between 1996 and

the end of 2019 and indexed in the Web of Science Core Collection, Scopus, or Google Scholar databases. The initial search returned 2,574 documents. Documents were excluded from the final database if the full-text was unavailable, the document was in a language other than English, the document was a book review, or opinion article in an industry publication. Documents were also excluded if the concept of social licence was not important to the research problem or context. The final database included 651 documents. To ensure currency and completeness, the literature consulted for this study included that captured by Dumbrell et al.'s (2020) systematic literature review as well as research published after 2019.

The ten conditions identified to be tested from the literature review included: *Economic benefits*; *Compensation*; *Consultation*; *Social impacts*; *Environmental change*; *Well-defined and enforced private property rights*; *Political opportunities*; *Media coverage*; *Public protests*; and *Private firm ownership*. Table 3.1 provides further detail of the conditions and how they are hypothesized to relate to social licence outcomes. Table 3.1 also maps the conditions used in this analysis to the corresponding conditions identified in the literature review, and key references informing condition selections. Conditions were included in this analysis if they had been defined as part of a conceptual framework for predicting or describing social licence outcomes, and tested with quantitative or qualitative analyses. Conditions were grouped to form one condition in this analysis (left column in Table 3.1 when different terminology was used to describe a similar concept or phenomenon (key phrases in right column in Table 3.1), or when conditions were separated by levels of impact. For example, the often-separated economic benefits and impacts/costs conditions were combined in this analysis to form a net economic benefit condition. Conditions were not included in this analysis if, in previous research, they were framed as case specific indicators of a more general condition in the path toward social licence outcomes. Examples include local authorities providing official approvals and the signing of benefit sharing agreements. All conditions are treated as having equal weight (as described later in methods), and listed in tables such that conditions that firms have more control over (e.g. consultation strategy) are listed first, and conditions that firms have less control over (e.g. political and governance arrangements) are listed second. Italics are used to denote the names for conditions tested and reported in subsequent sections.

Table 3.1. The identified conditions for a social licence that are tested (left column), and the key phrases used to describe those conditions in the existing literature with key references and hypothesised social licence outcomes (right column).

Conditions	Conditions as referred to and framed in the literature and hypothesised social licence outcomes, with key references
<i>Economic benefits</i>	<p><i>Economic legitimacy</i> (Thomson and Boutilier, 2011); <i>wealth generation</i> (Prno and Slocombe, 2014); <i>perceived benefits</i> (Jartti et al., 2020; Lesser et al., 2021; Walton and McCrea, 2020; Zhang and Moffat, 2015): The perception that a project/firm activity offers benefits to affected stakeholders, e.g. employment, supply of products the activity/firm creates. The greater the benefits the more likely a social licence will be granted.</p>
<i>Compensation</i>	<p><i>Distributional fairness</i> (Jartti et al., 2020; Lesser et al., 2021; Walton and McCrea, 2020; Zhang et al., 2015): Refers to the fair distribution of benefits from a project/firm activity. The more affected stakeholders perceive the distribution of benefits to be fair, the more likely a social licence will be granted.</p> <p><i>Perceived benefits</i> (Walton and McCrea, 2020): The greater the perception that a project/firm activity offers benefits (not directly related to operations, e.g. sponsorship for community activities) to affected stakeholders, the more likely a social licence will be granted.</p> <p><i>Mode of benefit sharing</i> (Saenz and Ostos, 2021): If shareholder (rather than paternalistic) modes of benefit sharing from a project/firm activity to affected stakeholders are adopted, then it is more likely a social licence will be granted.</p>
<i>Consultation</i>	<p><i>Community engagement performance</i> (Hurst et al., 2020; Mercer-Mapstone et al., 2017, 2018; Uffman-Kirsch et al., 2020; Walsh et al., 2017; Zhang et al., 2018): Community engagement focuses on creating shared (across stakeholder groups) understanding, and plans/agendas. The more engaged firms are with affected stakeholders in these processes, the more likely a social licence will be granted.</p> <p><i>Contact quality and quantity</i> (Eabrasu et al., 2021; Lesser et al., 2021; Moffat and Zhang, 2014): Quality and quantity of contact between affected stakeholders and firms, through formal consultation and other means. The higher the quality and quantity of interactions the more likely a social licence will be granted.</p> <p><i>Procedural fairness</i> (Jartti et al., 2020; Lacey et al., 2016; Lesser et al., 2021; Mercer-Mapstone et al., 2018; Moffat and Zhang, 2014; Zhang et al., 2018): The fairer and more inclusive project/firm decision-making processes, the more likely a social licence will be granted.</p> <p><i>Relationship quality</i> (Boutilier, 2020b; Walton and McCrea, 2020): Determined by extent that firms are open, transparent (and engage in in two-way dialogue with affect stakeholders) and respond to issues in a timely manner. If high quality relationships exist, it is more likely a social licence will be granted.</p> <p><i>Mode of engagement</i> (Saenz and Ostos, 2021): If project/firm and community values are balanced (rather than favouring the project/firm), it is more likely that a social licence will be granted.</p>

Table 3.1. The identified conditions for a social licence that are tested (left column), and the key phrases used to describe those conditions in the existing literature with key references and hypothesised social licence outcomes (right column) (continued).

Conditions	Conditions as referred to and framed in the literature and hypothesised social licence outcomes, with key references
<i>Social impacts</i>	<p><i>Impacts on social infrastructure</i> (Jartti et al., 2020; Moffat and Zhang, 2014; Zhang and Moffat, 2015): If community access to medical care, housing or community facilities is improved following the arrival of a new resource development project or firm, then a social licence is more likely to be granted.</p> <p><i>Culture, customs and history of the affected communities</i> (Prno and Slocombe, 2014): The more livelihoods, culture, and customs are maintained in communities affected by a project/firm activity, the more likely a social licence will be granted.</p>
<i>Environmental change</i>	<p><i>Environmental impacts/perceived environmental performance</i> (Lynch-Wood and Williamson, 2007; Prno and Slocombe, 2014; Walton and McCrea, 2020; Witt et al., 2021; Zhang and Moffat, 2015): Projects/firms that actively adopt eco-innovations, manage environmental risks and communicate how they minimise environmental impacts is more likely to have a social licence.</p> <p><i>Previous experience with resource use/development</i> (Boutillier, 2020b; Prno and Slocombe, 2014): If affected stakeholders have had positive (poor) past experiences with the same type of environmental resource use, they will be more (less) likely to grant a social licence.</p> <p><i>Negative externalities^a or undesirable negative consequences</i> (Dumbrell et al., 2020): The more a project/firm activity produces undesirable negative environmental consequences, the less likely a social licence will be granted.</p> <p><i>Threats to or undersupply of public goods^a</i> (Dumbrell et al., 2020): The more a project/firm activity negatively affects the quality or quantity of public goods, the less likely a social licence will be granted.</p>
<i>Well-defined and enforced private property rights</i>	<p><i>Governance and institutional arrangements</i> (Prno and Slocombe, 2014; Uffman-Kirsch et al., 2020): Governance and institutional arrangements affect the overarching conditions in which resource allocations are made, and firm-stakeholder interactions occur. The weaker these arrangements, the less likely a social licence will be granted.</p> <p><i>Political licence to operate</i> (Bice et al., 2017; Robinson et al., 2020): The more property right allocations, or government enforcement or oversight of regulatory approval conditions, can be influenced by state pro-development agendas, the less likely a social licence will be granted.</p> <p><i>Allocation of socially valuable assets to private uses</i> (Dumbrell et al., 2020): The poorer the understanding of property rights, the enforcement of responsibilities associated with property rights, or greater the disapproval of the allocation of property rights in socially valuable assets, the less likely a social licence will be granted.</p>

Table 3.1. The identified conditions for a social licence that are tested (left column), and the key phrases used to describe those conditions in the existing literature with key references and hypothesised social licence outcomes (right column) (continued).

Conditions	Conditions as referred to and framed in the literature and hypothesised social licence outcomes, with key references
<i>Political opportunities</i>	<p><i>Development and human rights</i> (Saenz and Ostos, 2021): The more empowered stakeholders are to interact with projects/firms and governing organizations in partnerships (rather than have paternalistic relationships) the more likely a social licence will be granted.</p> <p><i>Governance and political conditions</i> (Jartti et al., 2020; Lehtonen et al., 2020; Musiyarira et al., 2021; Prno and Slocombe, 2014): The more stakeholders perceive a firm or regulator to be corrupt, or pro-development or pro-resource-nationalism, the less likely they will perceive their interests to be protected, and the less likely they will be to grant a social licence.</p> <p><i>(Trust in) governance</i> (Lesser et al., 2021; Musiyarira et al., 2021; Walton and McCrea, 2020; Zhang et al., 2015, 2018): Framed in terms of the extent that regulators can and will hold private firms to account. The stronger the governance arrangements, the more likely a social licence will be granted.</p>
<i>Media coverage</i>	<p><i>Customer interest; corporate/brand visibility; community pressure</i> (Lynch-Wood and Williamson, 2007): Interest in, and visibility of projects and firms affects stakeholder perceptions of a project/firm activity. Media coverage of a project/firm activity indicates broad interest. Affected stakeholders also use the media to show a project/firm activity is unwelcome.</p>
<i>Public protests</i>	<p><i>Social resistance</i> (Luke, 2017); <i>protests</i> (Vanclay and Hanna, 2019); <i>socio-political obstacles</i> (Boutilier, 2020b): Participation in protests indicates identification with social resistance movements, which indicates the absence of a social licence.</p>

Note:^a Negative externalities and undersupply of public goods can also affect non-environmental assets, this condition therefore also maps on to ‘social impacts’.

Three early models of social licence (Lynch-Wood and Williamson, 2007; Moffat and Zhang, 2014; Thomson and Boutilier, 2011), plus their derivatives, describe the majority of conditions, and hypothesised relationships with social licence outcomes. First, Lynch-Wood and Williamson (2007) framed a social licence as a product of a firm’s environmental impacts, coupled with brand visibility, customer and community interest in the environmental consequences of the firm’s behaviour, and customer power (e.g. access to resources and ability to act collectively to influence the firm’s activities). Lynch-Wood and Williamson’s (2007) model also indicates that no one factor alone e.g. environmental impacts or brand visibility, is sufficient to determine whether a social licence will be granted or withdrawn. Since Lynch-Wood and Williamson (2007) stipulated this model, *environmental change*, or the perception of environmental impacts resulting from projects/firm activities, especially negative environmental externalities, has continued to motivate social licence concerns across industries and contexts (Dumbrell et al., 2020). As such, *environmental change* is a central condition in this analysis (Table 3.1). Likewise, three of the five factors identified as critical for social licence outcomes by Lynch-Wood and Williamson (2007) can be represented by the

extent and nature of *media coverage* the project or firm receives: customer interest; brand visibility; and community pressure (Table 3.1). The *media coverage* condition used in the analysis (as described in Table 3.2) accounted for the scale (e.g. local or global) and diversity of media attention about social licence issues. *Media coverage* is also included given the emergence and persistence of the social licence concept has been linked to improved public access to information about firms' activities via the increasingly connected internet, social media and rapid news cycles (Cooney, 2017; Cullen-Knox et al., 2017a).

Second, in mining contexts, a social licence has been established as a product of economic legitimacy, socio-political legitimacy, trust and credibility (Boutilier and Thomson, 2011; Thomson and Boutilier, 2011). More specifically, the model suggests no firm can obtain a social licence without economic legitimacy, that is, without delivering net *economic benefits* or contributing to wealth generation for affected stakeholders (Table 3.1). *Economic benefits* may include employment opportunities and/or spillover effects of increased economic activity in a location. Evidence of stakeholders making trade-offs between economic benefits and social costs across diverse contexts supports this model. Social licences have been granted in cases where *economic benefits* have been perceived to outweigh associated costs such as environmental degradation (e.g. Marcos-Martinez et al., 2019; Richert et al., 2015) and withheld or withdrawn when the benefits were deemed insufficient (e.g. de Jong and Humphreys, 2016). In addition, *compensation* payments such as those made by firms to communities via community trust funds, or other forms of benefit sharing such as new infrastructure for local communities have also been critical to social licence outcomes (e.g. Langbroek and Vanclay, 2012; Matebesi and Marais, 2018). The distributional fairness of *compensation* and other perceived or real benefits is also critical (Table 3.1). Applications of the Thomson and Boutilier (2011) model have confirmed the relationships between these factors and different levels of social licence (Jijelava and Vanclay, 2017, 2018), while others show a lack of economic legitimacy, trust and credibility, drives resistance movements and decisions to withhold/withdraw a social licence (Lesser et al., 2021; Luke, 2017).

Third, using mining developments as a case study Moffat and Zhang (2014) found *social impacts* (e.g. changes to service access, livelihoods, and cost of living) to be important to social licence outcomes, as well as: *consultation* (represented by contact quantity and contact quality); and procedural fairness. Here contact quantity and quality refer to contact between local communities and mining firms. Procedural fairness is concerned with decision-making processes, including the extent that stakeholders' views are accounted for in decision-making. Moffat and Zhang (2014) explored a mining firm's decision-making processes while public decision-makers processes to grant mining rights were not considered. Later research has modified and built on this model (Jartti et al., 2020; Mercer-Mapstone et al., 2018; Zhang and Moffat, 2015; Zhang et al., 2015). Notable advancements include detailed interrelationships between the different factors underpinning a social licence (Walton and McCrea, 2020) and the finding that procedural fairness is not only important, but a pre-requisite for a social licence (Zhang et al., 2018).

While different research uses various terms for *consultation* (see Table 3.1) and although some authors do not restrict their definition of contact to formal consultation processes, community consultation, relationships and engagement are considered critical to social licence outcomes (Mercer-Mapstone et al., 2017, 2018; Moffat and Zhang, 2014; Zhang et al., 2018). *Consultation* is a two-way discussion through which firms must outline any expected

benefits and costs to stakeholders, and stakeholders can raise any concerns and/or negotiate or request potential compensation for negative impacts. It is also the forum in which stakeholders can raise issues or concerns, or seek additional information on risks associated with a firm's activities and in-part address asymmetric information issues.

Alongside the factors identified as drivers of social licence outcomes above, it can be seen that firms and their activities exist in a social and political environment. The capacity to make acceptance or resistance known—as well as a firm's capacity to change behaviour as a response—are contingent on there being opportunities to do this. It can also be seen that certain political structures can make it more difficult than others for stakeholders to voice their acceptance or resistance to a project/firm activity (e.g. Ide, 2015; Rosyida and Sasaoka, 2018). Likewise, governance or institutional arrangements can stipulate the *consultation* or *compensation* processes that firms must engage in when seeking to establish a new project or undertake activities that impact stakeholders (Prno and Slocombe, 2014). Governance conditions tested in previous research (Table 3.1) have been framed to reflect the extent that stakeholders perceive regulators can and will hold private firms accountable, and factors that may prevent this (e.g. corruption Musiyarira et al., 2021). As a result, conditions such as the level of corruption, human development and democracy that can collectively be described as stakeholders' *political opportunities* (Kirchherr et al., 2016) were tested. Like the *well-defined and enforced property rights* condition (described below), the *political opportunities* condition can be seen as a form of institutional and governance strength in a country/region.

Dumbrell et al. (2020) identified social licence concerns as a response to the exploitative use of socially valuable assets such as land or water to generate private profits. Further, how property rights (constructs that define how resources are owned and used) are allocated, and the impacts of a firm's activities relative to the boundary of their property rights are considered important for social licence outcomes (e.g. de Jong and Humphreys, 2016; Westoby and Lyons, 2016). The condition of *well-defined and enforced property rights* was included to provide detail on the impacts of property right allocation processes as well as the impacts of the exploitation of resources, e.g. minerals, in which firms are granted property rights. It was hypothesised that in instances where property rights are well-defined and enforced (e.g. with regulation) and where a firm's activities have limited impact beyond the limits of their property rights (e.g. on neighbours), social licence concerns would be minimal. This is because negative externalities, a key driver of social licence concerns, would be minimised in this scenario (Dumbrell et al., 2020). In cases where property rights may be ambiguous or, institutions (usually governments) able to enforce property rights are absent or ineffective, there may be concerns about a firm's social licence status. However, capacity to withhold or withdraw a social licence in these cases may be minimal as there is little to no consequence to firms for ignoring rights without institutions to enforce rights.

While *public protests* have not (to date) been framed as underpinning the loss of a social licence, they have been identified as a way to show acceptance/approval of any resistance movement (Luke, 2017) and have been framed as a method through which stakeholders can highlight procedural and distributional fairness issues. It is for this purpose that the existence and severity of *public protests* was included as a condition. Likewise, the private/public status of firms has not previously been framed as underpinning the loss of a social licence (hence not included in Table 3.1). However, industries and firms often frame the need to maintain or improve profitability as the incentive to obtain a social licence (Jimena, 2011). Given this

incentive is often more pressing for private firms compared to governments (that are increasingly attracting social licence attention too), the ownership structure of the proponent firm was incorporated into the analysis via the tenth condition, *private firm ownership*.

3.3. Methods

A global dataset consisting of detailed case study information was examined to identify how the ten conditions described in the preceding section are associated with two outcomes of interest: (1) the loss or gain of a social licence for a project, firm or industry; and (2) whether threats to a social licence translate into firms changing their behaviour or prompt regulatory reform. As mentioned previously, QCA was used to identify the necessary and/or sufficient conditions for the two outcomes of interest, using data from 47 case studies across 25 countries. While it is common to compare and contrast social licence outcomes for a few cases (e.g. Koivurova et al., 2015; Prno, 2013), an advantage of the QCA approach is that it allows multiple case analysis. By allowing the conversion of qualitative data into quantitative data, QCA opens up the possibility to produce generalizations from otherwise non-generalizable case study research (Rihoux, 2006; Rudel, 2008). Consequently, QCA is increasingly being used to examine outcomes in natural resource or environmental management issues as a result of different interventions or institutional arrangements (Basurto, 2013; Ma'Mun et al., 2020; Pahl-Wostl and Knieper, 2014; van der Heijden, 2015).

3.3.1. Case study selection

The systematic review of the social licence literature (reported in Dumbrell et al., 2020 and described above) was used to identify case studies for this analysis. Of the 651 documents in the final database, 226 documents were classified as reporting on a case study or multiple case studies. Case studies reported in these 226 documents were selected for analysis using the following inclusion criteria: (1) information was available on the status of a firm or project's social licence; and (2) information was available on the actions undertaken and/or sentiments influencing a social licence. Each case study cited a variety of social and governance characteristics to be linked to social licence outcomes. However, information available to define the social licence status of a firm was not uniform across cases. Following this process 47 case studies were selected for analysis. Details of cases are listed alphabetically by country in Table A2.1 in Appendix 2.

As noted by Dumbrell et al. (2020), the majority of social licence research to date focuses on mining case studies from resource-rich countries and this is also reflected in the case studies selected for this analysis. Peru was the most common location (six cases); followed by Australia (five cases) and Canada (four cases); with mining the most common industry examined (Table A2.1 in Appendix 2). The majority of cases (36 out of 47) reported on instances where a social licence was under threat or had been withheld or withdrawn. This is likely a reflection of the ease with which researchers can identify and report that a social licence has been lost—compared to the alternative scenario of it being gained (Lacey et al., 2012). This also shows a reflection of interest by researchers in cases where a social licence is threatened or lost as an indicator of substantial environmental or social costs with consequences for multiple parties, including policy-makers.

3.3.2. Fuzzy-set QCA calibration methodology

Fuzzy-set QCA, based on fuzzy-set theory (Zadeh, 1965), was used instead of crisp-set QCA. The advantages of adopting fuzzy-set QCA include the ability to configure conditions based on partial membership of a condition or outcome set, i.e. it allows the use of non-binary conditions and outcomes unlike crisp-set QCA (Roig-Tierno et al., 2017). Fuzzy-set QCA also allows researchers to draw on a wide and non-uniform range of evidence to score conditions and outcomes for case studies (Ragin, 2008b).

Conditions and outcomes were measured by qualitative data, converted into quantitative data for the fuzzy-set QCA by a content analysis. With access to (in some cases) substantial information about each case study, and the variable nature of the evidence and reporting of evidence across cases, fuzzy-set calibration using four-value membership scores was used (Ragin, 2008b). The four possible values of 0, 0.33, 0.67 and 1 represent the following set relationships: 0=fully out of the relevant set; 0.33=more out than in the relevant set; 0.67=more in than out of the relevant set; and 1=fully in the relevant set. The same four-value set membership scale was used for the conditions and outcomes of interest. Scoring and calibrating the qualitative case study evidence to fit this membership structure was an iterative process and guided closely by the theorised relationships and the literature. All scoring decisions were made by one person (the candidate) to ensure consistency. Examples of scoring decisions are included in Table A2.2 in Appendix 2.

3.3.3. Defining conditions and outcomes

As previously mentioned (Table 3.1), based on the literature review, ten conditions were selected to be tested for associations with social licence and firm behaviour outcomes. The conditions included: *Economic benefits*; *Compensation*; *Consultation*; *Social impacts*; *Environmental change*; *Well-defined and enforced private property rights*; *Political opportunities*; *Media coverage*; *Public protests*; and *Private firm ownership*. Table 3.2 lists the ten conditions and defines the four levels of set membership for each condition. Three of the ten conditions were composite conditions with the sub-conditions combined as described below.

Following the procedure outlined in Ragin (2000), the sub-conditions for the *environmental change* and *social impact* (Table 3.2) conditions were joined by keeping the higher of the two sub-condition scores for each case study. The *political opportunities* condition used in the analysis was a composite of membership of the following sets: a developed country (as per United Nations Development Programme, 2018); a democratic country (as per The Economist Intelligence Unit, 2019); and a country perceived to be relatively free from corruption (as per Transparency International, 2018). Data to classify countries into the four-level set membership structure were quantitative indices. However, the indices also had 'qualitative' descriptors to section the indices into four levels, which aided the calibration of the data (Table 3.2). The composite *political opportunities* condition (i.e. combination of development, democracy and corruption sets), was created by joining development and democracy to the highest score and corruption to the lowest score. This was done as countries classified as being highly developed and democratic, with minimal to no corruption were hypothesized to represent greater political opportunities for stakeholders to express their acceptance or resistance of a firm's activities.

The outcome sets were constructed, scored and calibrated in a similar way to the conditions. It is recognised that social licence status is not binary (Prno, 2013). Indeed, the social licence status of firms are often described as: gained/maintained at either the ‘acceptance’ or ‘approval’ level as per the Thomson and Boutilier (2011) model; under threat or being challenged/questioned; and lost or never obtained. These statuses then naturally lend themselves to a four-level membership calibration process for the *loss of social licence* outcome (Table 3.3). Alongside social licence status, a second outcome was analysed: *change in behaviour/regulation*. When the loss of a social licence is framed as a risk management issue for firms (Cooney, 2017), it infers that there is an incentive to maintain a social licence, and therefore an incentive to change business practices, e.g. go beyond compliance (Gunningham et al., 2004). In addition, Lynch-Wood and Williamson (2007) find that social licence is a form of informal regulation on firms, requiring alignment of behaviour with expectations. Building on this, Dumbrell et al. (2020) further elicited some of the potential pathways social licence (as an informal regulation) can induce regulatory change. To capture this regulatory change was established as the most extreme form of behaviour change (as firms would be forced to change rather than choose to change) in the four-level outcome set (Table 3.3).

Table 3.2. Operationalisation and calibrated scores for conditions potentially associated with social licence outcomes.

Conditions		Definitions of conditions and sub-conditions
<i>Economic benefit</i>	0	Affected stakeholders stand to gain little (economically) from project/firm activity
	0.33	Affected stakeholders can benefit (economically) from project/firm activity, but gains do not outweigh costs
	0.67	Affected stakeholders can benefit from project/firm activity, i.e. benefits outweigh (or perceived to) the costs, at least in the short to medium term
	1	Project/firm activity is crucial for economic development for local community and/or other stakeholders
<i>Compensation</i>	0	No compensation (directly or indirectly) was given to affected stakeholders
	0.33	Compensation given to affected stakeholders was perceived to be insufficient
	0.67	Compensation given to affected stakeholders perceived to be mostly sufficient
	1	Sufficient compensation was negotiated with and granted to benefit the most affected stakeholders
<i>Consultation</i>	0	Firm reported only what was required by law, or shared communications to convince affected stakeholders of merits of project/activity
	0.33	Firm only consulted affected stakeholders on ad-hoc basis in response to issues/conflict with project/activity
	0.67	Firm shared information about project/activity relevant to affected stakeholders but did not actively incorporate feedback
	1	Firm openly shared information about project/activity relevant to affected stakeholders and adopted feedback

Table 3.2. Operationalisation and calibrated scores for conditions potentially associated with social licence outcomes (continued).

Conditions	Definitions of conditions and sub-conditions	
<i>Social impact</i>	<i>Cultural heritage or social identity impacts</i>	
	0 Project/firm activity will have/has minimal to no impact on daily life and valued assets/activities of affected stakeholders	
	0.33 Project/firm activity will have/has some impact on daily life and valued assets/activities of affected stakeholders	
	0.67 Project/firm activity will have/has impact on self-identification and place attachment for affected stakeholders	
	1 Project/firm activity will have/has substantial impact on self-identification and place attachment for affected stakeholders (e.g. forced displacement/resettlement)	
	<i>Health impacts</i>	
	0 Health/safety impacts of project/firm activity not perceived to be an issue for affected stakeholders	
	0.33 Health/safety impacts of project/firm activity are or perceived to be minimal to moderate for affected stakeholders	
	0.67 Health/safety impacts of project/firm activity are or perceived to be considerable for affected stakeholders	
	1 Health/safety impacts for affected stakeholders are or perceived to be of significant concern for affected stakeholders	
	<i>Environmental change</i>	<i>Environmental impacts</i>
		0 Environmental impacts of project/firm activity not perceived to be an issue
		0.33 Environmental impacts of project/firm activity are or perceived to be minimal to moderate
		0.67 Environmental impacts of project/firm activity are or perceived to be considerable
1 Environmental impacts of project/firm activity are or perceived to be of significant concern		
<i>Familiarity of resource use and characteristics of affected assets</i>		
0 Assets affected by project/firm activity already developed and to be used for a similar or familiar purpose		
0.33 Assets affected by project/firm activity already developed and reallocated from a familiar use to an unfamiliar use		
0.67 Assets affected by project/firm activity were previously undeveloped		
1 Assets affected by project/firm activity were previously undeveloped and considered rare/precious		
<i>Well-defined and enforced property rights</i>		0 Assets affected by project/firm activity are largely open access, or customary use and access rights largely ignored, or, jurisdiction is unclear
		0.33 Assets affected by project/firm activity are largely defined as common pool resources and/or the state can/does allocate rights in subsets of these resources
		0.67 Project/firm activity occurs on and affects property that has well-defined and enforced private property rights but impacts also manifest beyond the bounds of the private property
		1 Project/firm activity occurs on and affects property that has well-defined and enforced private property rights

Table 3.2. Operationalisation and calibrated scores for conditions potentially associated with social licence outcomes (continued).

Conditions	Definitions of conditions and sub-conditions	
<i>Political opportunities</i>	<i>Development</i>	
	0	Project/firm operates in low human development country (Index ^a score <0.55)
	0.33	Project/firm operates in medium human development country (Index ^a score ≥0.55 & <0.7)
	0.67	Project/firm operates in high human development country (Index ^a score ≥0.7 & <0.8)
	1	Project/firm operates in very high human development country (Index ^a score ≥0.8)
	<i>Democracy</i>	
	0	Project/firm operates under authoritarian regime (Index ^b score <4)
	0.33	Project/firm operates under flawed regime (Index ^b score ≥4 & <6)
	0.67	Project/firm operates under flawed democracy (Index ^b score ≥6 & <8)
	1	Project/firm operates under full democracy (Index ^b score ≥8)
	<i>Corruption</i>	
	0	No corruption perceived in country where project/firm operates (Index ^c score of ≥77)
	0.33	Limited corruption perceived in country where project/firm operates (Index ^c score of ≥49 & <77)
	0.67	Corruption perceived to be a significant challenge in country where project/firm operates (Index ^c score of ≥30 & <49)
	1	Corruption perceived to be pervasive in country where project/firm operates (Index ^c score of <30)
	<i>Media coverage</i>	0
0.33		Some coverage of project/firm activity and impacts on affected stakeholders in (local) mainstream and social media
0.67		Extensive coverage of project/firm activity and impacts on affected stakeholders in (national and or local) mainstream and social media
1		Extensive coverage of project/firm activity and impacts on affected stakeholders in (national and international) mainstream and social media
<i>Public protests</i>	0	No notable protests or conflict in response to project/firm activity
	0.33	Online petitions/activism set-up in response to project/firm activity
	0.67	Peaceful protests in response to project/firm activity
	1	Violent protests resulting in injuries or deaths in response to project/firm activity
<i>Private firm ownership</i>	0	Proponent of project/activity is a government or government institution
	0.33	Proponent of project/activity is a government-private partnership or state-owned company
	0.67	Proponent of project/activity is a private firm supported by government
	1	Proponent of project/activity is a private firm

Notes: ^a United Nations Development Programme (2018) Human Development Index; ^b The Economist Intelligence Unit (2019) Democracy Index; ^c Transparency International (2018) Corruption Perception Index. All conditions are ordered 0 to 1 where 0 is hypothesised to be associated with the absence of both outcomes and 1 hypothesised to be associated with the presence of both outcomes.

Table 3.3. Operationalisation and calibrated scores for the outcomes of a loss of social licence and a change in behaviour/regulation.

Outcome	Definition of outcome scores	
1. <i>Loss of social licence</i>	0	Project/firm has gained and maintained a high level of social licence (approval)
	0.33	Project/firm has gained and maintained a low level of social licence (acceptance)
	0.67	Project/firm's social licence threatened
	1	Project/firm lost or never obtained a social licence
2. <i>Change in behaviour/regulation</i>	0	Project went ahead/firm activity continued
	0.33	Project/firm activity went ahead with adoption of minor changes
	0.67	Firm's activity was scaled back or, project was mothballed/delayed
	1	Regulatory change occurred such that the project/firm activity was no longer permitted or firm/s stopped project/activity

3.3.4. Data analysis

As recommended by Schneider and Wagemann (2010), the first step of the analysis was to identify if any of the conditions in Table 3.2 were necessary to generate the two outcomes of interest displayed in Table 3.3: (1) loss or gain of a social licence; and (2) behaviour or regulatory change. The outcome *loss of social licence* was treated as a condition in the analysis of whether firms changed their behaviour or regulatory change occurred. The necessary condition analysis was run for all possible outcomes because fuzzy-set QCA assumes asymmetry, that is, the absence of a necessary condition such as *loss of social licence* or *private firm ownership* for the outcome *change in behaviour/regulation* cannot be assumed to lead to the absence of the outcome. A condition is deemed necessary, if, whenever the outcome is present, the condition is also present (Ragin, 2008a).

Following Goertz (2006) and Ma'Mun et al. (2020), 2 by 2 tables were created to identify sufficiency effects of the conditions. Along with this approach, a standard truth table analysis was used to identify configurations of the conditions that could be classed as sufficient for generating the outcomes of interest. Each row of a truth table contains one logically possible combination of conditions that may (or may not) be sufficient for an outcome. A condition is deemed sufficient if, whenever it is present across cases, the outcome is also present (Ragin, 2008a). For each assessment of necessary conditions and the truth table analyses, the coefficients of consistency and coverage were examined (and reported with results). These coefficients represent a numeric expression for how well the logical statement contained in the QCA solution term fits the underlying empirical evidence and how much it can explain (Schneider and Wagemann, 2010). While there is no agreed threshold value for consistency and coverage coefficients, and generally lower values are more acceptable in fuzzy-set QCA (such as that used here), Ragin (2008b) was followed in interpreting consistency values lower than 0.75 as showing significant inconsistency. For this reason, a demanding consistency threshold of ≥ 0.9 was adopted (Skaaning, 2011). Additionally, the frequency cut-off (to determine which combinations of conditions were relevant) was set to 1.

The hypothesised set of conditions (solution term) associated with the loss of a social licence, and voluntary behaviour change, or regulatory change is detailed in Equation 3.1 and 3.2, respectively. The conditions and outcomes in these equations are defined in Table 3.2 and

Table 3.3. The notation used in Equation 3.1 and 3.2 and the results tables (to follow) is based on Boolean logic: (*) indicates logical AND which joins conditions to the highest score; (+) indicates logical OR which joins conditions to the lowest score; (~) indicates negation or absence of a condition (or outcome); and (→) indicates sufficient for.

*~Economic benefits * ~Compensation * ~Consultation * Social impacts * Environmental change * ~Well defined and enforced property rights * Political opportunities * Media coverage * Public protests* → *Loss of social licence* (Eq. 3.1)

*Loss of social licence * Private firm ownership* → *Change in behaviour/regulation* (Eq. 3.2)

Sensitivity analyses were conducted on results. This additional testing consisted of including/excluding conditions and various case combinations in the analysis (Thiem et al., 2016). Following this, it was checked whether the results hold for cases regardless of: the state of development of the country; the *political opportunities* of affected stakeholders; and the industry application e.g. mining vs non-mining. Analyses also explored whether *media coverage* and *public protests* were potentially interdependent with other conditions, and explored in close detail the role of *compensation* (as defined in Table 3.2) as associated with the outcome *change in behaviour/regulation*.

All analyses were conducted using fs/QCA v3.0 (Ragin and Davey, 2017).

3.4. Results

No conditions were found to be necessary for a *loss of social licence* at the consistency threshold ≥ 0.9 (Table 3.4). Despite this, the generally high consistency and coverage scores for some conditions, such as *media coverage*, indicated the conditions analysed were important drivers of the outcome (Table 3.4). Both *loss of social licence* and *private firm ownership* were necessary conditions for a *change in behaviour/regulation* (Table 3.4). That is, in every case where the outcome (*change in behaviour/regulation*) was present, both of these conditions were also present. Necessary conditions for gaining or maintaining a social licence (*~loss of social licence*) and firms not changing their behaviour voluntarily or via regulatory reform (*~change in behaviour/regulation*) were also tested. No conditions passed the ≥ 0.9 consistency threshold for either of these outcomes. Note, Table 3.4 presents the most relevant results of the analysis for necessary conditions and all results are in Appendix 2.

Sufficiency effects were explored for the two necessary conditions for *change in behaviour/regulation* and the conditions that had relatively high (>0.8) consistency scores for *loss of social licence*. This analysis indicated that wherever *economic benefits* and *consultation* were lacking, the firm's social licence was under threat or lost (Table 3.5). In addition, in every case where extensive *media coverage* was present, the firm's social licence was under threat or lost (Table 3.5). This indicates that *media coverage* is a sufficient condition for *loss of social licence*. Interestingly, in every case where the outcome *loss of social licence* was absent (i.e. a social licence was maintained) there was also substantial environmental

change reported. Rather than interpreting this as an indication that environmental change is associated with maintaining a social licence, it is likely a reflection that the majority of cases included in the analysis (42 out of 47 cases) reported substantial environmental change (a consequence of the issues that attract social licence concern). In every case where scores for *loss of social licence* and *private firm ownership* were 0 or 0.33, firms did not voluntarily change their behaviour, nor were they forced by regulatory change (Table 3.5). This finding indicates that neither condition is sufficient for *change in behaviour/regulation*. Collectively this set of results indicates no unique pathway for *loss of social licence* or *change in behaviour/regulation* based on the conditions used in this analysis, and this was backed up by a fuzzy-set truth table analysis. However, the 2 by 2 tables (Table 3.5) indicate scope for a unique solution pathway for maintaining a social licence (*~loss of social licence*). This was explored using a standard fuzzy-set truth table analysis and the results are presented in Table 3.6.

Table 3.4. Analysis of necessary conditions for *loss of social licence* and *change in behaviour/regulation*.

Condition	Consistency	Coverage	Condition	Consistency	Coverage
<i>OUTCOME 1: Loss of social licence</i>			<i>OUTCOME 1: ~Loss of social licence</i>		
<i>~Economic benefits</i>	0.57	0.88	<i>Economic impacts</i>	0.87	0.56
<i>~Compensation</i>	0.78	0.77	<i>Compensation</i>	0.63	0.64
<i>~Consultation</i>	0.83	0.90	<i>Consultation</i>	0.85	0.75
<i>Social impacts</i>	0.75	0.77	<i>~Social impacts</i>	0.65	0.61
<i>Environmental change</i>	0.83	0.75	<i>~Environmental change</i>	0.55	0.66
<i>~Well-defined & enforced property rights</i>	0.78	0.76	<i>Well defined & enforced property rights</i>	0.61	0.63
<i>Political opportunities</i>	0.59	0.44	<i>~Political opportunities</i>	0.53	0.68
<i>Media coverage</i>	0.87	0.80	<i>~Media coverage</i>	0.65	0.75
<i>Public protests</i>	0.79	0.85	<i>~Public protests</i>	0.78	0.70
<i>OUTCOME 2: Change in behaviour/regulation</i>			<i>OUTCOME 2: ~Change in behaviour/regulation</i>		
<i>Loss of social licence</i>	0.94	0.52	<i>~Loss of social licence</i>	0.55	0.94
<i>Private firm ownership</i>	0.90	0.35	<i>~Private firm ownership</i>	0.14	0.72

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation (or absence).

Two intermediate solutions were identified. First, adequate *economic benefits* (benefits that outweigh costs), combined with adequate *compensation* and the absence of widespread *media coverage* and lack of *public protests* was sufficient for a social licence to be maintained. Second, a social licence was maintained in cases where substantial and potentially violent *public protests* were present, so long as the other conditions mentioned in the previous sentence were present (i.e. *economic benefits* and *consultation*) and the affected resources do not have *well-defined and enforced property rights*. The parsimonious solution (Table 3.6) shows that adequate *consultation* combined with the absence of widespread *media coverage* was sufficient to maintain a social licence in each of the 11 cases where a social licence was not lost nor threatened (a list of these cases is in Table A2.1 in Appendix 2). The important

role of the absence of *well-defined and enforced property rights* is notable. It is likely a reflection of the types of issues that attract attention and become labelled as social licence issues, as well as who is accountable to address concerns. This point is returned to in Section 3.5.

Table 3.5. Cross tabulation of outcomes against selected conditions. Numbers are number of case studies (n=47).

<i>OUTCOME 1: Loss of social licence</i>		
	<i>~Economic benefits</i>	<i>Economic benefits</i>
<i>Loss of social licence</i>	15	21
<i>~Loss of social licence</i>	0	11
	<i>~Consultation</i>	<i>Consultation</i>
<i>Loss of social licence</i>	30	6
<i>~Loss of social licence</i>	0	11
	<i>Media coverage</i>	<i>~Media coverage</i>
<i>Loss of social licence</i>	31	5
<i>~Loss of social licence</i>	0	11
	<i>~Environmental change</i>	<i>Environmental change</i>
<i>Loss of social licence</i>	5	31
<i>~Loss of social licence</i>	0	11
<i>OUTCOME 2: Change in behaviour/regulation</i>		
	<i>~Loss of social licence</i>	<i>Loss of social licence</i>
<i>Change in firm behaviour/regulation</i>	0	12
<i>~Change in firm behaviour/regulation</i>	11	24
	<i>~Private firm ownership</i>	<i>Private firm ownership</i>
<i>Change in firm behaviour/regulation</i>	0	12
<i>~Change in firm behaviour/regulation</i>	6	29

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation (or absence). For this table, fuzzy-set condition and outcome scores were grouped such that a condition or outcome with a score of 0 or 0.33 was classed as absent in a case study, and a score of 0.67 or 1 indicated a condition or outcome was present for the case study.

The analyses reported in Table 3.6 largely hold regardless of sub-sets of cases included in the analysis. *Economic benefits*, combined with *consultation*, and minimal *media coverage*, and absence of *well-defined and enforced private property rights* and/or *public protests* were sufficient to maintain a social licence regardless of *political opportunities*. When restricted to mining case studies (the majority of case studies included in the analysis) the importance of *public protests* falls away. When cases were restricted to non-mining, the lack of *public protests* returns to the solution pathway, while at the same time the consistency score drops to 0.86. Results of the sensitivity analyses are included in Table A2.10 in Appendix 2.

Additional to the robustness of the solution pathway, the influence of different conditions was also explored. The analysis was repeated with *media coverage* and *public protests* excluded

and the intermediate solution pathways hold, though the consistency score drops slightly. The *compensation* condition was embodied in the *loss of social licence* condition when the second outcome *change in behaviour/regulation* was explored in the main analysis. Whereas, in the sensitivity analysis it was examined as a stand-alone condition associated with *change in behaviour/regulation*. There was only one case where a firm significantly changed their behaviour despite sufficient *compensation* also being paid. The necessity for the lack of *compensation* (\sim *compensation*) for *change in behaviour/regulation* was evidenced by a consistency score of 0.92. This indicates that adequate *compensation* may be an alternative to changing behaviour from ‘business-as-usual’ to get stakeholder acceptance. In other words, stakeholders may be willing to accept a certain level of compensation in order to tolerate costs such as pollution associated with a firm’s activities.

Table 3.6. Solution pathways for maintaining a social licence (\sim *loss of social licence*).

Intermediate solution pathways	Cases covered
<i>Economic benefits</i> * <i>Consultation</i> * \sim <i>Media coverage</i> * \sim <i>Public protests</i>	cs7, cs10, cs15, cs16, cs27, cs29, cs36, cs41, cs43
Consistency 0.97 Raw coverage 0.52 Unique coverage 0.04	
<i>Economic benefits</i> * <i>Consultation</i> * \sim <i>Media coverage</i> * \sim <i>Well-defined & enforced property rights</i>	cs10, cs15, cs16, cs19, cs20, cs27, cs29, cs36, cs41, cs43
Consistency 0.90 Raw coverage 0.52 Unique coverage 0.04	
Intermediate solution formula	
<i>Economic benefits</i> * <i>Consultation</i> * \sim <i>Media coverage</i> *(\sim <i>Public protests</i> + \sim <i>Well-defined & enforced property rights</i>) \rightarrow \sim <i>Loss of social licence</i>	
Solution consistency 0.91 Solution coverage 0.56	
Parsimonious solution formula	
<i>Consultation</i> * \sim <i>Media coverage</i> \rightarrow \sim <i>Loss of social licence</i>	
Solution consistency 0.92 Solution coverage 0.60	

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “ \sim ” is used to indicate negation (or absence). All case studies are listed in Table A2.1 in Appendix 2.

3.5. Discussion

The findings in this article suggest a combination of five conditions were sufficient to gain/maintain a social licence. These conditions were: (1) delivery (or perception) of net *economic benefits* beyond the firm; (2) adequate stakeholder *consultation*; (3) absence of widespread *media coverage*; (4) minimal *public protests*; and/or (5) absence of *well-defined and enforced private property rights*. Further, the opposite scenario (e.g. lack of *consultation*

or presence of much *media coverage*) is not sufficient for a social licence to be considered under threat or lost. Against a backdrop of social licence research that largely focuses on one industry or firm, this research shows the same combination of conditions as sufficient to gain/maintain a social licence across different natural resource dependent industries.

The results support a number of findings in the existing literature, including that economic legitimacy is important for gaining and maintaining a social licence (Thomson and Boutilier, 2011). However, these results also show that there are occasions and contexts where stakeholders' willingness to accept *economic benefits* is insufficient to offset all (environmental or social) costs they experience (e.g. Bradshaw and Waite, 2017; de Jong and Humphreys, 2016). In the language of Coase (1960), these results indicate that stakeholders' willingness to tolerate social costs is contingent on the compensation provided but, identifying the level at which this trade-off will occur is not easy. The multiple conditions found to be sufficient for a social licence when combined with *economic benefits* suggests there are incentives for firms to go beyond economic legitimacy and invest in higher levels of social licence as per the Thomson and Boutilier (2011) hierarchical model. The results also add weight to the growing body of research that details the importance of *consultation* in underpinning a social licence (e.g. Corscadden et al., 2012; Mercer-Mapstone et al., 2017; Walsh et al., 2017). Likewise, the important role of *media coverage*, as an indicator of community interest, identified in this research supports the social licence model developed by Lynch-Wood and Williamson (2007). The important role of *media coverage* and *consultation* could also reflect information asymmetry problems that plague social licence issues, as well as the importance of governance arrangements that stipulate or allow for these conditions to be influential.

Additionally, while firms have some agency over the degree to which they share the *economic benefits* of their pursuits with affected stakeholders, either through local employment opportunities or benefit sharing agreements, not all conditions affecting a firm's social licence are within their control. For example, *well-defined and enforced property rights* (i.e. property rights with clear boundaries coupled with pathways to punish or dissuade misuse of property) were not present in most cases (10 out of 11 cases) where a social licence was maintained. This result is likely a reflection of the issues that are labelled as social licence issues. For example, Dumbrell et al. (2020) identified that social licence issues arise where there are concerns about the use of socially valuable assets for private gain, regardless of the property rights held in those assets. However, the result also indicates that institutions that allocate and enforce property rights are also critical to the mediation of any social licence concerns. Additionally, while *political opportunities*, inclusive of the status of human development and democracy and perception of corruption in a country (as defined by Kirchherr et al., 2016), were not necessary or sufficient to gain or maintain a social licence, the results of the sensitivity analysis emphasised that *political opportunities* can influence the pathway for gaining/maintaining a social licence. For example, cases in developing countries with a greater incidence of corruption report relatively more violent protests before intervention or change to a firm's activities (e.g. cases 8 and 28 in Table A2.1 in Appendix 2; see also, de Jong and Humphreys, 2016; Faruque, 2018). This result appears to support the findings from Ide (2015) and Ide et al. (2020) that violent protests emerge in cases where high power differences, low institutional/governance strength and political change exist.

Further to the results discussed above, the loss of a social licence (or threats to it) was also found to be necessary but not sufficient to push firms to voluntarily change behaviour or

governments to change regulations to align with stakeholder and societal expectations (a result also found by Lynch-Wood and Williamson, 2007). This is noteworthy as Dumbrell et al. (2020) describe the action of withholding or withdrawing a social licence as a mechanism to demand firms change behaviour or governments shift regulations or policies to enhance social welfare outcomes. In addition, Boutilier (2014) highlighted that interest in the social licence status of a firm is a product of the power of stakeholders to shift a firm's behaviour to align with their expectations. While this analysis did not identify the conditions additional to the loss of a social licence that would achieve firm behaviour or regulatory change, it will be important for affected stakeholders to identify them in order to demand improved environmental or social outcomes.

A potential explanation for only few cases reporting a regulatory change in response to social licence pressure could be related to the scope of public decision-makers (i.e. governments). Regulatory changes occur at national or state levels whereas social licence often operates at firm or local community levels. The withdrawal of a social licence may reflect the local impacts of a firm's activities but the decision to change regulations should depend on net welfare at a local, national or transboundary level. Despite this, it must be noted that information used in this assessment represents a snapshot in time. For some case studies it was possible to access a long timeline of events and information on the time lag between changes to social licence and changes to firm behaviour and regulatory change (e.g. Chailleux et al., 2018; Hoffman et al., 2015; Langbroek and Vanclay, 2012). A social licence reported as being under threat at one point in time but not leading to voluntary behaviour change or regulation change may not never lead to these outcomes. Instead, it may represent an early indication that changes may be needed in the future to maintain profitability or achieve other objectives of interest.

The extent conclusions can be drawn from this work is determined by the types of cases included, and for which the results hold. First, the analysis was conducted for cases studies written about in the (English language) literature. With this there is also a bias toward cases for which the social licence was classed as being under threat or lost, as it is distinctly easier to identify cases without a social licence than those with. Further, the majority of cases included in the analysis report significant environmental impacts (or perceptions of). This is likely a reflection of the focus on environmental issues at the origin of social licence terminology and therefore ongoing research focus on this subject (Cooney, 2017; Dumbrell et al., 2020). Repeat analyses could benefit from following cases with different social licence outcomes over time (e.g. gained and then lost) and including more cases that report on firms that have not lost their social licence.

Regardless of the above limitations, the results detailed in this article indicate that governance and institutional arrangements are critical for social licence outcomes (a result also found by others, e.g. Jartti et al., 2020; Lehtonen et al., 2020). But, even with strong governance and institutional arrangements, social licence pressure is insufficient to deliver improved social and environmental outcomes. Changing firm behaviour will also likely require other actions such as direct regulation or market-based instruments (van Putten et al., 2018). In addition, this research emphasises that the strength of property rights and institutions in a country plays a critical role in supporting any change underpinned by social licence pressure.

3.6. Conclusion

This article reports a fuzzy-set qualitative comparative analysis used to identify associations between a set of ten conditions (hypothesised as important based on relationships set out in the literature), and social licence outcomes and firm behaviour change across 47 case studies and 25 countries. The analysis identified that no one condition alone was necessary or sufficient to produce particular social licence outcomes, highlighting that social licence outcomes are complex, and often case specific. However, across natural resource dependent industries, a combination of five conditions created a robust pathway for maintaining a social licence, including: (1) delivery (or perception) of net *economic benefits* beyond the firm; (2) adequate stakeholder *consultation*; (3) minimal *media coverage*; (4) minimal *public protests*; and/or (5) absence of *well-defined and enforced private property rights*. This highlights that social licence outcomes are a product of: (1) conditions that are within the control of a firm; and (2) structural conditions and social norms beyond the operation of a firm. With this, future research exploring conditions underpinning social licence concerns and identifying potential responses will benefit from consciously framing both issues and potential responses in terms of conditions within a firm's control (e.g. consultation strategy) and conditions outside the firm's control (e.g. governance structures, institutional arrangements). Stakeholders and firms engaged in efforts to mediate social licence outcomes will also benefit from understanding that a number of conditions and actors have influence over social licence outcomes. Additionally, this research indicated that the loss of a social licence was necessary but not sufficient to make firms change their behaviour (to correct social and environmental externalities). However, this result could be an indication that a time lag exists between the loss of a social licence and voluntary firm behaviour change, and between the loss of a social licence and regulatory change. Regardless, this result indicates there could be negative consequences for stakeholders of increasingly shifting toward the use of the social licence mechanism as a form of natural resource governance if other governance structures are not also in place.

Chapter 4 Survey design and implementation

4.1. Introduction

This chapter details the design and implementation of 22 qualitative interviews and three quantitative surveys. One survey was designed to obtain responses from members of the public, the second designed to obtain responses from farmers and the third from landholders with a high-pressure transmission pipeline transecting their property, all in south-eastern Australia. The design and implementation of the interviews and first two surveys are described in conjunction with each other throughout this chapter. Given the third survey (of landholders with pipeline easements) was implemented with industry collaboration, and had a much narrower focus, the design and implementation of that survey is described separately toward the end of this chapter.

The interviews were used to gauge understanding of social licence terminology and issues that are described as social licence issues, and aid survey design. The public and farmer surveys were used to improve understanding of stakeholder groups' concerns about issues underpinning, or influencing the social licence of the Australian agricultural and energy (future fuels) industries. The third survey was designed to measure the social licence of a high-pressure natural gas transmission pipeline, as decided by affected landholders, using the Thomson and Boutilier (2011) hierarchical model of social licence.

The interviews and surveys described in this chapter were adopted as a way to gather information to test the key findings and explore research questions arising from the systematic literature review (Chapter 2) and qualitative comparative analysis of conditions associated with social licence outcomes (Chapter 3). The agriculture and energy (future fuels) industries were targeted because there is increasing academic and industry interest in the social licence status of firms and activities in these industries (see Section 2.3.2). Additionally, as stated in Section 1.5: (1) both industries are dependent on natural resources and in some instances compete for access to resources; and (2) the industries provide contrasting examples of an established industry (agriculture) with an assumed social licence that is facing threats, and a transitioning industry (energy, including a transition to future fuels such as hydrogen) that is seeking a social licence to develop.

This research follows a growing body of survey-based research seeking to elicit the views and attitudes of the public and consumers on: (1) agricultural 'social licence issues', e.g. animal welfare (Coleman, 2018; Coleman et al., 2018; Witt et al., 2021); and (2) a potential future hydrogen industry in Australia (Ashworth et al., 2019; Lambert and Ashworth, 2018; Martin et al., 2021). Likewise, this research follows studies that have explored issues of co-existence between the agriculture and the energy industries, especially the unconventional gas industry in eastern Australia (Everingham et al., 2016; Huth et al., 2018). The surveys described in this chapter build on existing research by: (1) measuring the social licence status of energy transmission infrastructure as determined by agricultural landholders that share the landscape; (2) capturing the experiences and perspectives of both farmers and the public toward agricultural social licence issues, in order to make comparisons between the views of both stakeholder groups; and (3) capturing public willingness to support a transition to

hydrogen energy production, transport and use, and what this willingness may be sensitive to. Specifically, the interviews and surveys were designed to address the following objectives (repeated from Section 1.4):

- Test the applicability of Thomson and Boutilier's (2011) hierarchical model of social licence for measuring the social licence of energy transmission infrastructure, particularly the social licence of a high-pressure natural gas transmission pipeline as decided by agricultural landholders sharing the landscape with the pipeline.
- Conduct comparative analyses of public and farmers' concern about issues that are reported as undermining or challenging the Australian agricultural industry's social licence and identify similarities and differences across different types of issues.
- Identify the trade-offs residents of south-eastern Australia may be willing to make in the transition to future fuels, namely, hydrogen energy.

The agriculture and energy (future fuels) industry survey research was limited to south-eastern Australia (South Australia and Victoria) for five key reasons: (1) SEA Gas, the firm that owns and operates the main high-pressure natural gas transmission pipeline in the area was motivated to measure their social licence; (2) both states were relatively early movers with respect to supporting energy transitions, including to renewable energy and hydrogen (Government of South Australia, 2019; Victorian State Government, 2019); (3) more specifically, South Australia's move to adopt more renewable energy, and become a net exporter of electricity (McGreevy et al., 2021), presented an opportunity to capture the public's experiences with the transition; (4) both states have less on-shore natural gas (including unconventional gas) than most other states, and this was seen as important so results were not conflated with attitudes and experiences related to unconventional gas extraction operations; and (5) the most common agricultural industries in these states are also the most common across Australia as a whole (Australian Bureau of Statistics, 2012), therefore results were considered to be broadly applicable.

This chapter continues with an outline of the survey design and data collection process. Results and analyses based on the data collected using the surveys are detailed in subsequent chapters. All of the research activities detailed in this chapter were approved by The University of Adelaide Human Research Ethics Committee in 2020, approval number H-2020-101.

4.2. Survey design

The survey design was informed by the research objectives (detailed above), a diverse set of survey-based research in the literature,⁷ consideration for the length of the survey (respondents required time input) and mode of delivery. The draft surveys were shared with experienced researchers for feedback and pre-tested with the different respondent groups

⁷ Including the surveys reported in Boutilier and Thomson (2011); Boutilier (2017); Dumbrell et al. (2016); Lambert and Ashworth (2018); Loch et al. (2014, 2016); Malek and Umberger (2021); Richert et al. (2015); Wheeler et al. (2018); and WWF (2018).

before implementation. Interviews conducted over the period July to September 2020 were also used to understand key issues, experiences and attitudes as well as pre-test the drafted design of the survey with farmers (interview questions are included in Appendix 3). Interviewees were selected using purposive sampling, where people identified to have the relevant experience and knowledge were targeted. Farmers were identified and approached to participate in interviews and to pre-test the survey via researcher and grower group networks (such as Ag Excellence Alliance in South Australia) and existing research-farmer networks (including farmers that work closely with The University of Adelaide and state government research groups on existing projects). From this process 33 potential respondents were identified and approached to complete a pre-test interview and 22 did complete a pre-test interview. The farmers interviewed represented a wide range of farm enterprise types and experiences with hosting existing high-pressure gas transmission pipelines, and wind and solar power infrastructure. A simple break-down of the experiences and enterprises represented in the farmer interviews is in Table 4.1. The interviews were completed over the phone (except one conducted via the video conferencing platform, Zoom) and ranged from 28 to 60 minutes in length.

Table 4.1. Number of interviewees with non-exclusive farm experience and characteristics.

	South Australia	Victoria
Livestock farmer (sheep, cattle)	4	4
Grain and other broadacre cropping farmer	5	3
Horticultural farmer (e.g. orchards, vineyards)	4	2
Certified organic farmer	1	1
Irrigators	3	4
Large-scale energy infrastructure on-farm or neighbouring farm	3	2
Total interviewees	13	9

A focus group with members of the public was used to understand awareness of the concept of a social licence and the two industries of interest (agriculture and the energy/future fuels industry) as well as pre-test the drafted design of the online survey. The focus group was held online on 17 July 2020.⁸ The focus group was attended by six participants, and had one moderator (the candidate). The participants in the focus group were not considered a representative sample of the population largely due to the relatively young age and high level of formal education completed by the participants. Additionally, all participants were residents of metropolitan Adelaide. The focus group discussion was conducted over a period of 65 minutes. One focus group was considered sufficient given the overlap with the farmer survey and a soft launch (with 102 respondents) was used to check the function of the online survey instrument and respondents' understanding of questions.

A number of changes were made to the draft surveys following pre-testing. First, three questions were removed from the farmer phone survey in order to keep respondents' time commitment to a minimum. Second, the presentation of the definition used for 'social licence' and information about the Australian hydrogen industry were simplified. Additional response options were added for some multiple-choice questions and combined for others. Some

⁸ The online focus group design was influenced by the advice and resources set out in a crowd-sourced document edited by Lupton (2020) and developed by researchers in response to COVID-19 induced restrictions on travel and group gatherings in 2020.

feedback from farmers regarding making wording of questions more specific (especially describing farming practices), while considered useful, was not acted on so as to enable the same question and wording to be presented to the public respondents as well as farmer respondents.

The final surveys each had four sections. The first component of the survey contained questions to elicit the respondents' environmental attitudes with particular focus on perceptions of climate change and potential impacts of climate change and relationships between environmental and economic outcomes.

Second, respondents were asked about their awareness and understanding of the concept of a social licence and their perception of the social licence status of the Australian agricultural industry and issues affecting this status, e.g. on- and off-farm animal welfare concerns, chemical use concerns, etc. The farmer survey also included questions about any actions taken to adapt to or respond to social licence concerns. Both public and farmer respondents were also asked about their preferred methods and thoughts on agencies (e.g. governments vs industry organisations) responsible for responding to social licence concerns in the industry.

The third component of the survey was designed to understand respondents' awareness of efforts to establish a hydrogen industry in Australia and then understand the factors likely to underpin a social licence for a hydrogen industry. This section of the survey was preceded by a brief description of properties of hydrogen and progress toward developing a hydrogen industry in Australia. All information presented was drawn directly from Australia's *National Hydrogen Strategy* (Commonwealth of Australia, 2019).

The final section of both surveys was designed to gather socio-demographic information about the respondent, and in the farmer survey, information about the farm. The final surveys are included in Appendix 3.

4.3. Implementation

The public and farmer surveys were implemented separately, with some key differences. These differences are summarised in the following sections.

4.3.1. Mode of survey

As is advised by Dillman et al. (2014) the mode of survey was a decision based on an assessment of the research objectives, target populations, timeline, and budget.

Public survey

An online survey was used to collect data from members of the public. The survey was administered by the online research company, Pureprofile⁹ In early internet-based survey studies the age, income and education level of internet survey respondents were found to differ from the population (Roster et al., 2004). However, with rapid expansion of internet access, sample selection bias issues associated with internet-based surveys have reduced (Dillman et al., 2014). Additionally, Lindhjem and Navrud (2011) identified a large body of

⁹ See <https://business.pureprofile.com>

literature in support of the use of online panels for social research. Some traditionally difficult to reach populations have also been found to prefer online based surveys (Haan et al., 2014) to some alternatives and as such, the use of an online survey method was deemed appropriate for the objectives and constraints (e.g. budget, timeline) faced in this study.

Farmer survey

Australian farmers receive multiple survey forms every year and often report having limited time to respond (Australian Bureau of Statistics, 2015). The mail-out format is most common, especially for the official statistics collection agencies. Given the burden of multiple requests for information and number of survey requests that farmers report to have rejected (Australian Bureau of Statistics, 2015), it was considered highly likely that requests to complete a mail-out survey for this project would also be rejected in large numbers. Using the experience of other survey research specifically targeting farmers (e.g. Wheeler et al., 2018), it was determined that a higher response rate and consequently a lower non-respondent bias could be achieved by using a telephone survey. Following this, a third-party, Q&A Market Research Services Pty Ltd¹⁰ was contracted to conduct the farmer survey as a telephone survey.

Advantages of telephone surveys include: (1) the opportunity to ask open ended questions and obtain answers where, had the survey been mailed-out or online, the respondent may not have written them down; (2) the option for respondents to make an appointment to complete the telephone survey at a time that best suits them; and (3) the possibility to complete the phone survey at the same time as other tasks, reducing the time burden on respondents. A disadvantage of the telephone survey format is the costs to administer and consequences for sample size if budget is limited.

4.3.2. Sampling plan

The target populations for the two main surveys were residents of, and farmers based in South Australia and Victoria, Australia. The focus on these states was a consequence of the research objectives, and interest from SEA Gas (the firm that owns and operates the main high-pressure natural gas transmission pipeline in the area) to measure their social licence. Further reasons for focussing on south-eastern Australia are detailed in Sections 1.5 and 4.1.

Public survey

In order to receive responses from a representative sample of the population of South Australia and Victoria, the candidate specified quotas for the sample to be collected by the online research provider, Pureprofile. Quotas were applied to ensure half the sample was drawn from each state (South Australia and Victoria), and the distribution of ages and genders was representative of each state. In addition, in order to capture views from metropolitan and regional communities, a metropolitan/regional split of 70/30 was specified.

Farmer survey

Given the dual focus on the agricultural and energy industries, the farm types included/excluded in the sample was based on likelihood that they would be affected (positively or negatively) by energy infrastructure, including that associated with a possible transition to hydrogen (e.g. new pipelines, solar and wind farms). Farmers with broadacre

¹⁰ See <https://qandaresearch.com.au>

annual cropping or grazing operations, and or specialised livestock (pasture) operations, rather than permanent plantings or intensive livestock operations were considered to be the most likely to be affected. Broadacre cropping and livestock farms are also the most common farm types in the two states of interest (Table 4.2), and Australia as a whole (Australian Bureau of Statistics, 2012). Following this, dairy, chicken, piggery and horticultural farms were not considered within the scope of the study.

To determine the minimum statistically significant sample size (n) required, based on the total eligible farmer population size (N ; Table 4.2) and using 0.05 as the acceptable level of precision or sampling error (e), the simplified formula developed by Yamane (1973) was applied:

$$n = \frac{N}{1 + N(e)^2} \quad (\text{Eq. 4.1})$$

A sample size of 350 was deemed sufficient and, within budget for this research. Once again, using the experience of previous telephone surveys of farmers (e.g. Wheeler et al., 2018) it was determined that a commercial list company could provide farmer telephone contact information and this could be shared with Q&A Market Research Services Pty Ltd to conduct the telephone surveys. The Impact Lists 'Australian Farmers' list was selected for this purpose. This list contained approximately 65,000 farmer names and their contact information classified by state, and enterprise type. However, the enterprise classifications were not based on the primary enterprise type of the farm. So, quotas were applied to ensure the sample included a mix of cropping and livestock farmers, and farmers from both states.

Table 4.2. Number of farms by enterprise type in South Australia and Victoria in 2017–18.

Industry classification	South Australia		Victoria	
	Number of farms	Percent of farms	Number of farms	Percent of farms
Grain-Sheep or Grain-Beef Cattle Farming	1,910	21	1,956	10
Other Grain Growing	1,813	20	1,986	10
Sheep Farming (Specialised)	1,273	14	2,945	15
Beef Cattle Farming (Specialised)	675	7	4,975	25
Sheep-Beef Cattle Farming	578	6	1,286	7
Other	2,762	31	6,591	33
Total	9,011	100	19,739	100

Notes: Estimated value of agricultural operations is >\$40K for all businesses included in the table. Data from ABARES (2020a,b).

4.3.3. Sample size and sample representativeness

Public survey

The online survey of residents of South Australia and Victoria received 2,032 complete responses between 9 October and 12 November 2020. Of these, 1,013 respondents were South Australian residents (including 758 metropolitan Adelaide residents and 255 regional South Australian residents) and 1,019 respondents were Victorian residents (including 709 metropolitan Melbourne residents and 310 regional Victorian residents; Table 4.3). A sample size of $n=1,000$ from each state exceeded the minimum statistically significant sample size required, based on the populations of South Australia and Victoria at the most recent Census

(Australian Bureau of Statistics, 2018a) and an acceptable level of sampling error of 0.05, as per Equation 4.1. Despite differences in population between the two states, equal respondents were sought from each state to enable separate and comparative analyses.

In addition to the completed responses, 184 incomplete responses were received and 1,237 responses were removed from the sample because the responses were considered to be 'careless'. Specifically, careless responses were those that met the following criteria: (1) the survey was completed faster than the quickest time deemed possible during pre-testing (in less than four-and-a-half minutes); and (2) if non-random patterns were detected in responses, e.g. consistently selecting the same response such as 'strongly agree' on a Likert scale, when that was not considered logical. Screening respondents on such grounds has been suggested as appropriate to reduce the influence of careless responses on survey results (Maniaci and Rogge, 2014; Meade and Craig, 2012). The survey was administered via a web-based panel hosted by Pureprofile and closed when the quota was filled.

Key socio-demographic characteristics of the sample are included in Table 4.3. The sample is considered representative of the population surveyed (Australian Bureau of Statistics, 2018a, 2020). More specifically, no difference was detected between the population and sample in the distributions for age (chi-square statistic=0.5122, $p=0.972$), gender (chi-square statistic=0.1055, $p=0.745$) and employment status (chi-square statistic=0.3405, $p=0.987$). Chi squared tests also revealed no difference ($p>0.05$) between the South Australian sample and Victorian sample, therefore where appropriate the statistics presented are for the combined sample.

Table 4.3. Socio-demographic characteristics of South Australian and Victorian residents that responded to the online survey (n=2032), compared to population.

Socio-demographic variables	Sample number	Sample percent	South Australia population^a percent	Victoria population^a percent	Australia population^a percent
State					
South Australia	1,013 ^b	49.85	–	–	6.90
Victoria	1,019 ^c	50.15	–	–	26.00
Gender					
Male	892	43.90	49.30	49.10	49.30
Female	1,135	55.86	50.70	50.90	50.70
Age					
18-34 years	566	27.85	26.53	29.26	29.43
35-44 years	367	18.06	17.56	18.86	17.58
45-54 years	276	13.58	18.33	17.68	17.32
55-64 years	352	17.32	16.25	14.82	16.54
65 years, plus	471	23.18	22.88	19.50	20.44
Highest level of formal education completed					
Year 10 or below	156	7.68	8.92	8.82	8.23
Year 12 or below	395	19.44	33.29	38.84	35.11
Diploma or certificate (incl. TAFE)	670	32.97	28.46	30.09	29.93
Bachelor degree	469	23.08	19.89	15.65	18.42
Graduate diploma or graduate certificate	133	6.55	2.97	2.18	2.41
Post-graduate degree	209	10.29	4.42	6.48	5.89
Employment status at time of survey					
Employed, working full time	771	37.94	33.77	35.20	36.45
Employed, working part-time	391	19.24	18.82	19.39	19.20
Employed, but away from work	47	2.31	3.57	3.03	3.16
Unemployed	117	5.76	7.00	7.40	7.00
Not in the labour force	706	34.74	36.90	35.00	34.20
Annual household income in Australian dollars (before tax)^d					
\$0 – \$24,500	159	7.82			10.00
\$24,501 – \$38,900	233	11.47			10.00
\$38,901 – \$52,900	258	12.70			10.00
\$52,901 – \$69,500	217	10.68			10.00
\$69,501 – \$88,500	196	9.65			10.00
\$88,501 – \$109,300	237	11.66			10.00
\$109,301 – \$134,800	183	9.01			10.00
\$134,801 – \$168,700	174	8.56			10.00
\$168,701 – \$222,300	110	5.41			10.00
\$222,301 or above	57	2.81			10.00
Prefer not to say	208	10.24			–

Notes: ^a Population information from Australian Bureau of Statistics (2018a); ^b This includes 758 metropolitan Adelaide residents and 255 regional South Australian residents; ^c This includes 709 metropolitan Melbourne residents and 310 regional Victorian residents; ^d Income deciles for South Australia and Victoria are different. For this reason, the income deciles for Australia, only, are presented in this table. The median household income in South Australia and Victoria at the 2016 Census was \$62,712 and \$73,788, respectively (Australian Bureau of Statistics, 2018a).

Farmer survey

A total of 351 farmer surveys were completed between 6 November and 4 December 2020. Given the farmer population information described in Table 4.2, this sample is greater than the minimum statistically significant sample required (Equation 4.1), allowing a standard error of 0.05, based on 95 percent confidence level. With 351 completed surveys (C; Table 4.4), and following Gripp et al. (1994) the survey cooperation rate (RR_1) was 56.89 percent, where the calculation includes those farmers that agreed to participate at a later date but were no longer required to do so once the survey quota was met (Equation 4.2). If these farmers were excluded from the calculation, the completion rate (RR_2 ; Equation 4.3) was 40.67 (Table 4.4). This response rate is considered good and on par with other farmer phone survey research in Australia (Wheeler et al., 2012; Wheeler et al., 2021), and higher than the 20 to 35 percent response rate recorded for most mail-out surveys (Fielke and Bardsley, 2014; Greiner and Gregg, 2011) and some telephone surveys (Campbell et al., 2014; Tingey-Holyoak, 2014).

Table 4.4. Outcomes of invitations to participants to complete the farmer phone survey.

Phone call outcome	Number	Percent
Refused to complete survey (R)	340	39.35
Suspended participation partway through survey (INC)	31	3.59
Quota full (Q)	1	0.12
Screened out (I)	1	0.12
Appointment to call back at another time (CNC)	140	16.20
Completed the survey (C)	351	40.63
Total	864	100.00

$$RR_1 = \frac{C + CNC}{C + R + INC + CNC + Q} \quad (\text{Eq. 4.2})$$

$$RR_2 = \frac{C}{C + R + INC + CNC + Q} \quad (\text{Eq. 4.3})$$

Within the sample of 351 farmers, 151 were based in South Australia and 200 in Victoria (Table 4.5). The larger sample from Victoria reflects the larger farmer population in the state, compared to South Australia (Table 4.2). There are more specialist beef producers (n=103) in the sample than any other farm type (Table 4.5), mirroring patterns in the population. The second most common enterprise represented by the respondents was broad-acre cropping with sheep (n=68; Table 4.5).

Across enterprise type and states, the farmers that completed the survey were considered representative in terms of gender and age of the South Australian and Victorian farming population (Australian Bureau of Statistics, 2018a). The median age of the farmers that completed the survey was 59 years, and in 2016, the median age of South Australian and Victorian farmers was 49 years (Australian Bureau of Statistics, 2018a). However, given the large proportion of sheep and beef farmers captured in this survey, a more comparable median age is that corresponding to this farmer type, of between 55 and 60 years (Barr, 2014; Wu et al., 2019). The age and gender distribution of respondents was similar across states and all farm enterprise types sampled. In 2016, 61 percent of South Australian and 53 percent of

Victorian farmers had a post-school qualification (Australian Bureau of Statistics, 2018a). In this sample, collected in 2020, 56 percent with post-school qualifications for the whole sample (Table 4.6) and 78 percent of farmers aged 18 to 44 reported a post-school qualification.

Table 4.5. Farm enterprise types, by state captured in sample (n=351).

Farm enterprise	South Australia	Victoria	Total sample
Broad-acre cropping with sheep	41	27	68
Broad-acre cropping with beef	12	14	26
Broad-acre cropping with sheep and beef	25	12	37
Broad-acre cropping only	17	20	37
Specialist sheep production	11	15	26
Specialist beef production	22	81	103
Both sheep and beef production	23	31	54
Total	151	200	351

Table 4.6. Socio-demographic characteristics of farmer respondents (n=351).

	Number	Percent
Gender		
Male	214	60.97
Female	137	39.03
Age		
18-34 years	13	3.70
35-44 years	32	9.12
45-54 years	66	18.80
55-64 years	113	32.19
65, plus years	127	36.18
Highest level of formal education completed		
Year 10 or below	62	17.66
Year 12 or below	92	26.21
Advanced diploma, diploma or certificate (including TAFE)	102	29.06
Bachelor degree	61	17.38
Graduate diploma or graduate certificate	10	2.85
Post-graduate degree	24	6.84

Physical characteristics of farms (e.g. area, access to or utilisation of irrigation) varied across the sample (Table 4.7). This variability is an expected consequence of the geographic distribution and farm enterprise types targeted. It was not an objective of the survey to obtain detailed financial information from respondents, rather, information on net farm income and net debt for the 2018-19 financial year was collected as a way to understand the financial constraints that farmers may be facing, as well as another way to determine the representativeness of the sample. The distribution of net debt reported by respondents (Table 4.7) is well aligned to that reported in the farm survey data collected and published by ABARES (2020c). For example, 49 percent of broadacre sheep and beef farmers in Australia reported being less than \$100,000 in debt in 2018-19 (ABARES, 2020c), similar to 50.14 percent in this sample (Table 4.7).

Table 4.7. Farm characteristics (n=351).

	Mean	Standard deviation	Median	Min	Max
Area (ha) ^a	6,994	49,934	630	3.94	600,000
Area—SA farms only (ha)	14,947	75,516	1181	3.94	600,000
Area—Victorian farms only (ha)	989	1,637	410	5.00	15,000
Irrigated area (percent of farm area)	5	16	0	0	100
Household income generated off-farm (percent)	26	30	10	0	100
	Number	Percent			
Farm net income 2018-19 in Australian dollars					
Less than \$0	20	5.70			
\$0 to \$50,000	72	20.51			
\$50,001 to \$100,000	56	15.95			
\$100,001 to \$200,000	57	16.24			
\$200,001 to \$300,000	23	6.55			
\$300,001 to \$400,000	26	7.41			
\$500,001 to \$1,000,000	24	6.84			
More than \$1,000,000	31	8.83			
Prefer not to say	42	11.97			
Farm net debt 2018-19 in Australian dollars					
Nil debt	123	35.04			
Less than \$50,000	30	8.55			
\$50,001 to \$100,000	23	6.55			
\$100,001 to \$200,000	19	5.41			
\$200,001 to \$5,000,000	39	11.11			
\$500,001 to \$1,000,000	36	10.26			
\$1,000,001 to \$1,500,000	20	5.70			
\$1,500,001 to \$2,000,000	13	3.70			
More than \$2,000,000	30	8.55			
Prefer not to say	18	5.13			

Note: ^a Four farms were more than 2 standard deviations greater than the mean. These farms were all in the South Australian arid zone and >100,000 hectares.

4.4. Survey timeframe

Data collection for the public and farmer surveys was conducted over a six-week period. Responses from members of the public were collected between 19 October and 12 November 2020. Farmer responses were collected between 6 November and 4 December 2020.

At this time, the COVID-19 pandemic and restrictions on local travel, and social gatherings for public health purposes had largely (temporarily) eased in the study areas. The benefits of implementing the survey at this time, rather than earlier in the pandemic and when more stringent public health policies were in place, may be reflected in the responses to questions about respondents' employment status. Only 48 respondents (2.36 percent) indicated that they were on leave from their job (for any reason) and 117 respondents (5.76 percent) identified as unemployed at the time of the survey (Table 4.3)—a similar number to before the COVID-19 pandemic (Australian Bureau of Statistics, 2018a).

The timing of the farmer survey coincided with the annual grain harvest and hay season across much of southern Australia. It was not the intention of the researchers to implement the survey

at this time. However, a number of factors combined to result in this timing: (1) the third party contracted to complete the phone surveys influenced the timing of survey implementation to fit around their other commitments; and (2) it was necessary to implement the survey as close to the public survey as possible to enable direct comparisons of responses. Once the public survey was launched, it was considered necessary to implement the farmer survey to limit any chance that external stimuli could affect the responses of the two groups unevenly. Despite overlapping with the peak of the season and on-farm labour demands, the timing of the survey is not thought to have negatively affected the outcomes of this research. For example, the cooperation rate was relatively high (56.89 percent; Table 4.4) and farmers were able to answer questions at times that suited them best.

4.5. Pipeline survey

The third survey used in this thesis was designed to collect data from a specific subset of landholders in South Australia and Victoria: the landholders that own/operate the land transected by the SEA Gas high-pressure natural gas transmission pipeline. These landholders were targeted because it is acknowledged that they are in a position to grant/withdraw a social licence from SEA Gas with consequences for ongoing operations. These landholders were also targeted because SEA Gas recognised the need to understand the status of their social licence as decided by this stakeholder group in order to develop strategies for improved landholder-firm relations into the future. The candidate adapted survey questions (Likert scale statements) for this study from those developed and tested by Boutilier and Thomson (2011) and Boutilier (2017) for mining and infrastructure cases, and subsequently used by other researchers in other industry contexts (e.g. Richert et al., 2015). The questions were designed to identify the four hierarchical levels of social licence: (1) economic legitimacy; (2) socio-political legitimacy; (3) interactional trust; and (4) institutional trust (Thomson and Boutilier, 2011). The Likert scale statements as administered are included in Table 5.1 in Chapter 5.

The survey data collection was completed between October 2020 and June 2021 as part of SEA Gas' annual landholder consultation processes. The survey was presented (in person or by telephone) to landholders by independent contractors hired to conduct the annual consultation interviews. The SEA Gas pipeline transects properties owned/occupied by 592 landholders. A total of 126 useable responses were obtained from the survey at a response rate of 21 percent. The data from these 126 responses was de-identified before being shared with the candidate for analysis. The pipeline survey data is analysed to measure the social licence of the pipeline in Chapter 5.

4.6. Summary

This chapter details the motivation for, design and implementation of three surveys. The three surveys were designed to collect information about the types of issues of concern to different stakeholder groups in relation to the Australian agricultural and energy (including future fuels) industries, e.g. pollution, land-use conflict. One survey was designed to understand the views and experiences of the South Australian and Victorian public, while a second was used to gain insights on the same issues from the farming community in these states. The third survey was

used to examine the social licence status of a high-pressure natural gas transmission pipeline as decided by landholders with a pipeline easement.

Collecting information and insights from different stakeholder groups makes this dataset unique. In a field of research where much focus has been on the concerns and attitudes of consumers and the public, the addition of a farmer survey to enable comparisons between stakeholder groups, is an important contribution to the survey-based literature on social licence issues in the focus industries.

The surveys were implemented between October 2020 and June 2021 and the samples were considered representative of the populations (public and farmers in South Australia and Victoria) sampled. The following chapters detail analyses used, interpret the responses received in each of the surveys described here, and ultimately address the research objectives stated in Section 4.1.

Chapter 5 Measuring a social licence: Landholders' assessment of a high-pressure natural gas transmission pipeline in south-eastern Australia

This chapter presents descriptive research conducted in collaboration with an industry partner with the aim to measure their social licence and provide a baseline assessment that could be tracked in the future relative to changes in management and external conditions. Another aim of this research was to test the applicability of the Thomson and Boutilier (2011) hierarchical model of social licence for measuring and tracking the social licence of a piece of energy transmission infrastructure. In addition, this chapter reports research that links the industries of focus in the subsequent chapters that report on social licence issues and concerns in agriculture only (Chapter 6), and energy only (namely future fuels; Chapter 7). By capturing agricultural landholders' willingness to grant a social licence to the energy transmission infrastructure that transects their properties, this chapter highlights that the two industries can impact each other's social licence.

5.1. Introduction

Firms or industries that have an (intangible) social licence enjoy ongoing acceptance or approval by stakeholders who are affected by the firm or industry, and who can affect the profitability of the firm or industry (Cooney, 2017; Gunningham et al., 2004; Raufflet et al., 2013; Thomson and Boutilier, 2011). Firms and industries have incentives to obtain a social licence because conflicts or disruptions to operations that originate from stakeholders not accepting a firm or industry's activities can put significant profits at risk, and increase costs (Franks et al., 2014). As well as financial costs, other consequences of ongoing social licence debates, or losing a social licence, can include project failures, delays and reputational costs. Alternatively, if a firm or industry is at least perceived to produce economic benefits that outweigh costs, e.g. environmental degradation, that may be sufficient for affected communities to grant a social licence (Boutilier and Thomson, 2011; Thomson and Boutilier, 2011). Building on this, Thomson and Boutilier (2011) suggest higher levels of social licence are associated with socio-political legitimacy, interactional trust and institutional trust. Applications of the hierarchical Thomson and Boutilier (2011) model have confirmed the relationships between legitimacy, credibility and trust and, different levels of social licence (Jijelava and Vanclay, 2017; Richert et al., 2015). While a lack of economic legitimacy, credibility and trust, has also been shown to drive stakeholders' decisions to withhold or withdraw a social licence (Jijelava and Vanclay, 2018; Lesser et al., 2021; Luke, 2017).

The majority of research exploring factors affecting a social licence, e.g. perceived impacts, benefits, legitimacy and trust, tend to focus on the experiences and attitudes of the public (Jartti et al., 2020; Mason et al., 2014; Richert et al., 2015; Zhang and Moffat, 2015), rather than specific stakeholder groups. While this is important, results can disguise the attitudes or perspectives of underrepresented or, be dominated by powerful stakeholder groups. One industry for which different stakeholders' perspectives and experiences have been studied in detail is the unconventional gas industry in eastern Australia. For example, research has

explored different social licence concerns and outcomes for the industry across jurisdictions (Cronshaw and Grafton, 2016), between local and non-local stakeholder groups (Lacey and Lamont, 2014), and different industry stakeholder groups, e.g. the agricultural industry (Chen and Randall, 2013; Curran, 2015; Everingham et al., 2016; Huth et al., 2018; Mehreen and Underschultz, 2017). These inter-industry perspectives show the agricultural and unconventional gas industries can impact each other, as well as environmental assets, infrastructure, and local economic and social systems—creating both opportunities and divisions (Clarke, 2021; Everingham et al., 2016). For example, Fleming and Measham (2015) showed the number of agricultural jobs decreased in areas with unconventional gas developments, while Everingham et al. (2016) noted risks of widening social divisions, e.g. between the ‘haves’ and ‘have nots’, i.e. those stakeholders benefitting from developments versus those not. These dynamics have been linked to the willingness (or otherwise) of the agricultural industry to co-exist with the unconventional gas industry, and grant the unconventional gas industry a social licence.

To date, few industries have been the focus of academic research or commentary on inter-industry social licence relationships and outcomes. Further, the research on this topic is dominated by mining, oil and gas extraction operations, as demonstrated by the unconventional gas example above, with less research investigating the social licence of energy transmission infrastructure. At the same time, while gaining and maintaining a social licence is seen as important for firms/industries, it is not clear how successful they are at meeting this objective, or how firms measure their social licence (Brueckner et al., 2014). While the research community struggles with ambiguity and other practical challenges toward implementing the concept (Boutilier, 2020a; Brueckner and Eabrasu, 2018), firms can use the social licence concept to defend their actions or promote their own agenda (Curran, 2017). Consequently, industry leadership and methods to measure social licence outcomes are needed.

This research aims to explore the co-existence of agriculture and energy transmission infrastructure and measure the social licence status of energy transmission infrastructure, as determined by agricultural landholders. Specifically, this research addresses the following question: to what extent are landholders in south-eastern Australian willing to grant a social licence to the high-pressure natural gas transmission pipeline that transects their properties? To answer this question, this study uses the Thomson and Boutilier (2011) hierarchical model of social licence. This study makes a valuable contribution to understanding inter-industry social licence outcomes, as well as the validity of the Thomson and Boutilier (2011) hierarchical model for measuring the social licence of energy transmission infrastructure. Further, it is possible that this research can contribute to an increased ability and momentum for private firms actively seeking to measure (and improve) their social licence.

5.2. Methods

5.2.1. Case study pipeline

The case study pipeline is the main high-pressure natural gas transmission pipeline running from Victoria to South Australia, in south-eastern Australia (Figure 5.1).

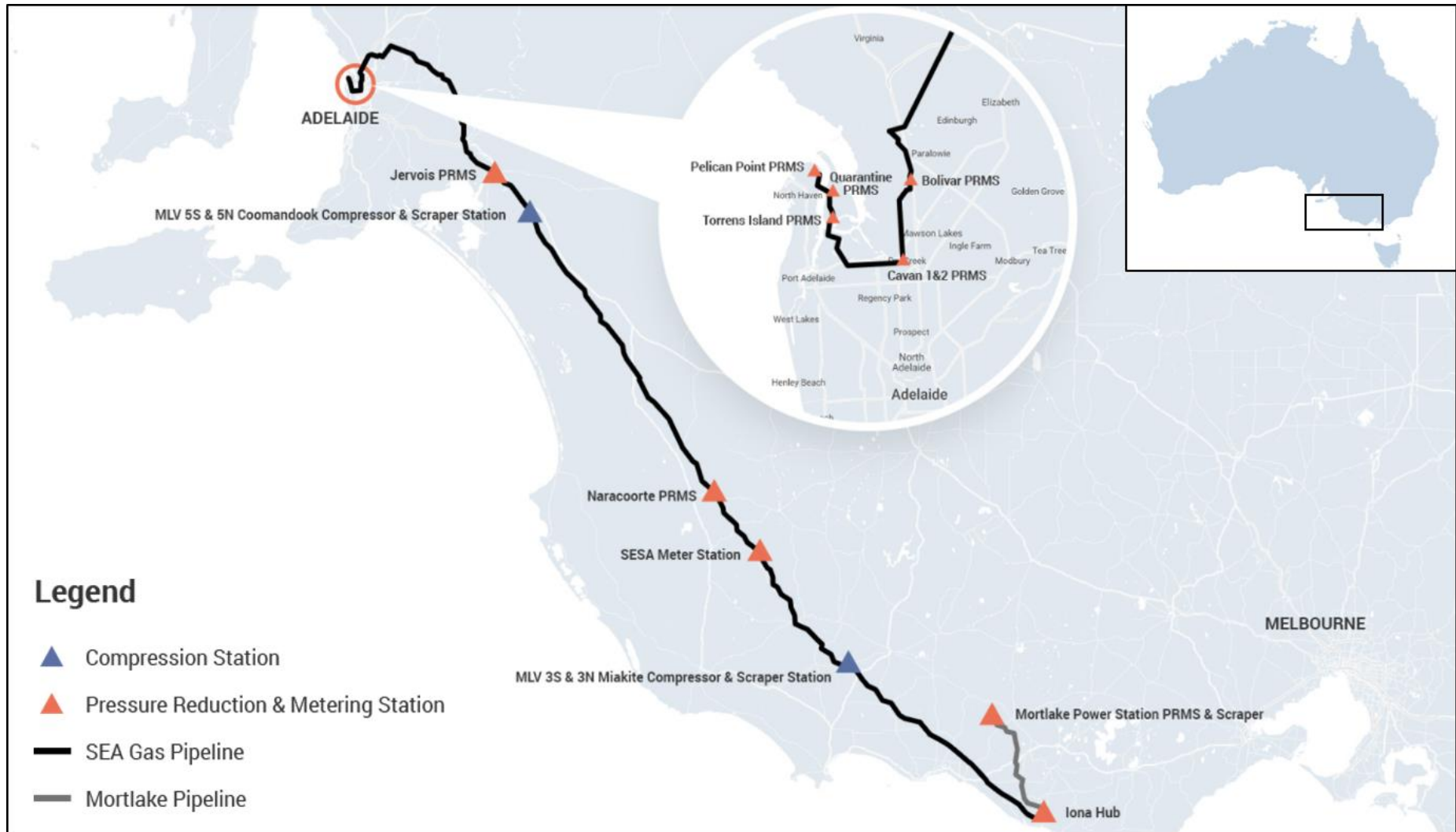


Figure 5.1. Map showing location of the case study pipeline. Adapted from map available from SEA Gas.

The pipeline is operated by SEA Gas. This pipeline is used as the case study because SEA Gas were interested in establishing a baseline from which to compare changes in their social licence following potential changes in management and external conditions. The pipeline largely runs underground and depth varies. The easement varies between 10 and 25 metres wide. The pipeline transects the properties of 592 landholders. Landholders with a pipeline easement receive compensation and must seek prior approval from SEA Gas before undertaking certain restricted activities or works that may affect the operation of the pipeline, or create potential safety risks.

5.2.2. Data

Data for this study was obtained through a survey of landholders with a high-pressure natural gas transmission pipeline easement. Landholder responses to the survey were collected from October 2020 to June 2021 as part of SEA Gas' annual landholder consultation program (further details in Section 4.5). The surveys were completed using an interview approach, either in-person or remotely with independent contractors. A total of 126 complete responses were obtained from the survey at a response rate of 21 percent.

The survey used a Likert Scale for respondents to indicate agreement with each statement in the right column of Table 5.1 where: 1=Strongly disagree; 2=Disagree; 3=Neither agree nor disagree; 4=Agree; 5=Strongly agree; or Unsure. The statements used were modified from the existing literature (Boutilier and Thomson, 2011; Boutilier, 2017; Richert et al., 2015) and were designed to measure the latent variables corresponding to the four (hierarchical) levels of social licence (left column of Table 5.1) as proposed by Thomson and Boutilier (2011).

5.2.3. Data analysis

A confirmatory factor analysis was used to test whether the data fit the hypothesised four-level model of social licence. Specifically, whether the observed responses to the statements (in the right column of Table 5.1) correspondingly measured the four latent variables in the left column of Table 5.1. The model goodness of fit statistics for the confirmatory factor analysis indicated that the data did not support the four-level model of social licence. For example, the model chi-square statistic was 158.6 and statistically significant at $p < 0.001$, the comparative fit index was 0.876 (where scores 0.95 to 1 indicate good model fit) and the root mean square error of approximation was 0.098 (indicating 'mediocre' fit). This result could reflect the relatively small sample size ($n=126$). Alternatively, this result could indicate that the four-level hierarchical model of social licence (and/or corresponding statements used to measure each level) does not hold for this study, at least not without modifications for context.

Following this, an exploratory factor analysis was used to identify the number of underlying constructs in the data, based on the observed responses to the statements in the right column of Table 5.1. The method to do this was adapted from Richert et al. (2015), and was appropriate for the data as suggested by Bartlett's test for sphericity (statistically significant at $p < 0.001$), and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy being 0.843 (far greater than the minimum 0.5 required).

Table 5.1. Statements designed to measure four hypothesised levels of social licence.

Social licence levels	Description	Corresponding statements
Economic legitimacy (Econ Leg)	The perception that the firm/industry provides benefits to the perceiver (usually affected stakeholders). If benefits are modest or absent, most stakeholders tend to withhold/withdraw a social licence. If benefits are sufficient, stakeholders tend to grant an acceptance level of social licence.	<ul style="list-style-type: none"> • Our community needs the cooperation of SEA Gas to protect the environment • Our community needs the cooperation SEA Gas to maintain or improve its economic performance • Our community needs the cooperation SEA Gas to maintain or improve community well-being • Our community needs the cooperation of SEA Gas to guarantee the well-being of the future generation
Socio-political legitimacy (SP Leg)	The perception that the firm/industry acts according to stakeholders' views of fairness, respects the local way of life, and meets expectations about its role in society. If both socio-political legitimacy and interactional trust (below) are lacking, stakeholders tend not to grant an approval level of social licence.	<ul style="list-style-type: none"> • SEA Gas treats everyone fairly • SEA Gas respects our local way of doing things • Our community and SEA Gas have a similar vision for the future of Australia
Interactional trust (Inter Trust)	The perception that the firm/industry listens, responds, keeps promises, engages in mutual dialogue, and exhibits reciprocity in its interactions with affected stakeholders. If stakeholders do not perceive they are treated this way, and socio-political legitimacy (above) is lacking, they are less likely to grant an approval level of social licence.	<ul style="list-style-type: none"> • SEA Gas do what they say they will do in the media • I am very satisfied by SEA Gas • SEA Gas listen to local community concerns
Institutional trust (Inst Trust)	The perception that relations between affected stakeholders' and/or their representative organisations and the firm/industry are based on an enduring regard for each other's interests. If stakeholders do not perceive this to be the case, psychological identification is unlikely.	<ul style="list-style-type: none"> • SEA Gas give more support to those it negatively affects • SEA Gas shares decision-making with relevant governments • SEA Gas takes into account the interests of our local community • SEA Gas is concerned about our local community • SEA Gas openly share information that is relevant to our local community

Note: Descriptions adapted from Williams and Walton (2013).

Factors were retained if the eigenvalue was greater than 1 (Kaiser, 1960). Further, statements were deemed to significantly load onto a factor if the factor loading was greater than 0.4 and at least 0.2 greater than the loading on any other factor (Stevens, 2009). Factors were also only kept if the Cronbach alpha (Cronbach, 1951) score exceeded the 0.7 threshold that indicates the statements loading on each factor measured a single construct (Nunnally and Bernstein, 1994). Noting a high number of ‘Unsure’ responses for some statements, the factor analysis was repeated. The first analysis included all ‘Unsure’ responses recoded to ‘Neither agree nor disagree’; and the second analysis excluded all ‘Unsure’ responses. The results were not different so the results presented include the recoded responses. Wilcoxon signed-rank tests were used to compare mean Likert scale scores. All analyses were conducted in StataSE 16.

5.3. Results

The mean score across all 15 statements designed to measure a social licence was 3.40 out of 5 (Table 5.2). Based on classifications defined by Boutilier (2017), the pipeline can be classed as holding a high acceptance/tolerance level of social licence. The highest mean score across the groups of statements designed to measure each of the four levels of social licence was for interactional trust, with a mean score of 3.55 out of 5 (Table 5.2).

Table 5.2. Mean response score for 15 statements measuring levels of social licence (n=126).

Social licence levels and corresponding statements		Mean	Min	Max
Inter Trust	I am very satisfied by SEA Gas	3.88 (0.73)	2	5
SP Leg	SEA Gas respects our local way of doing things	3.76 (0.81)	1	5
SP Leg	SEA Gas treats everyone fairly	3.65 (0.75)	2	5
Econ Leg	Our community needs the cooperation of SEA Gas to protect the environment	3.58 (0.80)	1	5
Inter Trust	SEA Gas listen to local community concerns	3.50 (0.68)	2	5
Inst Trust	SEA Gas takes into account the interests of our local community	3.44 (0.70)	2	5
Econ Leg	Our community needs the cooperation of SEA Gas to guarantee the well-being of the future generation	3.44 (0.91)	1	5
Inst Trust	SEA Gas is concerned about our local community	3.41 (0.72)	2	5
Inst Trust	SEA Gas openly share information that is relevant to our local community	3.27 (0.59)	1	5
Inst Trust	SEA Gas give more support to those it negatively affects	3.26 (0.81)	1	5
Inter Trust	SEA Gas do what they say they will do in the media	3.25 (0.55)	2	5
SP Leg	Our community and SEA Gas have a similar vision for the future of Australia	3.17 (0.50)	1	5
Inst Trust	SEA Gas shares decision-making with relevant governments	3.13 (0.37)	3	5
Econ Leg	Our community needs the cooperation SEA Gas to maintain or improve its economic performance	3.13 (0.79)	1	5
Econ Leg	Our community needs the cooperation SEA Gas to maintain or improve community well-being	3.06 (0.86)	1	5

Notes: Standard deviation in brackets. Means obtained using a Likert scale where: 1=Strongly disagree; 2=Disagree; 3=Neither agree nor disagree (or Unsure); 4=Agree; 5=Strongly agree. Levels of social licence are defined in Table 5.1.

An exploratory factor analysis revealed that 12 of the 15 statements designed to measure social licence loaded onto two factors (Table 5.3). Three of the 15 statements did not load onto either of the two factors. These statements were: 'SEA Gas openly share information that is relevant to our local community'; 'SEA Gas do what they say they will do in the media'; and 'SEA Gas shares decision-making with relevant governments'. A possible explanation for this outcome is the that these statements received a relatively high proportion of 'Unsure' responses. Factor 1 contained a mix of statements hypothesised to map onto three different levels of social licence: (1) socio-political legitimacy; (2) interactional trust; and (3) institutional trust. Factor 2 contained the four statements designed to evaluate the economic legitimacy of the pipeline (Table 5.3).

Table 5.3. Estimated weights for two significant factors obtained from an exploratory factor analysis.

Statement	Factor 1	Factor 2
SEA Gas treats everyone fairly	0.8282	
SEA Gas respects our local way of doing things	0.7662	
SEA Gas listen to local community concerns	0.7293	
I am very satisfied by SEA Gas	0.7220	
SEA Gas is concerned about our local community	0.6757	
SEA Gas takes into account the interests of our local community	0.6755	
SEA Gas give more support to those it negatively affects	0.5466	
Our community and SEA Gas have a similar vision for the future of Australia	0.4109	
Our community needs the cooperation SEA Gas to maintain or improve its economic performance		0.7352
Our community needs the cooperation SEA Gas to maintain or improve community well-being		0.7263
Our community needs the cooperation of SEA Gas to guarantee the well-being of the future generation		0.7068
Our community needs the cooperation of SEA Gas to protect the environment		0.5141

Note: Kaiser-Meyer-Olkin statistic=0.843, and Bartlett's sphericity test was statistically significant, p-value <0.001.

Table 5.4 presents scores for the two measures of social licence identified in this study. Cronbach's alpha scores of >0.8 confirm that these measures both represent a single construct. The statements that mapped onto Factor 1 were averaged to create a measure of 'local interactional legitimacy'—named to reflect the mix of statements that loaded onto this factor (Table 5.4). The statements that loaded onto Factor 2 were averaged to create a measure of 'economic legitimacy' (Table 5.4). The higher the scores for these social licence measures, the higher the level of social licence. A Wilcoxon signed-rank test revealed a statistically significant difference between the scores for the two factor measures, i.e. the respondents generally held a higher value for local interactional legitimacy compared to economic legitimacy for the pipeline ($p < 0.001$).

Table 5.4. Mean Likert score for statements that loaded onto each factor (n=126).

Factor	Mean	Standard deviation	Cronbach's alpha
Factor 1 – Local interactional legitimacy	3.51	0.533	0.8826
Factor 2 – Economic legitimacy	3.30	0.669	0.8062

Note: Means are statistically significantly different based on Wilcoxon signed-rank test Prob > |z| <0.001.

5.4. Discussion and conclusions

This research used the Thomson and Boutilier (2011) hierarchical model of social licence, to show landholders in south-eastern Australia assign a high-acceptance/tolerance level of social licence to the high-pressure natural gas transmission pipeline that transects their properties. The claim that the results indicate a high-acceptance/tolerance level of social licence is based on the Thomson and Boutilier (2011) and Boutilier (2017) classifications of the hierarchical model of social licence. This hierarchical model frames 'economic legitimacy' as the lowest level of social licence (Table 5.1), suggesting economic legitimacy is easier to obtain than socio-political legitimacy or trust and therefore would be obtained before higher levels of social licence can be obtained. However, the findings in this study show that respondents allocated higher scores to statements that mapped onto a 'local interactional legitimacy' factor, rather than an 'economic legitimacy' factor (Table 5.4). This result differs from that reported by Richert et al. (2015) where a clear lower level economic legitimacy score was found for the oil and gas industry in Western Australia. However, the identification of two levels of social licence, rather than four as hypothesised by Thomson and Boutilier (2011), was a point of agreement between this study and that reported by Richert et al. (2015).

The relatively higher scores for 'local interactional legitimacy' than 'economic legitimacy' might reflect the context of this research and types of respondents included in the study. The method used to measure social licence was developed and tested mostly with and for mining cases (Boutilier and Thomson, 2011; Thomson and Boutilier, 2011) where stakeholders surveyed were typically local residents in communities where, or adjacent to where, a mine was proposed. In such contexts many of the costs of mine development, e.g. environmental costs, were located in the same place as potential benefits, e.g. employment opportunities at the mine. However, in this research, the surveyed stakeholders experience the cost (e.g. inconvenience) of a high-pressure natural gas pipeline running through their land without any real change in access to benefits such as new employment opportunities or spill-over effects of increased economic activity in the region. Given the surveyed stakeholders were not the typical beneficiaries of the pipeline, e.g. those they may have access to employment or gas as a result of the pipeline, the higher scores for measures of local interactional legitimacy appear to be logical. The local and non-local distribution of costs and benefits of energy developments have been pointed out by others. For example, Measham et al. (2021) identified that the localised benefits of large-scale solar farms could be quite modest, with benefits such as climate change mitigation or lower energy costs experienced by the public and energy consumers located elsewhere. Likewise, Lacey and Lamont (2014) drew attention to the differing attitudes of local communities compared to communities geographically removed from the operations of the Australian coal seam gas industry.

The higher scores for 'local interactional legitimacy' relative to 'economic legitimacy' also reflects the importance of 'local interactional legitimacy' as a critical determinant of SEA Gas' social licence. Dumbrell et al. (2021) showed that conditions both within and beyond the control of a firm are associated with a social licence, and this SEA Gas case study is arguably an example of a firm doing well at the things they can control, e.g. interactions and maintenance planning with landholders. For example, the firm cannot change the nature of their business to reduce the geographical separation between communities that experience the costs (e.g. inconvenience) versus the benefits of the pipeline. Though, they appear to pay adequate compensation to landholders, else this would have been identified in the survey. These results add weight to the findings from other inter-industry social licence research that shows consultation, transparent communication, and planning of infrastructure siting and maintenance works to reduce the impact on agricultural operations, plus compensation, to be critical influences on farmers' attitudes toward co-existence with energy infrastructure (Everingham et al., 2016; Hall, 2014; Hindmarsh, 2014).

This research contributes to a limited body of academic research on inter-industry social licence relationships and influences. This study presents an evaluation of the social licence status of a high-pressure natural gas transmission pipeline as determined by landholders sharing the landscape with the pipeline. By measuring the factors that currently contribute to the pipeline's social licence, this study can act as a base to understand how the landholder and gas pipeline co-existence relationship might change with changes in pipeline management or, broader changes in the energy industry. This research also suggests there could be benefits associated with adapting the questions used to measure a social licence, originally developed for mining contexts, to be more suitable for other industries and contexts, such as energy transmission infrastructure for which local economic benefits may be modest. Future research that considers specific changes or infrastructure requirements (e.g. transmission pipelines) for the transition to a decarbonised energy industry could complement this exploratory study with specific insights from affected stakeholders or communities. This study could also be a starting point for SEA Gas to track their social licence through time, and in response to specific management changes, and drive broader industry adoption of methods to measure social licence before claiming its existence.

Chapter 6 Statement of Authorship

Title of Paper	Comparing public and farmer views on agriculture's social licence		
Publication Status	<input type="checkbox"/> Published <input checked="" type="checkbox"/> Submitted for Publication	<input type="checkbox"/> Accepted for Publication <input type="checkbox"/> Unpublished and Unsubmitted work written in manuscript style	
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Principal Author

Name of Principal Author (Candidate)	Nikki P. Dumbrell		
Contribution to the Paper	Conceptualisation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing		
Overall percentage (%)	75		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	3 February 2022

Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

- The candidate's stated contribution to the publication is accurate (as detailed above);
- Permission is granted for the candidate to include the publication in the thesis; and
- The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Sarah Ann Wheeler		
Contribution to the Paper	Conceptualisation, Methodology, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	Alec Zuo		
Contribution to the Paper	Methodology, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	David Adamson		
Contribution to the Paper	Supervision, Writing – review & editing		
Signature		Date	1 February 2022

Chapter 6 Comparing public and farmer views on agriculture's social licence

This chapter presents a paper submitted to Journal of Agricultural Economics. The paper is included in its submitted form, with only minor changes to formatting to bring it in line with the overall thesis. Consequently, there is some repetition with other chapters of this thesis.

Abstract

To develop best-practice management and policy that addresses social licence concerns in the agricultural industry, it is necessary for decisions to account for the concerns of different stakeholders. Using a survey of the public (n=2,032) and broadacre farmers (n=351) in south-eastern Australia this research is the first to compare public and farmers' attitudes regarding a broad set of issues that affect the social licence status of the agricultural industry. A principal component analysis of 15 statements describing issues underpinning agriculture's social licence revealed three dimensions of issues: (1) negative externalities; (2) undersupply or threats to public goods; and (3) the use of socially valuable assets for private profits. Compared to farmers, the public were more concerned about the undersupply of public goods, (e.g. farm animal welfare), and negative externalities (e.g. from the use of synthetic fertilisers and chemicals). The public and farmers recorded a similar level of concern regarding the use of socially valuable assets for private profit, e.g. irrigation water extraction. Seemingly unrelated regression analyses revealed associations between concern recorded for the three dimensions of social licence issues in agriculture and: socio-demographic characteristics (e.g. age, gender and education); environmental attitudes; sources of information; farm characteristics; and climate change concerns.

Keywords

Negative externalities; Public goods; Socially valuable assets; Principal component analysis; Seemingly unrelated regression; Stakeholder attitudes

6.1. Introduction

Agricultural management decisions are both influenced by, and exert influence on the biophysical, economic, and social environments surrounding them (Barrett et al., 2010). However, there is growing public concern about the acceptability of a number of specific management actions/behaviours such as those leading to adverse environmental impacts or poor animal welfare outcomes. The public can make their concerns known through consumption choices, by demanding regulatory changes, or otherwise questioning the industry's social licence status. Firms or industries that have an (intangible) social licence enjoy ongoing acceptance or approval by stakeholders affected by the firm/industry or their activities, and stakeholders who can affect the profitability of the firm/industry (Cooney, 2017; Gunningham et al., 2004; Thomson and Boutilier, 2011). However, it is easier to identify those firms or industries without a social licence than those with. This is because those without a social licence tend to attract media attention and face ramifications such as costly public disputes, loss of market share or access, or loss of legislative approval (Franks et al., 2014; Hampton et al., 2020; Luke, 2017).

Recognising the costs of not having a social licence, and that affected stakeholders are positioned to grant or withhold a social licence based on their attitudes and perceptions, research has sought to understand public perceptions and concerns about the agricultural industry (e.g. Coleman et al., 2018; Witt et al., 2021) or the use of specific technologies (e.g. Goddard et al., 2018). Further, research has also identified the role that environmental or animal welfare concerns play in consumers' food purchasing decisions (Coleman et al., 2018; Malek et al., 2019). These public perceptions and consumption decisions have farmers concerned about potential impacts on their market access, profitability, competitiveness and the potential introduction of stricter regulations (Henningesen et al., 2018). However, few studies document farmers' perceptions of social licence issues, or their self-assessment of performance relative to social expectations (Bassi et al., 2019; Buddle et al., 2021; van Huik and Bock, 2007). Likewise, comparisons of public and farmers' attitudes toward specific issues are rare, and those conducted have focussed on farm animal welfare (Latacz-Lohmann and Schreiner, 2019; Vanhonacker et al., 2008; Verbeke, 2009) and to a lesser extent, environmental conservation (Howley et al., 2014; Tienhaara et al., 2020). Since improvements towards the agricultural industry's social licence will be driven by perceived performance relative to expectations, it is important to understand any discordance between public and farmers' concerns about issues that underpin the agricultural industry's social licence. This research partially addresses this knowledge gap by posing the following research questions: (1) What are the south-eastern Australian public's concerns regarding social licence issues in agriculture? (2) What are farmers' concerns regarding the same issues? (3) To what extent do the two stakeholder groups' concerns about social licence issues align? (4) What socio-demographic and attitudinal characteristics are associated with concerns about social licence issues?

The four research questions were explored in the Australian context for three key reasons. First, approximately half of Australia's land area is managed for agricultural production (Australian Bureau of Statistics, 2018c), and while the largely urban population in Australia is sympathetic regarding the challenges facing farmers, they are increasingly concerned about farming impacts on the environment and animal welfare issues (Witt et al., 2009). Second, based on recent research output, natural resource dependent industries in Australia are highly

concerned about social licence outcomes (Dumbrell et al., 2020). Third, Australian agricultural industry bodies have stated that information and methods to explore social licence issues and improve community-industry relations are a high priority (Lockie, 2015). Despite the Australian focus, the findings are expected to be relevant for other middle- to high income countries with economically and culturally significant agricultural industries.

6.2. Background

This research compares public and farmers' concerns across a range of issues in the agricultural industry. The basis for this study is research exploring public and farmers' attitudes on animal welfare (e.g. Latacz-Lohmann and Schreiner, 2019; Te Velde et al., 2002; Vanhonacker et al., 2008) and environmental conservation (Howley et al., 2014; Tienhaara et al., 2020). Comparisons between public and farmers' attitudes have been made with the underlying assumption that individuals construct perceptions according to their frames of reference, influenced by: values, convictions, knowledge, and interests, including economic self-interest (Te Velde et al., 2002; Vanhonacker et al., 2008). The same approach is adopted for this study.

Previous comparison studies have identified greater heterogeneity in public attitudes relative to farmers' attitudes (Howley et al., 2014; Te Velde et al., 2002). Influences such as income, age, place of residence (urban vs rural) have contributed to this heterogeneity in public attitudes (Howley et al., 2014; Wolf et al., 2016). Alongside these findings, a study examining social acceptance of dairy farming in The Netherlands found that members of the public with greater experience and knowledge of farming were the most content and accepting of the industry (Boogaard et al., 2011). van Huik and Bock (2007) also found heterogeneity in attitudes among farmers. In particular, differences were identified between those with a strong price and production-efficiency focus, and those with a broader definition of quality and care for environmental and social outcomes. Following this, similar heterogeneity within the surveyed stakeholder groups was expected in this study. It was also hypothesised that a set of variable categories would influence concerns about agricultural issues within and across the two stakeholder groups, including: sociodemographic characteristics; farm characteristics; environmental concerns or attitudes; engagement, knowledge and sources of information about the agricultural industry.

It was also hypothesised that due to differences in the above listed variable categories, the two stakeholder groups would register differences in their levels of concern about agricultural industry issues (a result found in previous research on specific agricultural issues, e.g. Te Velde et al., 2002; Vanhonacker et al., 2008; Wolf et al., 2016). Evidence of this discordance exists for attitudes toward animal welfare, where public survey respondents have tended to register greater concern and farmers have been more positive or defensive (Te Velde et al., 2002; Vanhonacker et al., 2008). Such results align with research showing a higher willingness to pay for improved farm animal welfare outcomes (Lagerkvist and Hess, 2010). Recent research has also identified a mismatch in willingness to pay (by the public) and accept (by farmers) for improved animal welfare, and provision of ecosystem services, and this diverges at higher levels (Latacz-Lohmann and Schreiner, 2019; Tienhaara et al., 2020). Conversely Howley et al. (2014) found that their samples of the Irish public and farmers had similar levels

of concern about the environment, but diverged on specific environmental issues such as the importance of maintaining wildlife habitat on farms.

Recognising differences in attitudes across issues such as animal welfare compared to environmental conservation in previous research, a literature review was used to ensure the key issues underpinning the Australian agricultural industry's social licence were captured in this study. The issues identified could be classed into three distinct groups. As per Dumbrell et al. (2020) the issues identified as underpinning agriculture's social licence reflected concerns about: (1) an undersupply or threats to public goods; (2) negative externalities; and (3) the use of socially valuable assets for private gain. Issues identified within these groups are summarised below.

The first set of issues relate to the undersupply of public goods, namely animal welfare, food safety and climate change mitigation. The Australian public's attitudes to farm animal welfare have changed through time (Hampton et al., 2020); with increased attention following highly visible breaches of expected standards in live export supply chains (Bruce and Faunce, 2017). For this reason, animal welfare is often considered in two dimensions: on-farm and off-farm. To date the majority of on-farm animal welfare research has focussed on public attitudes, self-rated knowledge and expectations (e.g. Coleman et al., 2018; Futureye, 2018). On the other hand, for off-farm animal welfare and food safety issues, there has been more research focus on public responses to information about specific events and regulatory failures or opportunities for reform (Bruce and Faunce, 2017; Buchtman, 2014). Additionally, the Australian agricultural industry is responsible for approximately 14 percent of Australia's greenhouse gas emissions (Australian Government Department of Industry, 2020a) and the majority of Australians regard it as important to reduce greenhouse gas emissions (Colvin and Jotzo, 2021). Australian consumers concerned that meat production harms the environment by increasing greenhouse gases, for example, also tend to consume less meat compared to others (Malek et al., 2018).

A second set of issues relate to the use of chemicals, synthetic fertilisers and genetically modified crops, where the key concerns are biosafety externalities affecting human health and the environment (Beckie et al., 2020; Roth, 2011). This concern was evident when Australian public support for genetically modified organisms in food and crops was only 38 percent in 2017 (Cormick and Mercer, 2017). Such concerns have also led to decisions to prohibit or limit the use of such inputs or technologies in some jurisdictions (Beckie et al., 2020; Cormick and Mercer, 2017). However, farmers are already facing constraints on market access (e.g. Eady, 2017), and anticipate future decisions to prohibit or restrict access to inputs will increase costs of production (e.g. Walsh and Kingwell, 2021). Adding further complexity with respect to attitudes and concerns within the farming community are issues of coexistence between farmers operating different farming systems, for example organic (Kershner, 2014; Wheeler, 2011).

The final area of concern is the use of socially valuable assets, particularly natural resources, to create private profits (Martin and Shephard, 2011). The term socially valuable asset is used to describe an asset that may provide non-use values or other socially beneficial services/goods but has formal property rights, governing its ownership or use (and therefore does not meet the criteria to be defined a public good). In the Australian context concern about the use of socially valuable assets is highlighted in debates about: (1) limits on land clearing

on private properties (Martin and Shepherd, 2011); (2) foreign ownership of agricultural land (Keogh, 2014; Laurenceson et al., 2015); (3) co-existence of rural and urban land uses (Martin and Shepherd, 2011); and the re-negotiation of water sharing between irrigation and environmental purposes (Shepherd and Martin, 2008). For example, institutional arrangements governing land clearing and water use in Australia have been under significant change which has led to changing and differing expectations (Grafton and Wheeler, 2018; Simmons et al., 2018). Adding to this, there are records of diverse views and preferences among the public and farmers about strategies to achieve goals related to the recovery of water for the environment (Loch et al., 2014) and the optimal level of land clearing (Martin and Shepherd, 2011).

6.3. Methods

6.3.1. Survey design and implementation

Two surveys serve as the data source for the analysis presented herein. First, a survey administered by an online panel provider, was distributed to a sample of the public in south-eastern Australia. A representative sample (age and gender), and a split of metropolitan/regional residents of South Australia and Victoria was provided by the online panel provider. Second, a phone survey (modified slightly from the online questionnaire) was used to collect data from farmer respondents in the same jurisdictions. Broadacre cropping and livestock farms are the most common farm types in the two states of interest, and Australia as a whole (Australian Bureau of Statistics, 2018c). As a result, farmers operating broadacre annual cropping or grazing operations, and or specialised livestock (pasture) operations, were invited to complete the survey. Responses to both surveys were received between October and December 2020. The survey design was informed by a diverse set of survey-based research in the literature as well as pre-test interviews. Interviews conducted with farmers and agricultural industry professionals over the period July to September 2020 were used to understand key issues, experiences and attitudes as well as to pre-test the survey.

Guided by relationships found in the literature as described in Section 6.2, respondents to both surveys were asked to provide socio-demographic and attitudinal information, and farmers provided information about their farm and farm business (summary statistics in Table 6.1 and Table 6.2). Additionally, both surveys included questions for respondents to record their level of concern (on a Likert scale) about 15 issues in the Australian agricultural industry, including those outlined earlier, e.g. on- and off-farm animal welfare and chemical use, that are commonly described as affecting the industry's social licence status. Other issues such as adequate pay and conditions for employees were also identified but ultimately excluded from this study as these issues were not unique to the agricultural industry. Identical wording was used for both surveys to enable comparisons, and responses to these questions by both groups form the basis of the analyses presented in the following sections. Table 6.3 lists the 15 agricultural issue statements as presented in the survey.

6.3.2. Survey sample overview

The online public survey received 2,032 responses. However, only 1,824 responses provided complete sociodemographic information and as such, only these 1,824 responses were used

in the regression analyses. The sample was representative (age and gender) of the adult population of South Australia and Victoria (Australian Bureau of Statistics, 2018a, 2020). More specifically, no difference was detected in distributions in age (chi-square statistic=0.51, $p=0.972$), gender (chi-square statistic=0.11, $p=0.745$), or employment status (chi-square statistic=0.34, $p=0.987$), between the sample and population. Likewise, chi-squared statistics revealed no difference between public respondents from South Australia and Victoria and as such the respondents from the two states have been grouped in all results presented (and delineated in the regression analyses by a dummy variable).

351 farmers completed the phone survey. This represents a response rate of 57 percent, including farmers that agreed to participate at a later date but were not required once the survey quota for each state was met, or 41 percent when those non-interviewed farmers were excluded from the calculation. The respondents were considered representative in terms of age and gender of the farming population in South Australia and Victoria (Australian Bureau of Statistics, 2018a). The median age of the farmers that completed the survey was 59 years, and in 2016, the median age of South Australian and Victorian farmers was 49 years (Australian Bureau of Statistics, 2018a). However, given the large proportion of sheep and beef farmers captured in this survey, a more comparable median age is that corresponding to this farmer type, of between 55 and 60 years (Barr, 2014; Wu et al., 2019). The age and gender distribution of respondents was similar across states and all farm enterprise types sampled. In 2016, 61 percent of South Australian and 53 percent of Victorian farmers had a post-school qualification (Australian Bureau of Statistics, 2018a). In this sample, 56 percent of respondents had a post-school qualification.

6.3.3. Principal component and regression analysis

A Kruskal-Wallis test for one-way analysis of variance by ranks was used to determine whether there were any statistically significant differences between the public and various groups of farmers with respect to concerns recorded across the 15 agricultural issue statements (Hecke, 2012). Where statistically significant differences ($p \leq 0.05$) were identified, Tamhane's T2 tests were used to determine which respondent groups differed from each other (Tamhane, 1979).

Following this, a principal component analysis (PCA) was completed using responses from both the public ($n=2,032$) and farmer respondents ($n=351$) to each of the 15 agricultural issue statements. The PCA was used to determine whether responses to the different agricultural issue statements would load highly on specific components (Mooi et al., 2018). A PCA analysis was considered appropriate because the Kaiser-Meyer-Olkin statistic was 0.912, a value considered 'marvellous' (Kaiser, 1974) and Bartlett's sphericity test was statistically significant, p -value < 0.001 (Bartlett, 1950).

Components were retained if the eigenvalue was greater than 1 (Kaiser, 1960) and component loadings were considered significant if greater than 0.3. Component scores were determined using the least squares regression method as described by DiStefano et al. (2009). Component scores computed with this method have a mean of 0 and standard deviation of 1. Given these attributes, the component scores were used as dependent variables in seemingly unrelated regression (SUR) analyses. This was done with the aim of identifying characteristics of respondents associated with different levels of concern regarding components of agricultural industry issues identified in the PCA. A SUR model is a system of linear equations,

where for a given individual i , the errors are correlated across equations j . This is represented in Equation 6.1 in vector form where y is the dependent variable (component score for each component equation, j), x is the vector of all independent variables (the same variables were used for each of the component equations j), β the vector of regression coefficients and, u the error terms.

$$y_j = x_j \beta_j + u_j \quad (\text{Eq. 6.1.})$$

Separate SUR models were estimated for the public and farmer samples. This was done because some different explanatory variables were expected to be associated with the component scores for each respondent group (Table 6.1 and Table 6.2), and because different independent variables were available for both groups. The explanatory variables common in both the public and farmer analyses were: state (South Australia or Victoria); gender; age; education; attitudes, especially regarding environmental issues; and whether respondents lived in an area where agriculture was the main industry of employment. The explanatory variables in the public analysis only included: whether respondents lived in a metropolitan (urban) or regional area; household income; employment experience; main sources of information about agriculture; diet; membership of environmental or social activist groups; and confidence in government decisions (Table 6.1). The explanatory variables included in the farmer analysis only included: farm and farmer characteristics such as off-farm income, farm enterprise and management strategies used (Table 6.2). Findings from the literature described in Section 6.2 guided the variable choice (Coleman et al., 2018; Goddard et al., 2018; Howley et al., 2014; Latacz-Lohmann and Schreiner, 2019; Malek et al., 2018; Tienhaara et al., 2020; Wolf et al., 2016). The maximum correlation coefficient for the explanatory variables included in the public analysis was -0.398, and the mean variance inflation factor was 1.22. The maximum correlation coefficient for the explanatory variables included in the farmer analysis was 0.328, and the mean variance inflation factor was 1.17. These statistics indicate no serious issues with multicollinearity, and robust standard errors were used in model estimates to in-part control for heteroskedasticity. All analyses were conducted in StataSE 16.

Other variables and alternative variable forms, e.g. squared forms of continuous explanatory variables, were also tested before the final estimates were computed. Further, additional analyses were undertaken to complement the SUR estimates. The first additional analysis was ordinary least squares model estimates using a total social licence concern score as the dependent variable. The total social licence concern score was calculated by summing and rescaling respondents' agreement with the 15 agricultural issue statements that stated [issue] is a concern, on a Likert scale from: 1=Strongly disagree to 5=Strongly agree. The second additional analysis explored concerns related to each of the 15 agricultural issues (measured on a Likert scale: 1=Strongly disagree to 5=Strongly agree) using ordered probit models. Results from these analyses are included in Appendix 4.

Table 6.1. Public sample summary statistics, explanatory variables (n=1,824).

Explanatory variables	Definition	Mean	Min	Max
State (Victoria)	1=Victoria; 0=South Australia	0.51 (0.50)	0	1
Agriculture main industry ^a	1=Agriculture main industry of employment in postcode; 0=Otherwise	0.08 (0.26)	0	1
Urban	1=Metropolitan Adelaide/Melbourne; 0=Regional area	0.72 (0.45)	0	1
Male	1=Yes; 0=Otherwise	0.45 (0.50)	0	1
Age ^b	Years	46.39 (15.39)	26	65
University educated	1=University education; 0=Otherwise	0.40 (0.49)	0	1
Household income ^b	Thousands of AUD per year	86.76 (53.68)	24.5	222.3
Unemployed	1=Yes; 0=Otherwise	0.05 (0.23)	0	1
Omnivore	1=Nominated omnivorous diet; 0=Vegan/vegetarian/flexitarian	0.60 (0.49)	0	1
Activist member	1=Current financial member of an environmental or social activist group; 0=Otherwise	0.05 (0.22)	0	1
Agriculture experience	1=Employed, formerly employed, or have family employed in agriculture; 0=Otherwise	0.14 (0.35)	0	1
Information–farmers	1=Farmers a main source of information about agriculture; 0=Otherwise	0.40 (0.49)	0	1
Information–industry	1=Industry organisations a main source of information about agriculture; 0=Otherwise	0.35 (0.48)	0	1
Information–friends/family	1=Family/friends a main source of information about agriculture; 0=Otherwise	0.38 (0.48)	0	1
Information–government	1=Government a main source of information about agriculture; 0=Otherwise	0.41 (0.49)	0	1
Information–research organisations	1=Research organisations a main source of information about agriculture; 0=Otherwise	0.35 (0.48)	0	1
Confidence in government	1=Agree or strongly agree Australian governments make policy and regulatory decisions based on scientific and economic evidence; 0=Otherwise	0.38 (0.49)	0	1
Climate change (CC) is happening	1=Agree or strongly agree that climate change is happening; 0=Otherwise	0.83 (0.37)	0	1
CC is largely human induced	1=Agree or strongly agree climate change is largely human-induced; 0=Otherwise	0.74 (0.44)	0	1
CC will have negative impact	1=Agree or strongly agree that climate change will have a negative impact on household; 0=Otherwise	0.54 (0.50)	0	1
Pro-environmental trade-offs (average index) ^c	A healthy, well protected environment and a prosperous economy go hand in hand The environment needs to be protected even if it impacts economic prosperity In order to have economic prosperity, the environment is going to suffer a bit (reverse coded)	3.65 (0.63)	1.33	5

Notes: Standard deviation in brackets. AUD is Australian dollars. ^a As per the main industry of employment in 2016 Census for nominated postcode (Australian Bureau of Statistics, 2018a); ^b Age and Household income are semi-continuous variables; ^c Construction variables measured on Likert scale: 1=Strongly disagree to 5=Strongly agree.

Table 6.2. Farmer sample summary statistics, explanatory variables (n=351).

Explanatory variables	Definition	Mean	Min	Max
State (Victoria)	1=Victoria; 0=South Australia	0.57 (0.50)	0	1
Agriculture main industry ^a	1=Agriculture main industry of employment in postcode; 0=Otherwise	0.58 (0.49)	0	1
Male	1=Yes; 0=Otherwise	0.61 (0.49)	0	1
Age ^b	Years	56.55 (9.97)	26	65
University educated	1=University education; 0=Otherwise	0.27 (0.44)	0	1
Farm area	Thousands of hectares	7.05 (5.02)	0.004	600
Crop-only farm	1=Yes; 0=Otherwise	0.11 (0.31)	0	1
Livestock-only farm	1=Yes; 0=Otherwise	0.52 (0.50)	0	1
Organic	1=Certified organic operator; 0=Otherwise	0.08 (0.28)	0	1
Irrigator	1=Yes; 0=Otherwise	0.18 (0.38)	0	1
Off-farm income	Percent of household income generated off-farm	25.53 (29.96)	0	100
Farm productivity trend	(last 5 years: 1=strongly decreasing; 5=strongly increasing)	3.54 (0.92)	1	5
Farm group member	1=Active member of farm group or agricultural organisation; 0=Otherwise	0.59 (0.49)	0	1
Succession plan	1=Yes; 0=Otherwise	0.57 (0.50)	0	1
Climate change (CC) is happening	1=Agree or strongly agree that climate change is happening; 0=Otherwise	0.70 (0.46)	0	1
CC is largely human induced	1=Agree or strongly agree climate change is largely human-induced; 0=Otherwise	0.52 (0.50)	0	1
CC will have negative impact	1=Agree or strongly agree that climate change will have a negative impact on household; 0=Otherwise	0.49 (0.40)	0	1
Pro-environmental trade-offs (average index) ^c	A healthy, well protected environment and a prosperous economy go hand in hand The environment needs to be protected even if it impacts economic prosperity In order to have economic prosperity, the environment is going to suffer a bit (reverse coded)	3.71 (0.65)	1.67	5

Notes: Standard deviation in brackets. ^a As per the main industry of employment in 2016 Census for postcode nominated by respondent (Australian Bureau of Statistics, 2018a); ^b Age is a semi-continuous variable; ^c Construction variables measured on Likert scale: 1=Strongly disagree to 5=Strongly agree.

6.4. Results

6.4.1. Stakeholder concerns about issues in the agricultural industry

Overall, both public and farmer respondents indicated a high level of concern about the extent of foreign investment in the Australian agricultural industry, relative to other issues presented (Table 6.3). Farmers also recorded a high level of concern about urban sprawl. There was no

statistically significant difference ($p \geq 0.05$) in the level of concern indicated by the public and farmers with respect to: foreign investment, irrigation water extraction, culling pest animals, and extent that lobby groups can advocate for the industry and inform government decisions (Table 6.3). Public respondents indicated statistically significantly ($p \leq 0.05$) higher levels of concern about the lack of implementation of Indigenous knowledge and rights in agricultural best-practice management and the volume of greenhouse gas (GHG) emissions produced by the industry. There were also statistically significant differences ($p \leq 0.05$) in responses across types of farmers included in the sample. For example, cropping-only farmers registered statistically significantly less concern about the use of genetically modified (GM) crops than other farmer groups (and the public). Additionally, livestock-only farmers were statistically significantly more concerned than other farmer groups about off-farm animal welfare (Table 6.3). Comparisons of relative concern across issues, rather than respondent groups, are presented in Table A4.1 in Appendix 4.

6.4.2. Grouping stakeholders' concerns about agricultural issues

A PCA using responses from both the public and farmers revealed three components (Table 6.4). Three of the 15 agricultural issue statements did not load on to any component, these issue statements were related to: the lack of integration of Indigenous knowledge and rights into best-practice agricultural management; the extent that lobby groups can advocate for the industry and inform government decisions; and the impact of agricultural activities on soil health. There could be multiple reasons for this outcome, including as a result of the relatively higher number of 'I don't know' responses recorded for these agricultural issue statements. Five issue statements loaded onto Component 1, three issues statements loaded onto Component 2, and four issue statements loaded onto Component 3 (Table 6.4).

The agricultural issue statements that load onto each component can be classified as per the three motivations for social licence concerns described earlier. That is, the issue statements that load onto Component 1 describe issues related to the undersupply or threat to public goods (such as on- and off-farm animal welfare, food safety, and GHG mitigation). The issue statements that load onto Component 2 describe concerns about negative externalities associated with agricultural inputs. In particular, issues captured in this component include chemical, synthetic fertiliser and genetically modified input use that can have flow on effects for stakeholders other than the producer or consumer, e.g. a neighbour that may experience spray drift. The issue statements that load onto Component 3 describe the use of socially valuable assets. In particular, the use and ownership of land and water (i.e. the allocation of property rights), and extent that ownership and management of these assets, is regulated.

The mean component score for the public was statistically significantly ($p \leq 0.05$) higher than for farmers for Components 1 and 2, and not statistically different for Component 3 (Table 6.5). This result suggests the public respondents recorded higher levels of concern about an undersupply or threats to public goods, and negative externalities. Whereas, the public and farmers were equally concerned about the use of socially valuable assets for private profit.

Table 6.3. Comparison of the mean score for 15 agricultural industry issues, reflecting the relative concern held by various respondent groups.

	Public (n=2032)	Crop-livestock farmers (n=131)	Cropping-only farmers (n=37)	Livestock-only farmers (n=183)	Chi square statistic	p- value
Foreign investment: <i>The extent that farmers and other businesses in the agricultural industry can sell assets (including land) to and/or attract investment from overseas is a concern to me</i>	4.14 (0.94)	4.21 (1.16)	3.86 (1.23)	4.05 (1.26)	5.09	0.166
Off-farm animal welfare: <i>The treatment of animals during transport, sale, or processing, i.e. treatment of animals off-farm is a concern to me</i>	3.93 ^a (1.03)	3.16 ^b (1.42)	3.16 ^b (1.36)	3.50 ^c (1.37)	52.84	<0.001
Chemical use: <i>The type, timing of application and/or extent of use of chemical weed and pest controls is a concern to me</i>	3.90 ^a (0.92)	3.14 ^b (1.29)	3.05 ^b (1.54)	3.45 ^b (1.27)	60.64	<0.001
Urban sprawl: <i>Urban sprawl on agricultural land is a concern to me</i>	3.89 ^a (0.92)	4.07 ^{ab} (1.25)	3.86 ^{ab} (1.13)	4.14 ^b (1.14)	31.54	<0.001
Irrigation water extraction: <i>The volume of water from common resources (e.g. rivers, groundwater) allocated to and used for irrigation is a concern to me</i>	3.80 (1.01)	3.66 (1.25)	3.76 (1.21)	3.64 (1.28)	1.04	0.791
Clearing native vegetation: <i>Extent and circumstances under which farmers are able to clear land of native vegetation is a concern to me</i>	3.74 ^a (0.98)	3.38 ^b (1.27)	3.22 ^b (1.46)	3.64 ^{ab} (1.21)	11.46	0.010
Synthetic fertiliser use: <i>The type, timing of application and/or extent of use of synthetic fertilisers is a concern to me</i>	3.72 ^a (0.96)	2.96 ^{bc} (1.30)	2.54 ^c (1.43)	3.07 ^b (1.40)	94.95	<0.001
Soil health: <i>The extent that agricultural activities impact soil health is a concern to me</i>	3.66 (0.97)	3.40 (1.33)	3.32 (1.42)	3.65 (1.22)	4.23	0.237
Use of GM crops: <i>Use of genetically modified (GM) crops is a concern to me</i>	3.63 ^a (1.17)	2.90 ^{bc} (1.45)	2.16 ^c (1.48)	3.12 ^b (1.49)	75.08	<0.001
On-farm animal welfare: <i>The treatment of animals on farms is a concern to me</i>	3.63 ^a (1.14)	3.17 ^{bc} (1.43)	2.84 ^b (1.52)	3.42 ^{ac} (1.48)	20.15	<0.001
Indigenous knowledge and rights: <i>The lack of implementation of Indigenous knowledge and rights into best-practice land and water allocation and management is a concern to me</i>	3.62 ^a (1.10)	2.83 ^b (1.14)	2.78 ^b (1.13)	2.93 ^b (1.31)	106.45	<0.001
Volume of GHG emissions: <i>The volume of greenhouse gas (GHG) emissions produced by the agricultural industry is a concern to me</i>	3.56 ^a (1.10)	2.56 ^b (1.26)	2.84 ^b (1.38)	2.71 ^b (1.24)	139.82	<0.001
Culling pest animals: <i>The extent and circumstances under which farmers are able to cull pest animals, including native species is a concern to me</i>	3.44 (1.08)	3.18 (1.37)	3.00 (1.45)	3.26 (1.44)	7.20	0.066
Lobby groups: <i>The extent that agricultural lobby groups have the ability to advocate for the industry and inform government decisions is a concern to me</i>	3.36 ^a (0.96)	3.58 ^a (1.27)	3.30 ^a (1.31)	3.43 ^a (1.36)	10.46	0.015
Food safety: <i>Farmers' ability to meet food safety standards is a concern to me</i>	3.34 ^a (1.06)	3.05 ^{ab} (1.35)	2.68 ^b (1.36)	3.10 ^{ab} (1.48)	15.94	0.001

Notes: Agreement with statements measured on a 5-point Likert scale where: 1=Strongly disagree, 2=Disagree, 3=Neither agree nor disagree or I don't know, 4=Agree, 5=Strongly agree. Standard deviation is in brackets. Means with different superscript letters across rows were statistically significantly different ($p \leq 0.05$) based on Tamhane's T2 multiple comparison test. Short variable names (listed ahead of statements) are used elsewhere in this document.

Table 6.4. Estimated weights for three significant components obtained from a principal component analysis (n=2,383, which includes n=2,032 public, and n=351 farmer respondents).

	Component 1 Undersupply of public goods	Component 2 Negative externalities	Component 3 Use of socially valuable assets
On-farm animal welfare	0.5003		
Off-farm animal welfare	0.4332		
Volume of GHG emissions	0.3826		
Culling pest animals	0.3821		
Food safety	0.3190		
Use of GM crops		0.6391	
Synthetic fertiliser use		0.5096	
Chemical use		0.4391	
Urban sprawl			0.6219
Irrigation water extraction			0.4867
Foreign investment			0.4302
Clearing native vegetation			0.3697

Notes: Full statements describing issues as used in survey are listed in Table 6.3. Kaiser-Meyer-Olkin statistic=0.912, and Bartlett's sphericity test was statistically significant, p-value <0.001.

Table 6.5. Estimated component scores obtained from a principal component analysis and used as dependent variables in the seemingly unrelated regression analysis.

Dependent variables	Public (n=1824)			Farmers (n=351)		
	Mean	Min	Max	Mean	Min	Max
C1–Undersupply of public goods	0.16 ^a (1.81)	-6.03	4.57	-0.90 ^b (2.11)	-6.55	3.55
C2–Negative externalities	0.15 ^a (1.36)	-4.76	2.77	-0.90 ^b (1.80)	-5.19	2.67
C3–Use of socially valuable assets	0.05 (1.43)	-6.65	3.41	-0.14 (1.60)	-5.84	2.91

Notes: Standard deviation is in brackets. Across rows, means with different superscript letters were statistically significantly different (p≤0.05) based on Tamhane's T2 multiple comparison test.

6.4.3. Linking respondent characteristics and concerns about agricultural issues

SUR analyses revealed the characteristics statistically significantly associated with the public and farmers' concerns across each of the three components of agricultural issues identified above. For the public analysis (Table 6.6), males and respondents with higher household incomes had statistically significantly lower levels of concern across every component of issues. Additionally, respondents that reported not consciously reducing their intake of meat or other animal source foods (i.e. omnivores) were less concerned about issues in each component compared to those that stated making changes to their diet (e.g. vegan, vegetarian, flexitarian). Likewise, respondents that reported being financial members of environmental or social activist groups stated statistically significantly greater concern about the issues mapping onto all components, but particularly animal welfare issues captured in Component 1 (based on ordered probit analysis—results in Table A4.3 in Appendix 4). Respondents' concerned that climate change will have a negative impact on their household and willing to make pro-environmental

trade-offs, were statistically significantly more concerned about agricultural issues across all components (Table 6.6). Individuals that stated farmers were a main source of information about the agricultural industry were statistically significantly less concerned about the undersupply of public goods and negative externalities (Components 1 and 2). This result reflects the relatively lower level of concern recorded by the farmer sample for these components (Table 6.5). Individuals confident that governments make decisions based on evidence, were statistically significantly less concerned about the use of socially valuable assets for private profit (Component 3). This may indicate a confidence that governments will allocate and regulate socially valuable assets appropriately. Interestingly, there was no statistically significant association found between the level of concern recorded and whether respondents lived in an area where agriculture was the main industry of employment. Likewise, respondents living in urban centres, were only statistically significantly ($p \leq 0.1$) more concerned about an undersupply or threats to public goods (Component 1) compared to respondents from regional communities.

Table 6.6. Results of seemingly unrelated regression analysis for the public sample ($n=1,824$).

Variable	C1–Public goods		C2–Negative externalities		C3–Use of socially valuable assets	
State (Victoria)	-0.113	(0.071)	0.216***	(0.064)	-0.136**	(0.060)
Agriculture main industry	-0.169	(0.144)	0.005	(0.122)	-0.069	(0.122)
Urban	0.156*	(0.088)	0.003	(0.074)	-0.017	(0.074)
Male	-0.186**	(0.073)	-0.317***	(0.062)	-0.104*	(0.062)
Age	-0.008***	(0.003)	0.011***	(0.002)	0.020***	(0.002)
University educated	-0.049	(0.079)	-0.150**	(0.067)	0.117*	(0.067)
Household income	-0.003***	(0.001)	-0.002***	(0.001)	-0.002***	(0.001)
Unemployed	0.092	(0.155)	0.215	(0.132)	0.110	(0.131)
Omnivore	-0.712***	(0.073)	-0.463***	(0.062)	-0.368***	(0.062)
Activist member	0.983***	(0.157)	0.639***	(0.133)	0.574***	(0.133)
Agriculture experience	-0.754***	(0.103)	-0.172**	(0.087)	0.132	(0.087)
Information–farmers	-0.172**	(0.074)	0.138**	(0.063)	0.103	(0.063)
Information–industry	-0.026	(0.076)	0.044	(0.064)	0.024	(0.064)
Information–friends/family	0.063	(0.076)	0.121*	(0.065)	0.058	(0.065)
Information–government	0.033	(0.072)	-0.031	(0.061)	0.048	(0.061)
Information–research organisations	0.176**	(0.075)	0.019	(0.064)	0.125**	(0.064)
Confidence in government	-0.002	(0.072)	0.033	(0.061)	-0.190**	(0.061)
Climate change (CC) is happening	0.548***	(0.110)	0.143	(0.093)	0.257***	(0.093)
CC is largely human induced	0.474***	(0.093)	0.076	(0.079)	0.129	(0.079)
CC will have negative impact	0.549***	(0.079)	0.300***	(0.067)	0.560***	(0.067)
Pro-environmental trade-offs	0.514***	(0.060)	0.371***	(0.051)	0.524***	(0.051)
Constant	-1.701***	(0.299)	-1.595***	(0.254)	-3.027***	(0.254)
Chi squared statistic	997.18		399.48		623.04	
p-value	<0.001		<0.001		<0.001	
R squared	0.354		0.180		0.255	

Notes: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$; Robust standard errors in brackets.

The farmer analysis (Table 6.7) revealed associations between farm characteristics and concerns related to the three components of issues. Farmers that perceived their farm productivity to have increased over the five years preceding the survey recorded less concern about negative externalities and the use of socially valuable assets for private profit. Crop-only

farmers recorded statistically significantly less concern about genetically modified crops, synthetic fertilisers and chemical pest and weed control use (issues that map onto Component 2, i.e. produce negative externalities). This may be because they are more knowledgeable, or, more dependent on these technologies in their business. Farmer responses also reflected a degree of awareness about how issues may directly affect them. For example, farmers with greater land area were statistically significantly less concerned about the use of socially valuable assets compared to other farmers. This may be because they perceive issues captured in this component, such as urban sprawl and irrigation water extraction, to be less relevant to their situation—the largest farms in this sample tended to be rainfed and located away from urban centres toward the arid zone of inland Australia. Irrigators also recorded less concern about irrigation water extraction (based on an ordered probit analysis—results in Table A4.4 in Appendix 4), although this was not statistically significant. However, this result was not distinguishable in the overall positive association between irrigators and concern about the use of socially valuable assets (Table 6.7). This result may reflect the sample composition—only 18% of the sample were irrigators, and some reported a small land area under irrigation.

Table 6.7. Results of seemingly unrelated regression analysis for the farmer sample (n=351).

Variable	C1–Public goods		C2–Negative externalities		C3–Use of socially valuable assets	
State (Victoria)	0.019	(0.214)	0.211	(0.186)	-0.428***	(0.158)
Agriculture main industry	-0.377*	(0.207)	-0.077	(0.179)	0.000	(0.153)
Male	0.132	(0.212)	-0.711***	(0.184)	-0.324**	(0.156)
Age	0.012	(0.011)	0.004	(0.009)	0.019**	(0.008)
University educated	-0.277	(0.252)	-0.657***	(0.219)	0.006	(0.186)
Farm area	0.0003	(0.002)	-0.001	(0.002)	-0.003**	(0.002)
Crop-only farm	-0.142	(0.345)	-0.710**	(0.300)	-0.049	(0.255)
Livestock-only farm	0.219	(0.235)	0.072	(0.204)	0.075	(0.174)
Organic	0.582	(0.385)	1.706***	(0.335)	0.076	(0.285)
Irrigator	0.094	(0.266)	0.004	(0.231)	0.185	(0.196)
Off-farm income	0.007**	(0.003)	0.009***	(0.003)	0.001	(0.003)
Farm productivity trend	-0.130	(0.113)	-0.250**	(0.098)	-0.221***	(0.084)
Farm group member	0.290	(0.210)	0.157	(0.182)	0.147	(0.155)
Succession plan	0.150	(0.207)	0.145	(0.180)	0.388**	(0.153)
Climate change (CC) is happening	0.710***	(0.244)	-0.130	(0.212)	0.043	(0.180)
CC is largely human induced	0.144	(0.227)	0.145	(0.197)	0.119	(0.168)
CC will have negative impact	0.251	(0.220)	0.209	(0.191)	0.451***	(0.162)
Pro-environmental trade-offs	0.383**	(0.160)	0.211	(0.139)	0.280**	(0.118)
Constant	-3.570***	(1.025)	-1.056	(0.891)	-1.571**	(0.757)
Chi squared statistic	51.18		86.05		65.25	
p-value	<0.001		<0.001		<0.001	
R squared	0.127		0.197		0.157	

Notes: ***p≤0.01, **p≤0.05, *p≤0.1; Robust standard errors in brackets.

Farmers with succession plans recorded greater concern about the use of socially valuable assets for private profit (Component 3). This could reflect a perception that issues captured in this component could have long-term or future impacts on their business. Likewise, certified organic farmers recorded greater concern about the use of genetically modified crops, synthetic fertilisers and chemical pest and weed controls (issues that mapped onto Component 2—detailed ordered probit results showing associations with each issue are in Table A4.4 in

Appendix 4). This may represent concerns that led to the decision to operate an organic business and/or the threats that leakage or contamination with genetically modified materials or synthetic fertilisers and chemicals present to their business.

6.5. Discussion and conclusion

Agriculture's social licence is attracting increasing attention across the globe (Williams and Martin, 2011). As far as we are aware, this is the first study to record the concerns of both the public and farmers for a wide set of issues influencing the industry's social licence, using a case study of south-eastern Australia. It was possible to discern three underlying dimensions of social licence issues, based on the responses to 15 statements describing social licence issues posed to both stakeholder groups. Across and within stakeholder groups there were differences in concerns about issues that mapped onto each of the three dimensions of social licence issues.

In general, the public indicated greater concern about the issues presented. This result echoes comparisons of public and farmer attitudes toward more specific issues such as animal welfare (Vanhonacker et al., 2008). But, this result is in contrast to findings reported by Howley et al. (2014) of similar levels of concern about environmental issues between the two groups. However, there were also differences in attitudes within the two stakeholder groups surveyed. For example, public respondents consciously reducing their consumption of animal source foods recorded statistically significantly higher levels of concern about the social licence issues presented to them. Further, organic farmers recorded statistically significantly higher levels of concern about the use of genetically modified crops, synthetic fertilisers and chemical pest and weed controls. Similar differences between organic and conventional farmers have been identified previously (e.g. van Huik and Bock, 2007). There was also no strong evidence for a rural-urban divide in results, i.e. in most cases public concern levels were not higher in urban communities, or lower in agricultural communities. This, added to similar results reported in Witt et al. (2009), is an important contribution to our understanding of social licence issues as industry (Lush, 2018) and government (House of Representatives Standing Committee on Agriculture and Water Resources, 2020) continue to frame agricultural social licence issues as consequences of a rural-urban divide and lack of understanding of the industry.

The findings support the argument presented by Dumbrell et al. (2020), that social licence concerns can be categorised as responses to market and government failures, namely concerns about: (1) an undersupply or threats to public goods; (2) negative externalities; and (3) the use of socially valuable assets for private profit. Classifying social licence debates as a response to these market and government failures can be used to interpret stakeholders' decisions to grant or withhold social licences. Decisions to grant/withhold a social licence appear to be a way to highlight the social costs of negative externalities or benefits of public goods experienced, and demand firms and decision-makers adjust supply to the socially desirable level (Dumbrell et al., 2020). This result could encourage extended use of economic approaches to analyse the underlying drivers, rather than the symptoms, of social licence concerns in the agricultural industry. Economic analyses are already employed to analyse some issues that are described as social licence issues. For example, framing animal welfare as a public good (Lusk and Norwood, 2011) has seen the use of economic analyses such as willingness to pay and accept to understand the appetite for, and to map pathways to improve farm animal welfare (Latacz-Lohmann and Schreiner, 2019). Likewise, revealed preference non-market valuation techniques have been employed to value socially valuable assets such as native vegetation in agricultural

landscapes (Polyakov et al., 2015). However, the use of economic approaches to understand and overcome social licence issues more generally has been limited. This is despite the distribution of costs and benefits, and willingness to forego and accept, being key to social licence outcomes across natural resource dependent industries (Dumbrell et al., 2021; Jartti et al., 2020). By classifying the underlying drivers of social licence issues as market and government failures this research can act as a catalyst for the development of practical economics-based strategies to overcome them.

The public and farmer respondents differed in their concerns regarding negative externalities and the undersupply of public goods, but did not differ on concern about the use of socially valuable assets for private profit. This result could be in-part an artefact of our farmer sample. For example, there were few irrigators included in the farmer sample and if this was not the case, there could have been a greater divergence on the level of concern about irrigation water extraction, and consequently the use of socially valuable assets for profit, more generally. Further, the greatest concern about the extent and circumstances under which farmers can clear land of native vegetation in Australia is concentrated in states not surveyed in this study, e.g. Queensland (Simmons et al., 2018). The concerns captured here, from South Australian and Victorian farmers, may reflect that this issue is less relevant to these farmers. Farmer views captured in this research also likely, among other things, reflect the market and rationale behind the market they operate in, as found by van Huik and Bock (2007). For example, organic farmers recorded greater concerns related to the use of synthetic fertilisers, chemicals and genetically modified crops. Concerns about the use or overuse of these technologies could have acted as the motivation to adopt an organic production system initially. The use of these products by neighbours and potential contamination threats posed by this (e.g. Kershen, 2014) have most likely also compounded concerns expressed in the survey.

Caution should be applied when interpreting the relatively high level of concern about foreign investment compared to other issues presented. Given the general nature of the statement presented to respondents, it is not possible to draw conclusions about why respondents were concerned about this issue. However, the literature may provide insights (e.g. Keogh, 2014; Laurenceson et al., 2015). The broader literature should also be drawn on when considering the implications of this finding. For example, the Australian agricultural sector has been heavily dependent on foreign investment for growth and the concerns held by stakeholders may have implications for attracting investment to continue to grow the value of the Australian agricultural industry.

As the composition of the sample is likely to have influenced the results in this study, it is important to understand the potential changes to the composition of the surveyed groups through time and how results produced in this study are subject to change with this. Public views can be expected to change through time, dependent on multiple factors including the tone and content of information they are exposed to (Swinnen et al., 2005; Te Velde et al., 2002; Vanhonacker et al., 2008). Whereas, Vanhonacker et al. (2008) argued that a change in views or frames of reference for issues such as animal welfare may be harder to achieve among farmers, but once established, likely to be more permanent than among the public.

Across the globe, debate is ongoing with respect to how to best respond to social licence issues in the agricultural industry. As social licence issues tend to be defined as conflicts of interest between interdependent actors, in this case, farmers and the public, policy processes

established to frame and overcome these issues end in stalemates and efforts to shift attention or blame. For example, farmers often call upon consumers to pay more for goods produced in a particular way, and the public often call upon governments and other supply chain actors to create (dis)incentives for farmers to use certain management practices. By identifying the drivers behind social licence issues as responses to government and market failures, this research is a starting point for identifying socially efficient responses to these issues. Further research that teases out the influence of information asymmetry on the development of social licence concerns could also advance efforts to address social licence issues and discordant views between stakeholder groups. For now, with the social licence concept growing in prominence, the discordance in concerns between the public and farmers and the diverse influences on concerns, will both be important for policy-makers and researchers to understand when seeking to minimise or overcome social licence issues.

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Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certified that:

- The candidate's stated contribution to the publication is accurate (as detailed above);
- Permission is granted for the candidate to include the publication in the thesis; and
- The sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Sarah Ann Wheeler		
Contribution to the Paper	Conceptualisation, Methodology, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	Alec Zuo		
Contribution to the Paper	Methodology, Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Name of Co-Author	David Adamson		
Contribution to the Paper	Supervision, Writing – review & editing		
Signature		Date	3 February 2022

Chapter 7 Public willingness to make trade-offs in the development of a hydrogen industry in Australia

This chapter presents a paper submitted to Energy Policy. The paper is included in its submitted form, with only minor changes to formatting to bring it in line with the overall thesis. Consequently, there is some repetition with other chapters of this thesis.

Abstract

Hydrogen is attracting increasing attention and investment in the low carbon energy transition. However, it is expected that any transition to hydrogen at a meaningful scale or rate, will be dependent on the industry obtaining a social licence, underpinned by public acceptance. This study analyses a public survey that asked 1,824 residents of South Australia and Victoria (Australia) to indicate how important six characteristics of a hydrogen industry would be in their decision to support the development of such an industry, namely: (1) safety; (2) climate change mitigation; (3) affordability; (4) reliability; (5) accessibility; and (6) job creation. Overall, safety was rated as the most important characteristic, followed by climate change mitigation and affordability. Fractional multinomial logit model estimates found socio-demographic (e.g. age, location) and attitudinal characteristics (e.g. concern about climate change, hydrogen knowledge) statistically significantly influenced individuals' importance ratings of hydrogen industry characteristics. This research indicates the trade-offs that individuals may—or may not be—willing to make in the transition to hydrogen energy. Such information can be used to align policy and investment decisions with public expectations for further development of the hydrogen industry in Australia.

Keywords

Proportional data; fmlogit; Energy transition; Low carbon economy; Social licence; Social acceptance

7.1. Introduction

There is fast-growing international interest in a transition to hydrogen energy (International Energy Agency, 2019). This interest is driven by the need to decarbonise economies and prevent adverse impacts of climate change. However, the cost to decarbonise an economy is not trivial (Brear et al., 2020; García-García et al., 2020). The transition involves difficult choices that must be technically feasible, relatively safe, economically rational, and accepted by the public. While governments around the world are increasing investment into, and promoting, the transition to hydrogen-based economies (Kosturjak et al., 2019), public acceptance of hydrogen and potential trade-offs required to achieve the transition to hydrogen, are not well understood.

While public acceptance is in-part contingent on technical feasibility and costs, other influences affect acceptance of hydrogen energy and associated technologies (Flynn et al., 2009; Heinz and Erdmann, 2008; Ricci et al., 2008; Schmidt and Donsbach, 2016; Schulte et al., 2004). For example, trust in technology and governance as well as knowledge of hydrogen have been found to be important for public acceptance, and subsequently the establishment of a social licence (Ashworth et al., 2019; Lambert and Ashworth, 2018). An industry with a social licence enjoys the ongoing acceptance or approval of stakeholders affected by the industry and those able to affect its feasibility (Cooney, 2017; Graafland, 2002). Across the globe, the failure to gain a social licence for energy developments (including solar, wind, gas, coal) has led to costly disputes, regulatory restrictions and difficulty obtaining legal licences (Faruque, 2018; Langbroek and Vanclay, 2012; Luke, 2017; Measham et al., 2021). Consequences can also include project failures, delays and reputational and financial costs. The same ramifications confront the hydrogen industry should it fail to secure a social licence (Beck et al., 2019).

In a systematic review of the social licence literature, Dumbrell et al. (2020) found that threats to a business or industry's social licence emerge when the industry fails to meet stakeholders' expectations. This is especially the case when stakeholders experience undesirable external effects of these industries (negative externalities). However, the threshold of what is acceptable differs across groups, time and space, and with the benefits (real or perceived) that can be expected. For example, the oil and gas industries in Australia have been shown to provide sufficient benefits (e.g. employment opportunities) for some stakeholders to tolerate the undesirable external effects of these industries, such as environmental damage (e.g. Marcos-Martinez et al., 2019; Richert et al., 2015). However, other stakeholders are not as tolerant (e.g. Luke, 2017).

In particular, there has been increasing interest and investment in hydrogen in Australia (Australian Government Department of Industry, 2020b; Commonwealth of Australia, 2019). However, questions have arisen regarding the probability that a hydrogen industry will gain a social licence, and indeed, how the industry can best position itself to gain a social licence (Bruce et al., 2018; Carr-Cornish et al., 2019). Hence, an understanding of the Australian public's views towards hydrogen and the trade-offs they may, or may not be, willing to make to facilitate the transition to hydrogen energy are important to explore. Information on the public's views can be used to: (1) signal support and long-term stability for different private sector hydrogen capital investments; (2) inform public policy decisions for regulating and/or supporting hydrogen industry development; and (3) inform effective communication and education campaigns for the hydrogen transition. Failure to understand and account for the public's views in the development of a hydrogen industry could jeopardise any chance the industry has to

obtain a social licence. On the other hand, identification of the public's concerns at an early stage of hydrogen development may help to avoid path dependency and lock-in from government policy and investment, especially if alternative (and more socially acceptable) hydrogen development pathways or forms of energy exist (Cowan, 1990; Unruh, 2002).

This research aims to identify the trade-offs residents of south-eastern Australia may be willing to make in the transition to hydrogen energy. Specifically, we address the research questions: What characteristics of a future hydrogen energy system will be most important to Australians, and what (if any) trade-offs are individuals willing to make to transition to hydrogen energy? How do socio-demographic characteristics and attitudes affect individuals' hydrogen industry preferences? This research contributes to the social licence and hydrogen policy literatures by demonstrating the relative importance the public places upon different characteristics of the hydrogen industry that could be critical to understand as public and private investments continue to flow toward developing a hydrogen industry in Australia.

7.2. Examining stakeholders' preferences for various characteristics of a hydrogen industry

International research has shown psychological, attitudinal, and socio-demographic determinants to be associated with public acceptance of hydrogen (e.g. Huijts and van Wee, 2015; O'Garra et al., 2008). Similar to other studies in the field of public acceptance of new scientific developments, key psychological determinants shown to influence public acceptance of hydrogen include trust and knowledge. For example, trust and confidence in government and regulatory institutions has been positively associated with public acceptance of hydrogen energy and infrastructure (O'Garra et al., 2008). Likewise, objective and subjective knowledge of hydrogen has been found to be positively associated with acceptance in some circumstances (Huijts and van Wee, 2015; O'Garra and Mourato, 2007; Thesen and Langhelle, 2008). However, many studies indicate that the general public is relatively supportive of hydrogen at the same time that knowledge is low (e.g. Achterberg et al., 2010; Carr-Cornish et al., 2019; Lambert and Ashworth, 2018; Martin et al., 2021; Ricci et al., 2008). Carr-Cornish et al. (2019) and Bogel et al. (2018) noted that attitudes formed on limited information are subject to change. While Achterberg et al. (2010) suggested that this finding may arise because cultural predispositions and previous experience and trust in governance and technology play a mediating role in knowledge translating to acceptance.

Given hydrogen is largely attracting attention as an energy source for a low carbon transition, environmental attitudes have also been associated with public acceptance of hydrogen (Achterberg et al., 2010; Thesen and Langhelle, 2008; Zimmer and Welke, 2012). Environmental attitudes were statistically significant contributors to hydrogen vehicle and fuel station acceptance in a Norwegian study (Thesen and Langhelle, 2008) and a study in London (O'Garra et al., 2008). Survey results from a Dutch study also showed that those concerned about the environment were more supportive of hydrogen (Achterberg et al., 2010). Alongside attitudes, socio-demographic characteristics such as age and lower income have also been positively associated with opposition towards hydrogen storage and fuelling stations in London (O'Garra et al., 2008).

Noting the above influences on public acceptance, it is also anticipated that the energy industry's ability to gain a social licence for hydrogen will be based on society's perceptions of the affordability, reliability and environmental sustainability of hydrogen (Energy Networks Australia, 2019). The triple challenge of providing an energy system that is: secure/reliable, equitable (accessible and affordable) and environmentally sustainable is referred to as the energy trilemma (World Energy Council, 2020). The concept of the energy trilemma suggests that: (1) each of the dimensions are important and valued; and (2) investment and improvement in one dimension could have negative consequences for other dimensions, namely there are trade-offs to be made (Heffron et al., 2015).

In the Australian context, the main influences on future acceptance and social licence prospects for hydrogen energy have been identified as perceptions of: (1) safety; (2) environmental benefit—especially in regard to renewable versus non-renewable hydrogen production; and (3) cost (Carr-Cornish et al., 2019). This research follows a wider literature that has identified the balance of benefits and costs as drivers of social licence outcomes (Dumbrell et al., 2020) and hydrogen-specific research showing expected social and environmental costs and benefits to be influential for acceptance (Thesen and Langhelle, 2008). In particular, this research follows Martin et al.'s (2021) broad exploration of the Australian public's attitudes toward a hydrogen economy. This study builds on their identification of the hydrogen industry characteristics considered important by the public by soliciting trade-offs between these characteristics. This research also frames the hydrogen industry characteristics of interest as conditions that contribute to social licence outcomes (Dumbrell et al., 2020, 2021). Consequently, the focus of this research is to test public willingness to make trade-offs between six key characteristics of a hydrogen industry: (1) safety; (2) climate change mitigation; (3) affordability; (4) reliability; (5) accessibility; and (6) job creation. The following sections briefly summarise research and issues relevant to each characteristic as well as evidence for developing a series of hypotheses to test.

7.2.1. Safety issues

As with existing fuels such as petroleum and natural gas, safety risks related to hydrogen fuels are largely associated with combustion risks. Hydrogen can ignite more easily than petroleum and natural gas (Hord, 1978), and can cause some metals (used in existing energy infrastructure) to become brittle, increasing the risk of leaks. Consequently, ventilation, and leak and flame detection equipment are required for infrastructure designed to carry hydrogen (Rigas and Amyotte, 2012). Noting these potential safety issues, research that has asked the public to elicit spontaneous associations with the word hydrogen, has found mixed results. In most cases negative associations have been rare (Thesen and Langhelle, 2008; Zimmer and Welke, 2012), whereas others have found negative associations to be common (Montijn-Dorgelo and Midden, 2008). Public safety concerns identified in previous research tend to be intertwined with proximity to hydrogen infrastructure (and therefore potential combustion sites) and knowledge of hydrogen's properties (Huijts and van Wee, 2015; Lambert and Ashworth, 2018; O'Garra et al., 2008; Scott and Powells, 2020). Indeed, Huijts and van Wee (2015) and O'Garra et al. (2008) found that distance from a hydrogen site was positively associated with acceptance of hydrogen. In the same research, opposition from residents in the vicinity of hydrogen refuelling stations also appeared to be determined in-part by a lack of trust in safety regulations (O'Garra et al., 2008).

7.2.2. Climate change mitigation benefits

The key environmental consequences of a transition to hydrogen are related to greenhouse gas emissions. Hydrogen can be produced using fossil fuels (via steam methane reforming or coal gasification), or renewable energy to power electrolysis of water (Acar and Dincer, 2019). Only the production of hydrogen from renewable energy produces zero greenhouse gas emissions, even if the fossil fuel-based processes are paired with carbon capture and storage (Howarth and Jacobson, 2021). A clear social preference for renewable hydrogen was found in a German study with participants stating that there would be no incentive to purchase a hydrogen vehicle if the fuel was derived from fossil fuels (Zimmer and Welke, 2012). Climate change mitigation was also noted as an important benefit of hydrogen energy in recent Australian studies (Lambert and Ashworth, 2018; Martin et al., 2021). This is noteworthy because it is not yet clear which production pathway (fossil or renewable hydrogen) will be pursued, or incentivised in Australia. To date, the Australian Government have adopted a technology neutral stance (Commonwealth of Australia, 2019).

7.2.3. Affordability issues

Energy affordability is a critical issue for economically vulnerable groups (Willand and Horne, 2018). However, an ever-growing literature suggests consumers are willing to pay more for renewable energy, but willingness to pay is also contingent on the source of energy, e.g. wind or solar (Ma et al., 2015). In the Australian context, some research suggests hydrogen made from fossil fuels paired with carbon capture and storage technology would be more cost-competitive than hydrogen made from renewable energy powered electrolysis of water (Milani et al., 2020). Whereas other research puts renewable hydrogen as cost competitive with other hydrogen production technologies in the short-term (Advisian, 2021; Longden et al., 2022). This could be critical given Lambert and Ashworth (2018) found less than half of their Australian survey sample were willing to trade-off affordability of hydrogen energy and appliances/vehicles for environmental benefits.

7.2.4. Reliability issues

A reliable energy system features continuous supply with few to no disruptions. Renewable energy systems such as solar and wind have been labelled as unreliable, and despite the advent of new technologies to support these systems, continue to be plagued by the 'unreliable narrative' (Curran, 2012). Hydrogen can act as an energy storage medium to help overcome reliability issues (Eriksson and Gray, 2017). Although knowledge of this hydrogen attribute is low, the potential for hydrogen to contribute to energy reliability has been identified as advantageous by Australians who suffer from poor energy reliability or energy outages due to supply shocks (Lambert and Ashworth, 2018).

7.2.5. Accessibility issues

Energy accessibility is a critical consideration when assessing the distributional fairness of an energy transition (Goddard and Farrelly, 2018). Practical and affordable methods of storage, transport and conversion are required to ensure hydrogen energy as well as appliances and vehicles compatible with hydrogen gas are accessible to consumers (Milani et al., 2020). While

accessibility can be improved by proximity to hydrogen storage and refuelling stations, the perception of safety risks associated with proximity to hydrogen infrastructure have been found to outweigh accessibility issues in some public acceptance studies (O'Garra et al., 2008).

7.2.6. Job creation benefits

The energy transition (away from existing fossil fuel energy systems) has been framed by certain groups as an issue of “jobs versus the environment/climate” (Healy and Barry, 2017, p. 454). The situation in Australia is no exception to this framing (Goddard and Farrelly, 2018). Political barriers, as well as policy uncertainty have created an environment where the “jobs carnage” narrative has been able to thrive, particularly in reference to regional communities (Curran, 2012). In particular, the employment debate highlights that the transition will have employment consequences (positive and negative) that are not evenly distributed (García-García et al., 2020; Ram et al., 2020; Sharma and Banerjee, 2021). Indeed, in the absence of policies to support a just transition, stakeholders likely to lose their job in the current highly-regionalised fossil fuel-based energy system have an incentive to hinder the development of new energy industries (Effendi and Courvisanos, 2012). However, stakeholders able to access new employment opportunities have been more willing to grant social licences to other energy developments, and could be expected to act similarly in a transition to hydrogen (e.g. Richert et al., 2015).

Based on the literature summarised above, the following four key hypotheses were formulated for this research.

H1: Socio-demographic and attitudinal characteristics that have been associated with overall hydrogen acceptance will influence the characteristics of a hydrogen industry that individuals consider most important.

H2: Individuals with greater self-rated knowledge of hydrogen, how it is produced and how it can be used, will be less likely to place greater weighting on safety as an important characteristic of a hydrogen industry.

H3: Individuals who are more concerned about climate change (e.g. agree that climate change is occurring, that it is largely human-induced and likely to have negative impacts on their households) will be more likely to allocate greater weighting to climate change mitigation as an important characteristic of a hydrogen industry.

H4: Individuals most likely to benefit from job opportunities in the hydrogen industry (e.g. individuals of working age, with trade qualifications, living in regional areas with potential for hydrogen production sites) will be more likely to allocate greater weighting to job creation as an important characteristic of a hydrogen industry.

7.3. Methods

7.3.1. Data and case study area

An online survey, deployed by a professional survey company, was used to capture individuals' understanding of—and preferences for—a transition to hydrogen energy production and use in

Australia. Ethics approval to conduct the survey, and research tasks for survey design, was provided by the University of Adelaide Human Research Ethics Committee (H-2020-101). A representative sample (age and gender), and a split of metropolitan/regional residents of South Australia and Victoria was provided by the professional survey company. A total of 2032 survey responses were received in October and November 2020. Because of missing responses to some questions, the analyses reported are based on the 1,824 responses (897 from South Australia and 927 from Victoria) that had complete information.

There were three key reasons why south-eastern Australia (South Australia and Victoria) was chosen as a case study: (1) both states were relatively early movers with respect to supporting hydrogen developments (Government of South Australia, 2019; Victorian State Government, 2019); (2) more specifically, South Australia's move to adopt more renewable energy, and become a net exporter of electricity (McGreevy et al., 2021), presented an opportunity to understand whether that transition has influenced stakeholders' preferences for future energy transitions; and (3) there is a diverse (in terms of age, ownership and management) set of energy infrastructure (Australian Energy Regulator, 2021), across both states that present opportunities for comparisons of public experiences that may underpin a social licence for future fuels industries.

The survey design was informed by a literature review, as summarised previously, plus a focus group and 22 interviews. Questions in the survey were designed to collect information about respondents': (1) socio-demographic characteristics; (2) environmental attitudes and behaviours; (3) energy use behaviours; and (4) self-rated knowledge of the hydrogen energy industry in Australia. The question in the survey that is most important for this study asked respondents to allocate 100 points among six characteristics that may be important in their decision to support the development of a hydrogen industry in Australia. The six characteristics, as previously noted, were: (1) safety; (2) climate change mitigation; (3) affordability; (4) reliability and security of supply; (5) accessibility; and (6) job creation. These characteristics were tested prior to undertaking the online survey. Respondents were instructed to allocate more points to characteristics more important to them, and to allocate zero points to characteristics they considered 'not at all important'. The question design was informed by similar weighting questions in survey research by Loch et al. (2016) and Malek and Umberger (2021). The question, as administered in the survey is included as Q 12 in the 'Online survey for public respondents' in Appendix 3.

Point allocation questions (sometimes referred to as budget pie or constant-sum scaling questions) have been shown to be a reliable way to ask respondents to indicate relative intensity of preference (Mullen, 1999). They are also relatively easy for respondents to complete (Ryan et al., 2001). Constrained-choice methods such as the point allocation question used in this study are appropriate when, as in this situation, options are in competition and/or the objective is to understand respondents' willingness to make, or not make, trade-offs. Constrained-choice methods also ensure inter-person equity when scores are aggregated for analyses (Mullen, 1999). For this survey, each characteristic was framed in reference to current energy circumstances because respondents' answers are context-dependent (Louviere and Islam, 2008). For example, for 'safety' respondents were asked about the importance of safety of any future hydrogen energy industry relative to their perceptions of the safety of production, storage, transport and use of existing fuels.

By choosing six characteristics only, the choice task for respondents was easier than if more characteristics were provided. However, a consequence of this limited choice set is that the responses cannot provide preference information on a total comprehensive list of influential characteristics. The order that the six characteristics were presented to respondents in the online survey was randomised. This was done to remove any bias that could have been associated with respondents allocating greater points to the first listed characteristic.

7.3.2. Model specification

Given respondents were asked to indicate preferences and trade-offs by allocating a set budget of 100 points between six different hydrogen industry characteristics, the data for analysis is proportional. Proportional data has a set of unique traits that must be considered ahead of analysis (Aitchison, 1986; Cook et al., 2008). First, when more points are allocated to one characteristic, there are fewer points available to be allocated to the remaining characteristics, hence proportions are automatically negatively correlated (Buis, 2010). Second, point allocation choices are deliberate, especially at the extremes of zero and 1. A choice of zero or 1 (a corner solution) arises because the respondent is either unwilling or unable to make a trade-off. Third, given proportional data is bound by zero and 1, the variance decreases as the mean value is closer to either boundary (Cook et al., 2008; Loch et al., 2016).

Given the above described characteristics of the data and important points raised by other authors analysing proportional data (especially by Cook et al., 2008), it was determined that a fractional multinomial logit model was the most appropriate for this analysis. The fractional multinomial logit model is a multivariate generalisation of the fractional logit model developed by Papke and Wooldridge (1996). The model has been used to analyse a number of economic and allocation problems that are represented by proportional data, such as the allocation of a fixed land area to different uses, and the allocation of a fixed allotment of time to different activities (Luo and Escalante, 2017; Mu et al., 2018, 2019; Mullahy and Robert, 2010).

Given the dependent variable (proportion of importance weighting allocated to each of six characteristics of the hydrogen industry) meets the criteria $0 \leq y_{ij} \leq 1$, we followed Papke and Wooldridge (1996, 2008) and Mullahy (2015) such that y_{ij} was structured as a logistic function $\Lambda(\cdot)$; of a set of explanatory variables (x_i); observed for each individual, i ; and the characteristic of the hydrogen industry to which weighting was allocated, j . The proportions allocated to each characteristic can be estimated using Equation 7.1:

$$E[y_{ij} | x_i] = \Lambda(x_i \beta_j) = \frac{\exp(x_i \beta_j)}{\sum_{h=1}^J \exp(x_i \beta_h)} \quad (\text{Eq. 7.1})$$

All estimates were computed using the fmlogit package (Buis, 2008) in StataSE 16. Results report the average marginal effects of the fractional multinomial logit model estimates. Robust standard errors were used in model estimates to in-part control for heteroskedasticity. Variance inflation factors (VIF) and correlation coefficients were calculated and indicate no serious issues with multicollinearity. The mean VIF was 1.22 and the maximum was 1.43, and the highest correlation coefficient was 0.47. Additionally, the mean and median point allocation scores were also not statistically significantly different ($p \leq 0.05$) indicating, to some extent, the presence of

few outliers or strategic responses influencing the model estimates (Clark, 1974; Ryan et al., 2001).

7.3.3. Summary statistics

The six dependent variables are the proportion of points (out of 1) that respondents allocated to each of the six characteristics of a hydrogen industry, based on importance. The dependent variables are defined and presented with summary statistics in Table 7.1. The explanatory variables included in the analysis reflect the hypotheses outlined previously, namely the associations between importance weightings for hydrogen industry characteristics and influential variables identified in the literature (e.g. Achterberg et al., 2010; Bogel et al., 2018; Huijts and van Wee, 2015; O’Garra and Mourato, 2007; Ricci et al., 2008; Schmidt and Donsbach, 2016; Thesen and Langhelle, 2008). The explanatory variables included: state of residence (South Australia or Victoria); whether respondents lived in a metropolitan (urban) or regional area; gender (male); age; education; household characteristics; employment experience; attitudes, especially regarding environmental issues; and self-rated knowledge of the hydrogen industry (Table 7.2). Alternative variables and variable specifications, e.g. squared forms of continuous and semi-continuous variables (included in Appendix 5) were also tested in a variety of sensitivity analyses before the final estimates were produced.

Table 7.1. Sample summary statistics, proportion of points (out of 1.00 from point weighting allocation task) allocated by survey respondents (n=1,824), to each characteristic of the hydrogen industry.

Dependent variables	Mean	Standard deviation	95% confidence interval	Min	Max	Rated most important (%)
Safety	0.215 ^a	0.167	(0.207, 0.223)	0	1	36.13
Climate change mitigation	0.192 ^b	0.177	(0.184, 0.200)	0	1	30.32
Affordability	0.184 ^b	0.131	(0.178, 0.190)	0	1	25.60
Reliability	0.155 ^c	0.126	(0.149, 0.161)	0	1	18.31
Accessibility	0.130 ^d	0.111	(0.125, 0.135)	0	1	12.66
Job creation	0.124 ^d	0.117	(0.119, 0.130)	0	1	11.24

Notes: Rated most important (%) sum exceeds 100 because more than one characteristic could have equal highest importance weighting. Means denoted with different superscript letters were statistically significantly different at $p \leq 0.05$ based on Tukey’s Honestly Significantly Difference Test.

Table 7.2. Sample summary statistics, explanatory variables (n=1,824).

Variable	Definition	Mean	Min	Max
State (Victoria)	1=Victoria; 0=South Australia	0.51 (0.50)	0	1
Urban	1=Metropolitan Adelaide/Melbourne; 0=Regional area	0.72 (0.45)	0	1
Male	1=Male; 0=Otherwise	0.45 (0.50)	0	1
Older respondents	1=65 years and above; 0=18–64 years	0.23 (0.42)	0	1
University educated	1=University education; 0=Otherwise	0.40 (0.49)	0	1
Household income ^a	Tens of thousands of AUD per year	8.68 (5.37)	2.45	22.23
Household residents	Number of residents in household	2.57 (1.23)	1	8
Employed energy industry	1=Employed, formerly employed, or have family employed in energy industry; 0=Otherwise	0.06 (0.24)	0	1
Unemployed	1=Unemployed; 0=Otherwise (i.e. employed or not in labour force)	0.05 (0.23)	0	1
Low socio-economic region	1 = ≤20th percentile on Socio-Economic Advantage and Disadvantage Index ^b ; 0=Otherwise	0.21 (0.40)	0	1
Confidence in government decisions	1=Agree or strongly agree Australian governments make policy and regulatory decisions based on scientific and economic evidence; 0=Otherwise	0.38 (0.49)	0	1
Climate change is happening	1=Agree or strongly agree that climate change is happening; 0=Otherwise	0.83 (0.37)	0	1
Climate change is largely human induced	1=Agree or strongly agree climate change is largely human-induced; 0=Otherwise	0.74 (0.44)	0	1
Climate change will have negative impact	1=Agree or strongly agree that climate change will have a negative impact on household; 0=Otherwise	0.54 (0.50)	0	1
Index variables	Construction variables			
Pro-environmental trade-offs (average index)	To what extent do you agree: (1=Strongly disagree; 2=Disagree; 3=Neither agree nor disagree or unsure; 4=Agree; 5=Strongly agree) A healthy, well protected environment and a prosperous economy go hand in hand The environment needs to be protected even if it impacts economic prosperity In order to have economic prosperity, the environment is going to suffer a bit (reverse coded)	3.65 (0.63)	1.33	5
Knowledge of hydrogen industry (additive index)	Please indicate your knowledge of hydrogen production and its uses: (0=Never heard of it; 1=Had heard of it; 2=Had heard of it and could explain to a friend) How hydrogen is produced The use of hydrogen in fuel cell vehicles Burning hydrogen as a replacement for natural gas Hydrogen as an energy storage medium for electricity The use of hydrogen fuel cells in homes	3.22 (2.63)	0	10

Notes: Standard deviation in brackets. AUD is Australian dollars. ^a Household income is a semi-continuous variable; ^b As per the Socio-Economic Advantage and Disadvantage Index, 2016 for postcode nominated by respondent (Australian Bureau of Statistics, 2018b).

7.4. Results and discussion

Safety was the most important characteristic influencing respondents' willingness to support a hydrogen industry. This was followed by climate change mitigation and affordability, followed by reliability, then accessibility and job creation (Table 7.1). This result indicates that, in general, respondents were not willing to trade-off safety to meet other objectives, or pay more for energy to achieve climate change mitigation. The average marginal effects results of the fractional multinomial model estimates, are presented in Table 7.3, and the following describes the evidence to support the four hypotheses outlined in Section 7.2.

7.4.1. Socio-demographic and attitudinal characteristics

While there were statistically significant associations between importance weighting allocations and some socio-demographic and attitudinal characteristics of respondents, the results revealed no statistically significant relationship between state of residence, gender, household income or employment status and importance weighting allocations across the six characteristics (Table 7.3). With this, the results show mixed statistically significant evidence to support *H1: Socio-demographic and attitudinal characteristics that have been associated with overall hydrogen acceptance will influence the characteristics of a hydrogen industry that individuals consider most important*. However, there were notable differences between urban and regional respondents, for example urban respondents allocated statistically significantly more importance weighting points to safety, affordability and reliability. The difference in allocations for safety is possibly a consequence of perceived proximity to hydrogen infrastructure (we return to this point in the next section). As well as urban residents, the groups that allocated statistically significantly more importance to affordability and reliability included older respondents, those employed in the energy industry and those with confidence in government decisions. This finding could indicate demand for research to consider the affordability and reliability trade-offs of a hydrogen transition. This could be especially important given research has already indicated that it is possible for a transition to renewable energy without sacrificing energy affordability or reliability (Goddard and Farrelly, 2018). Other influences of socio-demographic and attitudinal characteristics on importance weighting allocations are highlighted in the subsequent sections.

7.4.2. Knowledge characteristics and safety weighting

Respondents with greater self-rated knowledge of hydrogen (e.g. how hydrogen is produced, and how hydrogen can be used) allocated statistically significantly ($p \leq 0.01$) fewer importance weighting points to hydrogen's relative safety. This result supports *H2: Individuals with greater self-rated knowledge of hydrogen, how it is produced and how it can be used, will be less likely to place greater weighting on safety as an important characteristic of a hydrogen industry*. Respondents confident that governments make decisions based on evidence and respondents with greater levels of self-rated knowledge about hydrogen allocated statistically significantly more importance weighting, than their counterparts, to accessibility (Table 7.3). This could indicate that individuals with greater knowledge about hydrogen recognise that new (or modifications to existing) infrastructure will be required to deliver hydrogen to end-users and as such, specific investments will be required to ensure accessibility is not sacrificed in the pursuit of other objectives. However, at the same time, it is not surprising that accessibility received relatively fewer importance weighting points in general given that accessibility has been sacrificed in order to minimise social costs, namely safety risks, associated with proximity to

hydrogen infrastructure in other contexts (O'Garra et al., 2008). Further research will be required to understand whether these results hold if and when localised hydrogen infrastructure is installed in Australia. Current research reporting on public acceptance toward specific technology or infrastructure such as vehicles and refuelling stations has largely drawn on experiences in more advanced hydrogen economy contexts, e.g. Europe (e.g. Huijts and van Wee, 2015; Thesen and Langhelle, 2008).

Alongside the associations detailed above, this research also shows low levels of self-rated hydrogen knowledge in the survey case study area (Table 7.2). This finding aligns with other survey research across the globe (Achterberg et al., 2010; Huijts and van Wee, 2015; Ricci et al., 2008). Such results, coupled with recent policy interest and investment in developing a hydrogen industry in Australia, indicates that building the public's objective and subjective knowledge of hydrogen could be critical for social licence outcomes, and therefore industry success and sustainability (Australian Government Department of Industry, 2020b; Commonwealth of Australia, 2019).

7.4.3. Environmental attitudes and climate change mitigation

Respondents that agreed climate change is happening (83 percent), largely human-induced (74 percent), and who expect climate change to have a negative impact on their household (54 percent), allocated statistically significantly ($p \leq 0.01$) more importance to climate change mitigation as an important characteristic of a hydrogen industry (Table 7.3). Respondents willing to make pro-environmental trade-offs allocated six percent more weighting to the importance of climate change mitigation ($p \leq 0.01$). This finding supports existing research that suggests there is a desire for hydrogen to be made using renewable energy to power electrolysis (Zimmer and Welke, 2012), and provides evidence for *H3: Individuals who are more concerned about climate change (e.g. agree that climate change is occurring, that it is largely human-induced and likely to have negative impacts on their households) will be more likely to allocate greater weighting to climate change mitigation as an important characteristic of a hydrogen industry.*

Other studies show that while Australians consider climate change mitigation important, it is not always the most important issue when making decisions with inherent trade-offs (Colvin and Jotzo, 2021). The research reported here supports that finding: nearly a third of respondents rated climate change mitigation as the most or equal most important characteristic of a hydrogen industry but only 18 respondents (out of 1824) assigned all of their available importance weighting points to climate change mitigation. The respondents that allocated statistically significantly ($p \leq 0.05$) less importance to climate change mitigation included residents of low socioeconomic regions, indicating they may be making trade-offs to prioritise other objectives. On balance, the relative importance of climate change mitigation from the transition to hydrogen appears to be an important consideration for at least a subset of south-eastern Australians to support the transition to a hydrogen industry. If seeking to maximise the likelihood that the industry gains a social licence, this result may be pertinent in any policy decision for Australia to maintain or abandon the current technology neutral status for hydrogen production.

Respondents willing to make pro-environmental trade-offs also allocated 1.5 percent fewer importance weighting points to reliability ($p \leq 0.01$; Table 7.3). Additionally, there were statistically significant relationships between environmental attitudes and importance weightings for safety and affordability characteristics. A possible explanation for these findings is that as respondents

allocated more importance to climate change mitigation there were fewer importance allocation points to allocate to these characteristics, i.e. these were the characteristics that respondents were willing to trade-off.

7.4.4. Job and regional economy characteristics

Job creation attracted relatively fewer importance weighting points from older respondents and respondents with a university education (Table 7.3). This result was expected as these groups are less likely to directly benefit from any job opportunities created by the establishment of a hydrogen industry. For example, older people may already be, or may anticipate, that they will be retired before any meaningful progress is made toward scaling up the hydrogen industry. University educated respondents may be sufficiently confident in their job prospects regardless of the development or rate of development of a hydrogen industry. This result also largely supports *H4: Individuals most likely to benefit from job opportunities in the hydrogen industry (e.g. individuals of working age, with trade qualifications, living in regional areas with potential for hydrogen production sites) will be more likely to allocate greater weighting to job creation as an important characteristic of a hydrogen industry.* However, it must be noted that there was no statistically significant evidence for individuals living in regional areas allocating greater weighting to job creation. This is likely a reflection of the scope and timing of this study. The hydrogen industry is in its infancy in Australia and the job opportunities and where they may be located is largely yet to be determined. Further research aimed at understanding public acceptance of specific hydrogen demonstration plants or other infrastructure in the future may reveal different results. Further, respondents willing to make pro-environmental trade-offs allocated 1.5 percent fewer importance weighting points to job creation ($p \leq 0.01$), i.e. they were willing to trade-off job creation for environmental objectives (Table 7.3). These results are notable given that job opportunities and associated socioeconomic ramifications of the energy transition have been used as an argument for and against the transition to renewable energy (including renewable hydrogen) in the Australian context (Commonwealth of Australia, 2019; Curran, 2012; Garnaut, 2019; Goddard and Farrelly, 2018).

7.4.5. Overall findings

This research builds on a growing body of literature that captures public views toward plans for our energy future (Ostfeld and Reiner, 2020). The results indicate that individuals are more likely to place importance on characteristics they are concerned about (e.g. safety risks, or climate change mitigation) or, likely to directly benefit from (e.g. job creation). This mirrors research findings in other energy contexts where those individuals likely to benefit from jobs or economic activity willingly (or due to other constraints) trade-off other objectives to access those benefits. The relative importance of safety and climate change mitigation (both public goods) also supports the argument that market failures underpin public concerns that are critical in the decision to grant or withhold a social licence (Dumbrell et al., 2020).

Table 7.3. Average marginal effects for fractional multinomial logit modelling of importance weighting allocated to six hydrogen industry characteristics by survey respondents (n=1,824).

Variable	Safety		Climate change mitigation		Affordability		Reliability		Accessibility		Job creation	
State (Victoria)	-0.003	(0.008)	0.004	(0.008)	-0.003	(0.006)	-0.001	(0.006)	0.008	(0.005)	-0.005	(0.006)
Urban	-0.020**	(0.010)	-0.011	(0.010)	0.024***	(0.007)	0.014*	(0.007)	0.002	(0.006)	-0.008	(0.007)
Older respondents	0.003	(0.010)	-0.005	(0.011)	-0.013	(0.008)	0.024***	(0.008)	0.003	(0.007)	-0.013*	(0.007)
Men	-0.003	(0.008)	-0.010	(0.009)	0.009	(0.007)	0.007	(0.007)	-0.001	(0.006)	-0.003	(0.006)
University educated	0.001	(0.009)	0.013	(0.009)	-0.002	(0.007)	0.008	(0.007)	0.000	(0.006)	-0.016***	(0.006)
Household income	0.0003	(0.001)	-0.0003	(0.001)	0.0002	(0.001)	-0.0000	(0.001)	0.0004	(0.001)	0.0003	(0.001)
Household residents	0.005	(0.004)	-0.003	(0.004)	-0.005*	(0.003)	0.003	(0.003)	-0.001	(0.003)	0.001	(0.003)
Employed energy industry	-0.007	(0.014)	0.020	(0.018)	-0.024**	(0.011)	-0.002	(0.011)	0.007	(0.012)	0.006	(0.011)
Unemployed	0.003	(0.018)	0.000	(0.017)	-0.005	(0.012)	0.013	(0.015)	-0.011	(0.012)	0.001	(0.012)
Low socio-economic region	0.011	(0.010)	-0.021**	(0.010)	0.009	(0.008)	0.004	(0.008)	0.000	(0.007)	-0.003	(0.008)
Confidence in government decisions	-0.005	(0.008)	-0.036***	(0.008)	-0.003	(0.006)	0.011*	(0.006)	0.012**	(0.005)	0.020***	(0.006)
Climate change is happening	-0.003	(0.014)	0.048***	(0.014)	-0.018	(0.010)	-0.004	(0.010)	-0.006	(0.010)	-0.017	(0.010)
Climate change is largely human induced	0.003	(0.011)	0.047***	(0.011)	-0.023***	(0.008)	-0.006	(0.008)	-0.009	(0.007)	-0.011	(0.008)
Climate change will have negative impact	-0.025***	(0.009)	0.030***	(0.009)	0.001	(0.007)	-0.005	(0.007)	0.004	(0.006)	-0.005	(0.006)
Pro-environmental trade-offs	-0.000	(0.007)	0.058***	(0.007)	-0.025	(0.006)	-0.015***	(0.005)	-0.004	(0.004)	-0.015***	(0.005)
Knowledge of hydrogen industry	-0.006***	(0.002)	-0.001	(0.002)	0.001	(0.001)	0.002*	(0.001)	0.004***	(0.001)	0.000	(0.001)
Number of observations	1824											
Wald χ^2	472.58											
Log pseudolikelihood	-3,193.33											

Notes: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1; Robust standard errors in brackets.

7.5. Conclusions and policy implications

The need to decarbonise energy systems is a pressing issue attracting the attention of governments and private firms across the globe. Australia has started to explore and invest in an energy transition that uses hydrogen (Commonwealth of Australia, 2019). With a focus on technical feasibility and costs, this investment has largely occurred without in-depth understanding of whether the Australian public considers the transition to hydrogen acceptable, or what industry characteristics public acceptance would be sensitive to.

The research reported here shows the relative importance that 1824 residents of south-eastern Australia (namely South Australia and Victoria) placed on six characteristics of a future hydrogen energy system in 2020. Overall, safety was rated the most important characteristic, followed by climate change mitigation and affordability, reliability and then accessibility and job creation. This order of importance indicates that individuals were generally not willing to trade-off safety to meet other objectives, or trade-off affordability for climate change mitigation. However, the weighting across each of the six characteristics, and different weightings made by various groups, indicates that policies prioritising one characteristic over others could be detrimental to any pursuit of public acceptance or high-level social licence outcomes. The results of the fractional multinomial logit modelling indicated that individuals are more likely to allocate importance to characteristics they are: (1) concerned about; and (2) expect to benefit from. For example, individuals concerned about negative impacts of climate change on their household were statistically significantly more likely to allocate importance to climate change mitigation.

Noting that trade-offs are complex, a clear understanding of society's preferences for decarbonising the economy can guide both public policy and private investment. For example, the results of this research indicate that maintaining the current technology neutral approach to hydrogen production (i.e. supporting both renewable hydrogen and fossil hydrogen), could be costly to the industry's chances of obtaining a social licence. The policy and investment implications of this research are also not limited to Australia. Australia has established various partnerships and agreements to further collaborate on hydrogen research and regulations and to build markets with countries such as Japan, South Korea, Singapore and Germany (Commonwealth of Australia, 2019; Prime Minister of Australia, 2021). Any impact that the Australian public's expectations and preferences have on shaping policy and investment in hydrogen in Australia will inevitably influence potential interactions with partner countries. Likewise, partner countries, particularly trading partners, can create (dis)incentives to influence the direction of hydrogen policy and investment in Australia (e.g. Muller et al., 2021).

The findings reported here also indicate that self-rated hydrogen knowledge is relatively low among the public in south-eastern Australia. By understanding the characteristics of a hydrogen industry considered most important as done here, it is possible to tailor communication and knowledge campaigns to focus on areas of particular interest or concern. Indeed, information about the industry is likely to be critical to social licence outcomes given that information is required prior to any decision to consent. However, decisions to grant a social licence are not based on information and knowledge alone, rather this is one condition alongside other expected costs and benefits that have been shown to be associated with social licence outcomes in natural resource dependent industries (Dumbrell et al., 2021). To reflect this, continued growth in the hydrogen industry, including the construction of demonstration plants,

would benefit from specific research to understand the local and broader community's preferences and perceptions of the magnitude and distribution of costs and benefits and their willingness to accept any proposed trade-offs in the hydrogen transition.

Chapter 8 Summary, conclusions and implications

8.1. Thesis overview

This thesis examined the concept of a social licence as a form of governance at the intersection of government and markets. The social licence concept can be used to highlight instances of resource use and exploitation that are not aligned with social expectations of sustainable or socially responsible resource management. The overarching objective of this thesis was to bring clarity to the understanding and analysis of the social licence concept and social licence outcomes using perspectives from the economics discipline. This was an objective in response to the concept having a history of practical interpretation and measurement ambiguity. A cost of this ambiguity is that the social licence concept can be used opportunistically to promote individual agendas. Adopting economic perspectives was identified as a way to consider and measure: (1) affected stakeholders' willingness to make trade-offs between objectives and costs and benefits; and (2) influences on affected stakeholders' decisions to grant/withhold a social licence. It was also an opportunity to analyse the interplay of institutions and incentives that promote certain decisions and subsequent social licence outcomes.

The research reported in this thesis crossed disciplinary boundaries and employed a range of qualitative and quantitative data analysis techniques. Further, this thesis reports two streams of research designed to achieve the overall aim of bringing greater clarity to the understanding and analysis of the social licence concept and outcomes.

The first stream of research focussed on drawing lessons from the existing social licence literature. A systematic literature review was used to detail the origins of the social licence concept and the current uses of the term. It was also used to draw connections between social licence and welfare economics. Separately, the review was used to identify case studies for the first-ever qualitative comparative analysis of conditions associated with different social licence outcomes in natural resource dependent industries. This was considered an important contribution because the social licence literature is fast growing (see Section 2.3.1), and efforts to systematically summarise or bring together research at different scales to make clear patterns or generate new insights, are relatively rare.

The second stream, informed by the outcomes of the first, used the agricultural and energy (including future fuels) industries in south-eastern Australia as case studies. Agriculture and energy (future fuels) were selected because: (1) both are dependent on natural resources and in some instances compete for access to resources; and (2) they provide contrasting examples of an established industry (agriculture) with an assumed social licence that is increasingly facing threats, and a transitioning industry (energy, including a transition to future fuels such as hydrogen) that is seeking a social licence to develop. The problems or concerns highlighted by social licence debates, e.g. uneven distribution of benefits and costs from resource use, are expected to continue to attract attention in the Australian agricultural industry, and through low carbon energy transition. The findings in this thesis therefore have important implications for the future framing and management of social licence across natural resource dependent industries.

This conclusion chapter provides a summary of the main findings reported in each analytical chapter (Chapters 2, 3, 5–7), where each chapter addressed one of the five research objectives specified in Section 1.4. Following this, the chapter details contributions of this research to the social licence and natural resource economics literatures, and implications for natural resource dependent firms, industries and policy-makers. The chapter concludes with suggestions for future research to better understand and manage social licence issues in natural resource dependent industries.

8.2. Summary of main findings

Chapter 2 addressed Objective 1 (repeated from Section 1.4): *Systematically review and synthesise the social licence literature to understand key research themes and how these relate to the foundations of welfare economics.*

Chapter 2 detailed the origins of the social licence concept and the current uses of the term as identified in a systematic literature review. The findings from the systematic literature review also formed the basis from which to detail links between the social licence concept and welfare economics. Across industries and sectors, the motivations for social licence concerns were identified as responses to market and government failures, namely: (1) negative externalities; (2) undersupply or threats to public goods; and (3) use of socially valuable assets to generate private profits. In addition, by drawing on ideas established in the welfare economics literature, it was suggested that the definition of social licence could be reinterpreted such that a firm or industry with a social licence is making positive contributions to the welfare of a community or society. Likewise, the understanding of social licence can be reoriented to be seen as a mechanism through which affected stakeholders try to highlight the externalities they experience, or importance of public goods, and demand firms and government decision-makers adjust externality and public good supply to the socially desirable level. It is argued that this contribution brings clarity to the understanding of drivers of social licence concerns.

Chapter 3 addressed Objective 2 (repeated from Section 1.4): *Identify whether the conditions that drive social licence outcomes differ across natural resource dependent industries and institutional settings.*

Chapter 3 describes the use of a fuzzy-set qualitative comparative analysis to identify associations between a set of ten conditions and social licence outcomes and firm behaviour change. The ten conditions tested were drawn from a growing set of literature that has attempted to measure the extent different conditions are associated with social licence outcomes for a specific project, activity, or industry. The analysis, using data from 47 published case studies across 25 countries, identified that no one condition alone was necessary or sufficient to produce particular social licence outcomes. This result highlights that social licence outcomes are complex and case-specific. However, across the natural resource dependent industries and contexts examined, a combination of five conditions created a robust pathway sufficient for a social licence, including: (1) delivery (or perception) of net economic benefits beyond the firm/project, i.e. to affected stakeholders; (2) adequate stakeholder consultation; (3) minimal media coverage; (4) minimal public protests; and/or (5) absence of well-defined and enforced private property rights. This research highlights that social licence outcomes are a product of: (1) conditions that are within the control of a firm/project manager; and (2) structural conditions, institutional arrangements, and social norms beyond the

operation of a firm/project. Further, this research showed that threats to, or withdrawal of a social licence is not always sufficient for firm behaviour or regulatory change, at least in the short-term.

Chapter 4 describes the approach taken to design and implement 22 semi-structured interviews and three surveys (a public online survey, n=2,032; a farmer phone survey, n=351; and an in-person and telephone survey of landholders with a high-pressure natural gas transmission pipeline easement, n=126) that serve as the data source for subsequent chapters. The chapter describes the target population, mode, timing and response rates of each of the surveys, and representativeness of the samples collected.

Chapter 5 addressed Objective 3 (repeated from Section 1.4): *Test the applicability of Thomson and Boutilier's (2011) hierarchical model of social licence for measuring the social licence of energy transmission infrastructure, particularly the social licence of a high-pressure natural gas transmission pipeline as decided by agricultural landholders sharing the landscape with the pipeline.*

Chapter 5 presents an analysis of the pipeline survey described in Chapter 4. The study used the Thomson and Boutilier (2011) hierarchical model and an exploratory factor analysis to measure the social licence of the main high-pressure natural gas transmission pipeline in south-eastern Australia. The results revealed that landholders coexisting with the high-pressure natural gas transmission pipeline were accepting of the pipeline. This research highlighted relationships between firms and the stakeholders they affect as a key factor in social licence outcomes for energy transmission infrastructure when local economic benefits are modest. This study could represent a starting point for: (1) the operators of the pipeline to track their social licence through time, and in response to specific management changes or external conditions; and (2) driving broader industry adoption of actual social licence measurement before claiming its existence.

Chapter 6 addressed Objective 4 (repeated from Section 1.4): *Conduct comparative analyses of public and farmers' concerns about issues that are reported as undermining or challenging the Australian agricultural industry's social licence and identify similarities and differences across stakeholder groups and issues.*

Using responses to the public and farmer surveys described in Chapter 4, **Chapter 6** presents an analysis of the concerns of both the public and farmers for a wide set of issues (e.g. animal welfare, chemical and fertiliser use) influencing the agricultural industry's social licence. The analysis revealed differences between the public and farmers' concerns, and heterogeneity in concerns held by stakeholders within these groups. A principal component analysis also revealed that the issues of concern aligned with the three key motives for social licence concerns as presented in Chapter 2, namely: (1) undersupply or threats to public goods; (2) negative externalities; and (3) the use of socially valuable assets for private profit. The public were generally more concerned than farmers about an undersupply or threats to public goods (e.g. animal welfare) and negative externalities from agricultural input use (e.g. chemicals, fertilisers and genetically modified crops). However, there was no difference in concern between the two stakeholder groups regarding the use of socially valuable assets for private profit. By identifying similarities and differences within and across stakeholder groups, as well

as the underlying drivers for concerns, it is argued that this research can be used as a basis for identifying priorities and theoretically-consistent responses to social licence concerns.

Chapter 7 addressed Objective 5 (repeated from Section 1.4): *Identify the trade-offs the public in south-eastern Australia may be willing to make in the transition to future fuels, namely, hydrogen energy.*

Chapter 7 presents an analysis of the relative importance that the public survey (described in Chapter 4) respondents assigned to six characteristics of a future hydrogen energy industry. Overall, safety was rated the most important characteristic, followed by climate change mitigation and affordability, reliability and then accessibility and job creation. This result shows that a hydrogen industry planned without sufficient attention paid to the provision of public goods (namely safety, and climate change mitigation) may jeopardise the industry's ability to gain a social licence. In general, respondents were not willing to trade-off safety to meet other objectives, or trade-off affordability for climate change mitigation to develop a sizable hydrogen industry. The different weighting across each of the six characteristics by various groups indicated that respondents' preferences and willingness to make trade-offs were heterogeneous. Fractional multinomial logit model estimates indicated that individuals were more likely to allocate importance to characteristics they are concerned about and expect to benefit from.

8.3. Key contributions

This thesis makes novel and practical contributions to the social licence and natural resource economics literatures, as well as a substantial contribution to the agricultural, energy and environmental literatures. While each analytical chapter details contributions to the literature, the six most critical contributions of this thesis are detailed below.

8.3.1. The importance of how a social licence is defined

This research emphasises the importance of how a social licence is defined. Detailed analyses highlighting the ambiguity of the social licence concept are not new (e.g. Brueckner and Eabrasu, 2018; Gehman et al., 2017; Parsons and Moffat, 2014a). But, by incorporating economic perspectives, this research highlights the importance of a key aspect of the definition of social licence—the ability of affected stakeholders to influence the profitability of firms. In the most general sense, firms or industries with a social licence have been described as those that have the ongoing acceptance or approval of affected stakeholders (typically local communities). However, a critical aspect of the definition—contributing to enduring relevance of the concept and the incentive for firms or industries to achieve a social licence—is that stakeholders positioned to grant or withhold a social licence are not only affected by the firm's activities, but are also in a position to affect the profitability of the firm (or capacity of the firm to meet other objectives). This second part is often excluded from the definition of social licence and the argument in this thesis is that such an exclusion is detrimental. Limiting the definition to acceptance or approval by affected stakeholders limits the pathways for exploring and understanding the impacts of decisions to grant/withhold or withdraw a social licence. As much of the early social licence research focused on the mining industry, the definitions adopted tended to focus on the impacts and benefits of mining for local communities.

However, as the use of the social licence concept has expanded to other industries and contexts, including communities of interest, as well as location, the power of affected stakeholders to affect the profitability or other objectives of firms or industries has become clearer (see Chapter 2). This research shows that the definition of firms/industries with an (intangible) social licence as those that enjoy ongoing acceptance or approval by stakeholders who are affected by the firm/industry, *and* who can affect the profitability of the firm/industry (or capacity to meet other objectives), holds across natural resource dependent industries and contexts.

8.3.2. Linking social licence and economic principles

This research draws links between the social licence concept and economic principles. The social licence literature offers examples where stakeholders were willing to trade-off environmental and social costs for access to employment opportunities and other benefits (Bastian et al., 2015; Mason et al., 2014; Richert et al., 2015). However, other cases provide evidence of stakeholders not making the same trade-offs (de Jong and Humphreys, 2016; Luke, 2017; Westoby and Lyons, 2016). These cost-benefit trade-offs made by affected stakeholders, indicate that social licence debates appear to arise in cases where the first theorem of welfare economics is violated, i.e., markets, alone, do not allocate resources to their most valued use and thus do not lead to efficient or socially desirable outcomes. Using this observation as a starting point, this thesis (especially Chapter 2), drew connections between ideas established in the welfare economics literature and prominent ideas in the social licence literature. This research suggests the definition of social licence can be reinterpreted to understand that a firm with a social licence is making positive contributions to the welfare of a community or society. Likewise, the understanding of social licence can be reoriented to be seen as a mechanism through which stakeholders try to highlight the externalities they experience, or importance of public goods, and demand firms and government decision-makers address these externalities and/or change public good supply to the socially desirable level. It is argued that this contribution brings more clarity to the understanding of the social licence concept and the drivers of social licence concerns.

8.3.3. Using econometric analyses to consider social licence decision-making

This thesis demonstrates the benefits of using econometric analyses to understand heterogeneity within groups of stakeholders positioned to try and grant or withhold a social licence. While the econometric techniques employed in this research are standard in the economics discipline, they bring about new insights in the context of social licence research. For example, the social licence literature has typically concentrated on the development of descriptive, qualitative and path models for social licence (Boutilier, 2020b; Lynch-Wood and Williamson, 2007; Moffat and Zhang, 2014; Prno, 2013; Prno and Slocombe, 2014). Previous research has also tended to take a representative sample of a population, or affected stakeholder group and conduct analyses on that group without exploring how differences in income, sources of information or knowledge, or other variables may influence decisions to grant or withhold a social licence (Jartti et al., 2020; Moffat and Zhang, 2014; Richert et al., 2015; Zhang et al., 2018). This thesis adds to the social licence literature by examining a wide range of potentially influential variables on different stakeholders' concerns about issues in

the agricultural industry, and willingness to support a transition to hydrogen energy in Australia. Understanding how social licence concerns or public acceptance changes with respect to different socioeconomic or other conditions can be used to establish priorities for tackling social licence issues. Further, econometric methods also enabled study of the relative intensity of preferences. Where much existing social licence research elicits perceptions or concerns about issues or trade-offs between impacts and benefits associated with a firm or industry's activities, this research explicitly explored the extent to which individuals were willing to make trade-offs between characteristics of a future hydrogen industry (Chapter 7). This research therefore provides more detail about the impact-benefit trade-offs that underpin different stakeholders' decisions to try and grant or withhold a social licence.

8.3.4. Conditions influencing social licence and firm behaviour

While social licence has been framed as a risk management issue for firms (e.g. Falck, 2016), this research has highlighted that conditions within and beyond the control of firms contribute to social licence outcomes (see Chapter 3). More specifically, firms can make changes to their strategies to consult and engage with stakeholders that may be affected by their activities with the aim to improve the likelihood of gaining or maintaining a social licence. At the same time, institutional and governance arrangements that allocate and enforce property rights can be influential in social licence outcomes, as can the regulations that require consultation and compensation to affected stakeholders. This finding adds weight to the emerging argument that social licence operates and regulates firm behaviour at the intersection of markets and governments (Vince and Haward, 2017). However, the same research also indicated that threats to, or withdrawal of, a social licence is not always sufficient to catalyse firm behaviour or regulatory change (see Section 3.4). These results have implications for industry conceptualisation of the concept of social licence and for future research, as discussed later in Section 8.4.

8.3.5. Contextualising tools to measure social licence

Research reported in Chapter 5 of this thesis shows the Thomson and Boutilier (2011) four-level hierarchical model of social licence (based on legitimacy, credibility and trust) is context specific and may not always hold. In measuring the social licence of a high-pressure natural gas transmission pipeline only two levels of social licence were identified, a result also obtained by Richert et al. (2015). While methods to measure social licence remain rare, the hierarchical model of social licence and survey approaches used to measure it are important (Boutilier and Thomson, 2011; Boutilier, 2017; Richert et al., 2015). However, as the use and application of the social licence concept grows beyond the mining industry (where most models and tools to measure social licence were developed) and other natural resource dependent industries seek to transfer methods to measure a social licence, attention must be paid to the applicability of social licence models to other contexts. This research has shown that economic legitimacy, though hypothesised to be the first step toward and necessary for a social licence in the Thomson and Boutilier (2011) model, may not be the most critical factor in determining a social licence for energy transmission infrastructure, especially when local economic benefits are modest. Therefore, this research suggests modifications to the model may be required if there is demand for a structured approach to measuring a social licence across diverse industry contexts. The need to adapt tools and guidelines to local communities, circumstances and political dynamics has been acknowledged (Prno and Slocombe, 2014;

Thomson and Boutilier, 2011). Changes to the model for the context explored in this study, may include a greater focus on compensation as a way to gauge economic legitimacy as well as more specific questions regarding how and with whom, firms share decision-making.

8.3.6. Insights for the agricultural and energy (future fuels) industries

By collecting primary data on issues attracting social licence attention in the Australian agricultural and energy (future fuels) industries, this research makes practical contributions to those employed in these industries, and affected by these industries. This is especially significant because information and methods to approach social licence issues and improve community-industry relations are a high priority for research and leadership in both industries (Clarke et al., 2021; Lockie, 2015). This thesis provides evidence of the motivations or concerns underpinning the social licence status of these industries, and explores the role of stakeholders in one natural resource dependent industry (agriculture) in granting or withholding a social licence from another (energy; see Chapter 5). Further, this research also directly compares the concerns and perspectives of firm and industry decision-makers (in this case, farmers) and the public on issues underpinning the agricultural industry's social licence (Chapter 6). This is relatively novel as much of the research concerning a social licence to-date has concentrated on the views and concerns of the public or consumers only. Information garnered from direct comparisons between the concerns of different stakeholder groups can be used to inform priorities for industries seeking to invest in a social licence.

8.4. Implications

This research has improved understanding of the social licence concept, and described a number of conditions associated with social licence outcomes. These findings have implications for how social licence is understood and framed by affected industries and stakeholders, and implications for policy and industry-government relations.

8.4.1. Implications for firms and industries

A key implication of this research for firms and industries is the need to recognise that social licence outcomes are a product of both: (1) conditions that are within the control of a firm; and (2) structural conditions and social norms beyond the operation of a firm. The research in this thesis also shows that the most likely pathway to achieve a social licence can differ across contexts. Economic legitimacy, though often framed as the first step to a social licence (Thomson and Boutilier, 2011) may not be the most critical element of a social licence in every case. As shown in Chapter 5, other factors, e.g. relationships between firms and the stakeholders they affect, may be more influential in social licence outcomes when economic benefits to affected stakeholders are modest. Likewise, firms and industries must be aware that social licence outcomes vary with socioeconomic and political (dis)advantage and as such different stakeholders will be willing and able to make different trade-offs, e.g. between environmental and economic objectives, in the decision to grant or withhold/withdraw a social licence. These findings have ramifications for research and industry decisions to continue to frame social licence as a risk management issue for firms, and not adequately account for the role of institutional and governance arrangements in social licence outcomes.

8.4.2. Implications for affected stakeholders

While there have been a number of attempts to model the drivers of stakeholder decisions to grant/withhold a social licence (e.g. Moffat and Zhang, 2014), such studies do not produce information or strategies that affected stakeholders can exploit to obtain the social licence outcome they seek. Affected stakeholders engaged in efforts to mediate firm behaviour, will benefit from understanding that several conditions and actors have influence over social licence outcomes. Likewise, this research (especially that reported in Chapter 3) shows that affected stakeholders will benefit from understanding that withholding or withdrawing a social licence may be necessary but insufficient to encourage firm behaviour change to meet social demands or expectations, at least in the short-term. Understanding local conditions or industry-specific opportunities to change management to reflect social expectations may help affected stakeholders to understand the potential lag or gap between social licence and firm behaviour or regulatory change.

8.4.3. Implications for hydrogen industry development in Australia

The research exploring public willingness to support the development of a hydrogen industry in Australia (Chapter 7) is a cautionary tale for the industry and government. Development of a hydrogen industry in Australia, though in the early stages, is proceeding with investment and support from private firms and the government. However, there has been limited research into public acceptance and the potential trade-offs that may need to be made to satisfy public expectations. The research presented in Chapter 7 shows that exploring public attitudes or expectations in the early stages of industry development is an opportunity. The identification of public concerns at an early stage of development can help firms, industries, and governments to avoid path dependency and lock-in to a policy or technology that is revealed to lack acceptance from affected stakeholders. While in this example the research did not show any signs of widespread concern toward hydrogen, the importance weightings across each of the six characteristics of the industry examined, and different weightings made by various groups, indicated that policies prioritising one characteristic (e.g. affordability) over another (e.g. climate change mitigation) is likely to be detrimental to efforts to obtain public support for industry development. The results, especially related to the importance of job creation in a future hydrogen industry, also show that managing the economic transition and employment in areas likely to be most affected by the transition will be important (a result also found by others studying the potential impacts of the low carbon energy transition, e.g. Fleming-Muñoz et al., 2020).

8.4.4. Implications for the Australian agriculture industry

This research also has implications for the Australian agricultural industry. The research reported in this thesis (especially Chapter 6) shows that public and farmers' concerns about agriculture's social licence are not homogenous, rather multidimensional, and different on most issues. The current emphasis on consumer and public views of agriculture in the literature, without aligning them to farmers' views, or willingness or capacity to change practices is detrimental to the industry's ability to identify and target priority areas to align community and industry interests. Likewise, this thesis shows that any policies developed to manage social licence outcomes in the agricultural industry must recognise diversity in

attitudes and power to express these attitudes (e.g. by high income groups) across and within stakeholder groups. The implication? Government and industry policies designed to manage social licence outcomes will need to be flexible to account for the diverse interests of different stakeholder groups, and the power of different groups to lobby for particular outcomes and/or capture regulatory processes. Persuasive or voluntary market and economic incentives to reduce the social and environmental costs associated with agricultural management practices or activities could be adopted to serve this purpose (Witt et al., 2009). At the same time, such market and economic incentives have been shown to be effective responses to the underlying drivers of social licence issues, i.e. negative externalities and the undersupply of public goods, in some cases (Pannell, 2008). While the most efficient and effective policy response to social licence issues may vary across issues, industries and contexts, this research indicates a response will be necessary. This thesis is therefore in agreement with Martin and Williams (2011) point that any choice by the agricultural industry to opt for a largely defensive approach to public questions about the industry's social licence status will leave issues, highlighted by social licence debates, unsolved. For example, calls to reduce greenhouse gas emissions, restrict the use of technologies or inputs, and improve animal welfare outcomes will likely continue unabated and with potential ramifications for farmers' market access.

8.5. Limitations and future research

This research has contributed to a better understanding of the social licence concept and associated impacts in natural resource dependent industries. However, this research is best viewed as a starting point on a path toward greater inter- and multidisciplinary social licence research and management. This section outlines some overarching limitations of the research presented in this thesis and suggests potential strategies to address these limitations in future research. More specific limitations of the data and analyses employed in this thesis are discussed where relevant in each analytical chapter. Further extensions to this research are also suggested in Section 8.5.1.

One of the key limitations of the research reported in this thesis is that it presents a snapshot in time. The social licence literature highlights that having a social licence (or acceptance) one day, is no guarantee of ongoing acceptance. Indeed, public attitudes and perceptions change through time, or, can change in response to a particular event. The case studies analysed in Chapter 3 also highlight the delay that can exist between social licence questions being raised and eventual change in management practices or perhaps eventual regulatory reform. Firms are also thought to respond differently to social licence debates when conflicts arise at different stages in a project or development (Franks et al., 2014). For these reasons, future research that follows the evolution of public attitudes and perceptions as well as firm or industry management practices through time would make a particularly valuable contribution to our understanding of social licence. Additionally, there is emerging interest in whether a social licence is recoverable following a particular event or sustained threats of withdrawal. Research that explores how natural resource dependent firms or industries can recover a social licence, plus whether and how social licence considerations can be built into business models (De Giacomo and Bleischwitz, 2020) is of broad interest.

All results and conclusions drawn in this thesis reflect the data sources available. It is recognised that this is not necessarily comprehensive, particularly in the case of Chapter 2

and Chapter 3 for which documents analysed were limited to those published in English. Additionally, this research, and the social licence research generally, does not capture information from cases that are politically and/or commercially sensitive, at least not in a timely fashion. If calls for greater transparency in the extractive industries are realised (Bleischwitz, 2014), or there is deeper industry engagement or commitment from industry to tackle social licence issues (like SEA Gas demonstrated in Chapter 5) there be opportunities for future research to explore how more firms understand their social licence. There may also be opportunities to understand how firms share information with affected stakeholders, and/or tailor their management decisions to be sensitive to public perceptions or social licence questions.

The results and conclusions drawn from the regression-based analyses in Chapter 6 and Chapter 7 are largely based on associations rather than causation. Given much of the research in Chapters 5–7 is exploratory, the focus on associations was considered a necessary first step. A logical next step would be to extend this to examine causal relationships. Opportunities also exist for replication studies that adopt the survey questions used in this thesis for use in different industries (e.g. intensive agricultural production industries), market contexts, or locations.

8.5.1. Extended future research

Given natural resource industries (in particular) face increasing pressure to change practices to gain or maintain a social licence, there is a need to better understand the influence of this pressure on firm and government decision-making, and associated consequences for social welfare. For example, at what point do the costs associated with poor social licence outcomes inhibit firms from continuing with business-as-usual behaviour? Do firms voluntarily change behaviour to minimise or avoid the costs that social licence debates impose on them? What are the key decision criteria informing this decision? Is it rational for firms to change their management or practices to meet social expectations, and chase a social licence? Or, is it rational to invest in public education and persuasion to accept current practices, and/or wait for regulatory change and compensation before changing practices?

To address these questions, future social licence research could incorporate methods typically used by economists, such as cost-benefit analysis (with careful considerations of appropriate discounting of future benefits and costs expected from any decision and extensive sensitivity analysis), or constrained welfare maximisation (Randall, 1975). These methods can also be integrated with non-market valuation techniques to capture the costs and benefits experienced outside of the market system, such as externalities. Without diminishing the value of site-specific negotiations of a social licence and potential compensation, this thesis provides a framework for arguing that there is value in introducing structured economic-based methods to identify the quantifiable and non-quantifiable costs and benefits of different firm/industry management and social licence outcomes. Behavioural economics research could also become increasingly important in social licence research as it can be used to understand the influences on stakeholders' decisions to grant/withhold a social licence when in possession of incomplete cost and benefit information. It can also help to elicit the heterogeneity of perspectives within affected communities. Further, from the firm perspective, behavioural economics approaches could be used to understand the management decisions that may be

induced by the introduction of regulatory changes or disincentives for activities or behaviours that affect the firm's social licence status.

Given affected stakeholders are positioned to grant or withhold/withdraw a social licence based on their perceptions of a firm or industry's activities, how they construct their perceptions or access information about such activities is critical to social licence outcomes. Important research has related social licence decisions to the principle of Free, Prior and Informed Consent, and Impact and Benefits Agreements (Hanna and Vanclay, 2013). Additionally, industry-community consultation processes and legal requirements for consultation have attracted considerable attention in the social licence literature. These processes have been found to be important in this research e.g. consultation was an important condition for maintaining a social licence (Chapter 3), and interactional legitimacy was a critical driver of landholders' high acceptance level of social licence for a high-pressure natural gas transmission pipeline (Chapter 5). However, a key assumption in research concerned with information provision is that barriers associated with imperfect information, or information asymmetry can be overcome with the provision of (more/different) information. However, this often does not account for information biases, the agendas of information providers, or the idea that it is often economically rational for the affected stakeholders to be imperfectly informed (Swinnen et al., 2005). Building on the ideas in the preceding paragraph, future social licence research could benefit from exploring the organisation of, and supply of information to affected stakeholders that are positioned to grant or withhold a social licence. Future research could also examine the extent that industry or firm efforts to improve information provision to affected stakeholders is a strategy to delay structural change that addresses the underlying issues driving social licence concerns, namely: the production of negative externalities, undersupply or threats to public goods, or use of socially valuable assets for private profit.

8.6. Concluding remarks

This thesis has contributed further clarity to the understanding and analysis of the social licence concept and social licence outcomes using perspectives from the economics discipline. Consequently, this thesis has advanced theoretical and applied understanding of the social licence concept and how it operates in natural resource dependent industries. The research shows that social licence is a fast-growing concept that has also evolved over its 25-year history and will likely continue to do so. It is hoped that the ideas explored and knowledge produced in this thesis will endure, and inspire further interdisciplinary research to identify and develop solutions to the many challenges that are highlighted by social licence debates in natural resource dependent industries.

Appendix 1. Information recorded in systematic review

Table A1.1. Information recorded for each document captured in the systematic literature review to enable filtering and exclusion as well as analysis.

Item	Description
<i>Bibliographic information</i>	
Year	Record the year the document was published.
Document type	Record the document type, e.g. journal article, conference paper, review, book review, etc. as classified by searched databases (and corrected if the document was clearly described differently in the main text by the authors).
Source title	Where applicable record the book/journal the chapter/article was published in. Note when part of a special issue on social licence or closely related topic.
Document title	Record title of the document.
Database	Recorded the database from which the document record was extracted (one of the three databases searched), i.e. one of Web of Science Core Collection, Scopus or Google Scholar.
Author information	Record number of authors, the affiliation and disciplinary expertise and location (country) of author if redeemable from the affiliation listed for each author on the document
Author keywords or KeyWords Plus®	Record author keywords. If not available, KeyWords Plus® were recorded.
Citations	Record number of citations listed by the database searched at the time of data extraction.
<i>Study characteristics</i>	
Geography	Record location (country or region) of data collection or case study. More than one could be recorded.
Industry application	Record industry and/or business activity of focus. More than one could be recorded.
Perspectives analysed	Record stakeholders' perspectives or experiences included/excluded from analysis.
Theoretical framework	Record theoretical framework or framing of social licence used in the document.
Methodology	Record methodology and data collected/analysed.
<i>Results/Conclusions of studies</i>	
Social licence status	If the document commented on the social licence status of a case study, that was recorded.
Drivers of social licence concerns	Record reported sources of stakeholder or community resistance or acceptance of business or industry activities.
Responses to social licence concern	Record reported strategies to consult with or respond to community resistance or demands.
<i>Limitations of studies</i>	
Limitations/biases	Record limitations of studies as well as potential sources of bias (including author conflicts of interest e.g. those employed by companies facing or responding to social licence pressure).

Appendix 2. Case study and supplementary information for Chapter 3

Table A2.1. Case studies included in analysis.

No.	Location and or development name	Industry/issue	Social licence status	Documents identified in systematic review
1	Bajo De La Alumbraera, Argentina	Mining (minerals)	Gained then lost	Zamprile and Llorente (2009)
2	Murray-Darling Basin, Australia	Agriculture (re-negotiation of water rights)	Threatened	Baldwin (2011); Christen et al. (2011); Clifton and Afeworki (2014); Hall (2015); Martin and Shepherd (2011); Shepherd and Martin (2008)
3	New South Wales, Australia	Mining (coal seam gas)	Threatened	Bartley et al. (2017); Curran (2015, 2017); Lai et al. (2017); Liss and Murphy (2014); Luke (2016, 2017); Luke and Evensen (2018); Luke et al. (2018a,b); Marcos-Martinez et al. (2019); Snashall and Genter (2017); Turton (2015)
4	New South Wales and Queensland, Australia	Agriculture (cotton cropping)	Threatened	Roth (2011)
5	Queensland, Australia	Mining (coal seam gas)	Threatened	Bartley et al. (2017); Curran (2015); Everingham et al. (2014); Liss and Murphy (2014); Luke and Evensen (2018); Luke et al. (2018b); Luke and Emmanouil (2019); Paragreen and Woodley (2013); Parsons and Moffat (2014b); Rifkin et al. (2015); Towler et al. (2016); Turton (2015); Witt et al. (2018)
6	Tasmania, Australia	Aquaculture	Threatened	Cullen-Knox et al. (2017b, 2019); Fleming et al. (2017); Leith et al. (2014); Murphy-Gregory (2018); Vince and Haward (2017, 2019)
7	Bangladesh	Agriculture (genetically modified crops – Bt Brinjal)	Gained	Roy (2018)

Table A2.1. Case studies included in analysis (continued).

No.	Location and or development name	Industry/issue	Social licence status	Documents identified in systematic review
8	Phulbari coal mine, Bangladesh	Mining (coal)	Lost	Faruque (2018)
9	Bento Rodrigues, Brazil	Samreco Fundão tailings dam collapse	Lost	Demajorovic et al. (2019)
10	Canaã dos Carajás, Brazil	Mining (iron ore)	Gained	Matlaba et al. (2017)
11	Alberta and British Columbia, Canada	Infrastructure (gas pipeline)	Never obtained	Bunnell (2013); De Jong (2015); Forrester et al. (2015); Gunster and Neubauer (2019); McGaurr and Lester (2017); Wood and Thistlethwaite (2018)
12	Canada	Wildlife harvesting (seals)	Threatened	Hampton and Teh-White (2019)
13	Manitoba, Canada	Renewable energy (hydropower)	Threatened	Dipple (2015)
14	Pictou County, Nova Scotia, Canada	Pulp mill	Threatened	Hoffman et al. (2015)
15	El Morro, Colombia	Mining (oil)	Gained	Silva (2018)
16	Kittilä, Finland	Mining (gold)	Gained	Heikkinen et al. (2016); Koivurova et al. (2015); Lesser et al. (2017)
17	France	Mining (unconventional oil and gas)	Lost	Chailleux et al. (2018)
18	Svaneti region, Georgia	Renewable energy (hydropower)	Lost	Jijelava and Vanclay (2018)
19	Birim North District, Ghana	Mining (gold)	Gained	Andrews (2019); Ofori and Ofori (2019)
20	San Juan Sacatepéquez, Guatemala	Mineral quarry and processing plant for cement production	Gained	Costanza (2016)
21	Bangka Island, Indonesia	Mining (tin)	Never obtained	Rosyida and Sasaoka (2018); Rosyida et al. (2018)
22	Malaysia	Rare Earth Elements Processing	Threatened	Jamaludin and Lahiri-Dutt (2017)
23	Urk, The Netherlands	Renewable energy (offshore wind farm)	Threatened	Langbroek and Vanclay (2012)
24	Groningen gas field, The Netherlands	Mining (unconventional oil and gas)	Threatened	van der Voort and Vanclay (2015)
25	Niger Delta, Nigeria	Mining (oil and gas)	Threatened	Idemudia (2007); Ite (2004, 2007); Musa et al. (2013); Zalik (2004)

Table A2.1. Case studies included in analysis (continued).

No.	Location and or development name	Industry/issue	Social licence status	Documents identified in systematic review
26	Kautokeino, Northern Norway	Mining (gold and copper)	Threatened	Espiritu (2015); Koivurova et al. (2015)
27	Kvalsund, Northern Norway	Mining (copper)	Gained	Espiritu (2015); Koivurova et al. (2015)
28	Bagua tragedy, Peru	Natural resource exploitation in the Amazon	Lost	de Jong and Humphreys (2016)
29	Cajamarca district, Peru	Mining (copper, gold and silver)	Gained	Zamprile and Llorente (2009)
30	Espinar Province, Peru	Mining (copper)	Threatened	Rangan and Barton (2010); Saenz (2018, 2019)
31	Minas Conga, Peru	Mining (gold and copper)	Lost	Morales et al. (2018); Pike (2012)
32	Puno Province, Peru	Mining (silver)	Threatened	Paine (2018); Saenz (2018)
33	Tambogrande, Piura Province, Peru	Mining (copper, gold and zinc)	Never obtained	Hitch et al. (2018)
34	Rosia Montana Gold, Romania	Mining (gold)	Never obtained	Bortun and Crisan (2012)
35	Mumsarak, Russia	Phosphorous fertiliser manufacturing (and associated infrastructure)	Threatened	Koivurova et al. (2015); Nysten-Haarala et al. (2015); Riabova and Didyk (2014)
36	Mumsarak, Russia	Mining (phosphorous)	Gained	Koivurova et al. (2015); Nysten-Haarala et al. (2015); Riabova and Didyk (2014)
37	Jagersfontein mines, South Africa	Mining (diamonds)	Threatened	Matebesi and Marais (2018)
38	Kumba Iron Ore, South Africa	Mining (iron ore)	Threatened	Tarras-Wahlberg et al. (2017); Taylor and Mahlangu (2017); Thulo (2015)
39	Xolobeni Mineral Sands Project, South Africa	Mining (mineral sands)	Lost	Gqada (2011)
40	Barcelona, Spain	Infrastructure (railway extension)	Threatened	Mele and Armengou (2016)
41	Svappavaara, Sweden	Mining (iron ore)	Gained	Koivurova et al. (2015); Nysten-Haarala et al. (2015); Ranangen and Lindman (2018); Tarras-Wahlberg et al. (2017)
42	Bulyanhulu mine, Tanzania	Mining (gold)	Threatened	Kessy et al. (2017); Mundeve (2016)

Table A2.1. Case studies included in analysis (continued).

No.	Location and or development name	Industry/issue	Social licence status	Documents identified in systematic review
43	Buzwagi mine, Tanzania	Mining (gold)	Gained	Goldstuck and Hughes (2010); Kessy et al. (2017); Mundeve (2016)
44	North Mara mine, Tanzania	Mining (gold)	Threatened	Goldstuck and Hughes (2010); Newenham-Kahindi (2011); Pike (2012)
45	Uganda	Plantation forestry	Threatened	Westoby and Lyons (2016)
46	Lancashire, United Kingdom	Mining (shale gas)	Threatened	Bradshaw and Waite (2017); Bradshaw (2017); Whitton et al. (2017)
47	Fray Bentos, Uruguay (border with Argentina)	Pulp mill	Threatened	Kaakinen and Lehtinen (2016)

Note: To score each condition and outcome, additional information about case studies was obtained from the (English language) peer-reviewed literature and the publicly available grey literature.

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies.

Condition	Calibrated score and definition	Sample of coded data
<i>Economic benefit</i>	0 Affected stakeholders stand to gain little (economically) from project/firm activity	“From this perspective, the economic benefits of the windfarm will likely be minimal for Urk, because it has a population of only 18,000, has fishery as its only major industry, and is surrounded by many bigger centres within easy commuting distance. The number of local construction and operations jobs created by a wind installation depends to some extent on the skills available in the local community.” (Langbroek and Vanclay, 2012, p. 175)
	0.33 Affected stakeholders can benefit (economically) from project/firm activity, but gains do not outweigh costs	“... the proposed neoliberal modernization of the Amazon was not successfully justified in terms of beliefs shared by dominant and subordinate groups. While the administration sought to do this by constructing a narrative that economic benefits would flow to the Amazon, this narrative was rejected by the people who would be affected.” (de Jong and Humphreys, 2016, p. 560) “The policies may also be seen as lacking moral legitimacy: they would have undermined local cultures, lifestyles and customs and ran counter to beliefs on traditional rights over territory and self-determination. The maintenance of these rights was valued more highly by the protestors than the economic gains and development model that were promised by the administration.” (p. 561)
	0.67 Affected stakeholders can benefit from project/firm activity, i.e. benefits outweigh (or perceived to) the costs, at least in the short to medium term	“The spatial regression analysis indicates that, everything else constant, regions with CSG activity had 6.4% ($\pm 5.7\%$, 95% confidence interval, C.I.) higher family income than regions in the population density based control group.” (Marcos-Martinez et al., 2019, p. 341)
	1 Project/firm activity is crucial for economic development for local community and/or other stakeholders	“The company continued to expand its activities in the municipality, contributing to Mariana's growing dependence on the mining activity, as recognized by the Samarco representative interviewed... The excessive economic dependence of the municipality and the non-resumption of the company's activities raised the unemployment rate in Mariana in 2016 to 25%.” (Demajorovic et al., 2019, p. 279)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data
<i>Compensation</i>	0	No compensation (directly or indirectly) was given to affected stakeholders
		<p>“For example, Hon. Nte Adasi Christopher, a resident of Emereoke 1, asserted that: Shell lived with us here as neighbours for over 20 years, but there was no employment of people of Emereoke 1, no social infrastructure was provided for us, yet we continue to suffer the negative effect of oil spill and gas flaring till today.” (Idemudia, 2007, pp. 377-378).</p> <p>“Respondents in Inua Eyet Ikot and Emereoke 1 were particularly unhappy that while there have been over five oil spills off the coast of their communities with negative environmental and socioeconomic impact on the communities, Exxon Mobil has never paid compensation to the people.” (p. 378)</p>
	0.33	Compensation given to affected stakeholders was perceived to be insufficient
		<p>“The prominent reasons for disagreement with SD operations include compensation and royalty amounts not balanced with the economic losses they sustained (35%) and 26% showed concern about not receiving benefits once SD operations cease. Some villagers (21%) disagreed because the compensation and royalties received were low compared to the quantity of tin extracted.” (Rosyida et al., 2018, pp. 168)</p>
	0.67	Compensation given to affected stakeholders perceived to be mostly sufficient
		<p>“LKAB has agreed to terms ... on compensation for the move and/or replacement of properties and services. ... In 2014, LKAB spent a total of US\$400 million ... on relocation and compensation, and in total the amount set aside for such purposes was US\$1.4 billion...In cases where relocation is required, this is based on the Law on Expropriation (1972), which at present means that compensation is made at 125% of the market value.” (Tarras-Wahlberg et al., 2017, p. 654) “According to LKAB, the compensation package offered was above the legal requirements, and it was also said that care was taken to ensure that everyone received identical and fair terms.” (p. 657)</p>
	1	Sufficient compensation was negotiated with and granted to benefit the most affected stakeholders
		<p>“By lending labor within and beyond corporate facilities to projects of extraction, and by doing something similar with land, communities can elevate their importance to the industry. That mutual dependence obviously leaves companies with a degree of power, but also gives communities and local governments a great deal of leverage when negotiating the terms of the presence of an extractive project.” (Silva, 2018, p. 146)</p>

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data	
<i>Consultation</i>	0	Firm reported only what was required by law, or shared communications to convince affected stakeholders of merits of project/activity	“During its community consultation process in early 2005, AEC vaguely informed local communities that it would build an open pit coal mine if it received government approval. Without knowing much about the project, the local communities were initially supportive. They participated in AEC’s social surveys, but they slowly became concerned with the project. They ... were unconvinced by the narratives assuring them the coal mine would bring benefits...” (Faruque, 2018, p. 179)
	0.33	Firm only consulted affected stakeholders on ad-hoc basis in response to issues/conflict with project/activity	“This alternative interpretation of the CD approach is due to the fact that consultation with communities under community development was still largely ad hoc and limited to philanthropic issues as opposed to genuine engagement that focussed on stakeholder relationships.” (Idemudia, 2009, p. 107)
	0.67	Firm shared information about project/activity relevant to affected stakeholders but did not actively incorporate feedback	“There is ongoing consultation with local and district municipalities to support Integrated Development Plans.” (Thulo, 2015, p. 47) “A large number of community members indicated that they welcome and appreciate programmes and projects initiated by the Sishen Mine, however, they also indicated that contrary to what the mine says, they were not consulted about what their needs consist of.” (p. 72)
	1	Firm openly shared information about project/activity relevant to affected stakeholders and adopted feedback	“Company formed a ‘resource group’ of interested people to discuss concerns raised during the scoping plan phase for the land use plan and EIA... Emphasizes significant involvement of the community by running the company within the region, setting up feedback systems to foster understanding and communication and providing local employment opportunities. CEO also very active in meeting with communities and other stakeholders.” (Koivurova et al., 2015, p. 200)
<i>Cultural impacts</i> (combined with <i>Health impacts</i> to create <i>Social impacts</i> condition)	0	Project/firm activity will have/has minimal to no impact on daily life and valued assets/activities for affected stakeholders	“Complaints to the Environment Protection Authorities (EPA) are a good indicator of the absence of strong community dissatisfaction in relation to industry performance. ... Fewer complaints lead to greater social harmony in the community, which in turn leads to less threats to the farmers’ social licence to operate.” (Roth, 2011, p. 76)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data	
<i>Cultural impacts</i> (combined with <i>Health impacts</i> to create <i>Social impacts</i> condition)	0.33	Project/firm activity will have/has some impact on daily life and valued assets/activities for affected stakeholders	“Yet in Gualeguaychú the fight against Botnia left no room for optimism. The pulp mill cast a dark shadow over the town and its inhabitants' future scenarios seemed gloomy. For the local community, Botnia entailed visual pollution, loss of tourism, devaluation of real estate and outmigration, at best; while contamination and conflict, intoxication, sickness and death were the bleakest prospects.” (Kaakinen and Lehtinen, 2016, p. 109)
	0.67	Project/firm activity will have/has impact on self-identification and place attachment for affected stakeholders	“The most frequently stated reasons for opposing fracking related to pollution. Residents were concerned about: air pollution caused by flaring of methane and increased industrial traffic; water pollution from flowback fluid from drilling and hydraulic fracturing operations; the possibility of groundwater contamination; and light and noise pollution from industrial activity... It was these local issues that compounded the public's fear for the loss of the peace, tranquillity and the idyllic nature of the affected area of the Fylde coast.” (Bradshaw and Waite, 2017, p. 33)
	1	Project/firm activity will have/has substantial impact on self-identification and place attachment for affected stakeholders (e.g. forced displacement/resettlement)	“During the 1980s, the Soviet government built a new settlement (which was also called Khaishi) in southern Georgia (about 500 kms away) and started to resettle people out of Khaishi. When the Soviet Union collapsed in 1991, about 80 of the 200 households in Khaishi had been moved... The 80 households who had been resettled found it difficult to remain in the new village, since promised infrastructure had not been completed and essential services were lacking. Some 50 households returned to their original houses in Khaishi. Many just abandoned the houses provided to them by the Soviet government, although a few managed to sell the houses for small amounts mostly to Internally Displaced Persons who had fled the Abkhazia war.” (Jijelava and Vanclay, 2018, p. 35)
<i>Health impacts</i> (combined with <i>Cultural impacts</i> to create <i>Social impacts</i> condition)	0	Health/safety impacts of project/firm activity not perceived to be an issue for affected stakeholders	“... Agnico Eagle's ... safety, health, environment and sustainable development ... committee which assists their board in monitoring risk, ensuring the company's compliance with legal and regulatory requirements and supporting the adoption of best practices to promote a healthy and safe work environment as well as environmentally sound and socially responsible resource development” (Koivurova et al., 2015, p. 208)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data	
<i>Health impacts</i> (combined with <i>Cultural impacts</i> to create <i>Social impacts</i> condition)	0.33	Health/safety impacts of project/firm activity are or perceived to be minimal to moderate for affected stakeholders	“Although the windfarm is unlikely to directly affect the actual health of the Urk population, it potentially will affect their perceived health to a considerable extent. The social impacts described above are likely to also be experienced as reduced mental and physical well-being. In theory, an individual’s perception of a windfarm leads to a (negative or positive) social change in perceived health due to the disturbing or potentially calming effect to the individual of the windfarm.” (Langbroek and Vanclay, 2012, p. 175)
	0.67	Health/safety impacts of project/firm activity are or perceived to be considerable for affected stakeholders	“More than half the respondents (58%) perceive the Lynas plant to be dangerous (one-quarter believe it will cause severe health effects such as cancer, and almost one-fifth believe it will cause less-serious health effects such as headaches or respiratory disorders)... Waste management is one of the issues of greatest concern the public has raised since establishment of the plant... Lynas’ proposed solution to treat its chemical wastes seems unrealistic to locals, who suspect that the company will dispose of wastes in common practice: that is, discharging it into local rivers, surreptitiously burying it at unmarked sites, or leaving it untreated in mountains of tailings where it will leach into surrounding aquifers.” (Jamaludin and Lahiri-Dutt, 2017, p. 270)
	1	Health/safety impacts of project/firm activity are or perceived to be of significant concern for affected stakeholders	“The interviews reveal that the safety of the dam complex had always been a concern to the residents of Bento Rodrigues, due to its proximity to the dam. According to residents’ reports, confirmed in an interview with the company’s spokesman, the issue was often discussed with company officials on their visits to the community.” (Demajorovic et al., 2019, p. 278)
<i>Environmental impacts</i> (combined with <i>Familiarity of resource use</i> to create <i>Environmental change</i> condition)	0	Environmental impacts of project/firm activity not perceived to be an issue	“... carried out a technical analysis of the tunnel project and the works on completion, and of their influence on the <i>Sagrada Familia</i> . Their report stated that ground deformation levels due to the activity of the tunnelling machine were measured at 2.5 times less than the permissible limit. Their report also considered the vibrations and oscillations of groundwater levels as potential sources of damage to the structure of the church, but these effects are rated as negligible.” (Mele and Armengou, 2016, p. 740)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data
<i>Environmental impacts</i> (combined with <i>Familiarity of resource use</i> to create <i>Environmental change</i> condition)	0.33 Environmental impacts of project/firm activity are or perceived to be minimal to moderate	“They describe the objective of their project as ‘contributing to mitigating climate change ... to sustainable environmental management, community development and poverty alleviation in Uganda’ ... “(Westoby and Lyons, 2016, p. 267) “Yet while many of the government representatives ... described license agreements ... as delivering environmental and social benefits at the local scale – for example, reforestation, increased tree cover and habitat, as well as creating some local employment – many NGO representatives, along with some government staff, lamented such arrangements also created new mechanisms that exacerbated environmental and social problems...” (p. 269)
	0.67 Environmental impacts of project/firm activity are or perceived to be considerable	“The most frequently stated reasons for opposing fracking related to pollution. Residents were concerned about: air pollution caused by flaring of methane and increased industrial traffic; water pollution from flowback fluid from drilling and hydraulic fracturing operations; the possibility of groundwater contamination; and light and noise pollution from industrial activity.” (Bradshaw and Waite, 2017, p. 33)
	1 Environmental impacts of project/firm activity are or perceived to be of significant concern	“After several accidents – spills from the long pipeline – community pressures grew persistently; meanwhile, <i>Alumbrera</i> ’s management produced, every two years, several Environmental Impact Reports (EIRs) without acknowledging them. In an accident provoked, on September 17 2004, by an earthquake – 6.5 on the Richter scale – concentrated minerals spilled in Villa Vil river which provides drinking and irrigation water to the Andalgalá department, in Catamarca; shortly after, a team of legal advisors, representing the inhabitants of that town, accused before the Federal courts <i>Alumbrera</i> for the “dissemination of dangerous wastes” for the infringement of the provisions of Law 25612 (Integral management of industrial and service sector wastes). Societal grievance reached the courts in Tucumán; after a trial motivated by a series of fish die-offs, in 2001-2004, in the Salí-Dulce river system, environmentalists succeeded: Tribunal judges decided to press criminal charges against <i>Alumbrera</i> .” (Zamprile and Llorente, 2009, pp. 10-11)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data
<i>Familiarity of resource use (combined with Environmental impact to create Environmental change condition)</i>	0	Assets affected by project/firm activity already developed and to be used for a similar or familiar purpose
		“In 1870 diamonds were discovered in Jagersfontein, a remote town in what is today the Free State Province of South Africa. De Beers Consolidated Mines acquired the Jagersfontein Mine in 1930 and operated it (with some periods of inactivity) until its official closure in the early 1970s (Davenport, 2011). In April 2010, De Beers advertised its willingness to sell the Jagersfontein mine dumps to a black empowerment firm (Smith, 2010). Later that year, De Beers sold the mine dumps of Jagersfontein Mine to the Superkolong Consortium, a black economic empowerment company.” (Matebesi and Marais, 2018, p. 374)
	0.33	Assets affected by project/firm activity already developed and reallocated from a familiar use to an unfamiliar use
		“To almost all people the crucial issue was food – to avoid hunger, and their analyses of the only two ways of dealing with hunger were to: (i) appropriate some land – through accessing land of the company (to intercrop among plantation trees), or ‘encroaching’ into other nearby land, often illegally, or (ii) find employment within the company that might then enable them to generate a cash income to purchase food. The issue of access to land was not just related to securing food; however, it was also vital to access water supplies for animals, and sites of cultural significance. In ‘locking up’ land for forestry plantations – especially when the goal is to ensure maximum carbon capture and storage – local peoples’ access rights are prohibited, for fear of damaging trees that may disrupt ‘permanence obligations’ (referring to the time period carbon must be stored plantations undisturbed); thereby reducing the value of carbon stocks for sale in international carbon markets.” (Westoby and Lyons, 2016, p. 270)
	0.67	Assets affected by project/firm activity were previously undeveloped
		“... is a copper mining company with one copper project in the planning phase in northern Norway. Although the field was discovered in the 1970s, the deposits are as yet undeveloped.” (Koivurova et al., 2015, p. 200)
	1	Assets affected by project/firm activity were previously undeveloped and considered rare/precious
		“The new mining project also caused several local conflicts. Firstly, it was the clash with the local environmental NGOs on the National park ‘Khibiny’ planned for the opening in close proximity to the new mines. The conflict peaked in 2012 due to the intention of the company to build the road for ore transportation from the ‘Partamchorr’ mine to the processing plant through the National park.” (Koivurova et al., 2015, p. 214)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data
<i>Well-defined and enforced property rights</i>	0 Assets affected by project/firm activity are largely open access, or customary use and access rights largely ignored, or, jurisdiction is unclear	“The Argentinian government filed a complaint against Uruguay with the International Court of Justice, claiming that by unilaterally authorizing the construction of Botnia's pulp mill, Uruguay breached the Bilateral Treaty of the Uruguay River (1975), which obliges both countries to inform and consult the counterpart on all issues relating to the shared watercourse. Uruguay, in turn, appealed to the Mercosur Arbitration Court accusing Argentina of violating the Treaty of Asunción as regards the principle of free circulation of goods and services, hindered by blockades on bi-national bridges.” (Kaakinen and Lehtinen, 2016, footnote on p. 106)
	0.33 Assets affected by project/firm activity are largely defined as common pool resources and/or the state can/does allocate rights in subsets of these resources	“In countries where land rights are not particularly developed it is often the case that mining rights are sold without the express consent of those who have historically exercised control over the land or that previous landowners are not adequately educated or compensated for the sale of their livelihood. Most grievances that ABG faces are related to land issues, some genuine and some arising from confusion over the process of land acquisition. (Pike, 2012, p. 6)
	0.67 Project/firm activity occurs on and affects property that has well-defined and enforced private property rights but impacts also manifest beyond the bounds of the private property	“The issues raised in these studies included: community health: harmful chemicals, chemical smells, aircraft noise and spraying, beef cattle contamination by Helix and endosulfan, and soil contamination; pesticides, herbicides and defoliants: excessive use and spray drift...” (Roth, 2011, p. 76)
	1 Project/firm activity occurs on and affects property that has well-defined and enforced private property rights	N/A

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data	
<i>Media coverage</i>	0	Little coverage of project/firm activity and impacts on affected stakeholders outside interest groups	<p>“Key informant interviews revealed that the dusun chief and the committee hold strategic positions that bridge the company and the rest of the stakeholders. The dusun chief and the committee deliver information to the company and vice versa. The dusun chief also plays the role of mediator among all stakeholders, ensuring that the entire process from proposal submission to acceptance or rejection runs smoothly.” (Rosyida et al., 2018, p. 171)</p> <p>Information such as the above, combined with very few available materials from media outlets, was used to indicate a rather closed-loop of information exchange, and very little access to information through the media or other public forums.</p>
	0.33	Some coverage of project/firm activity and impacts on affected stakeholders in (local) mainstream and social media	<p>“The conflict was actively discussed in the local media and among the members of internet communities...” (Riabova and Didyk, 2014, p. 6)</p>
	0.67	Extensive coverage of project/firm activity and impacts on affected stakeholders in (national and or local) mainstream and social media	<p>“In 2011, the government signed an agreement with a consortium involving Trans Electrica International (formerly Continental Energy International Limited), Trans Electrica Georgia Limited, and a range of other parties. During 2012 and 2013, there was much protest against the project at local and national levels, and a national debate about the dam and related issues raged in the media.” (Jijelava and Vanclay, 2018, p. 36)</p>
	1	Extensive coverage of project/firm activity and impacts on affected stakeholders in (national and international) mainstream and social media	<p>“The border dispute gained wide spread media coverage both in Argentina and Uruguay, and the interviewees interpreted its scope and impact accordingly.” (Kaakinen and Lehtinen, 2016, p. 108)</p>
<i>Public protests</i>	0	No notable protests or conflict in response to project/firm activity	<p>“Limited opportunities, feelings of anxiety, and a lack of confidence became reasons for the low participation of attendees during public meetings. Thus, they preferred to act as passive participants.” (Rosyida et al., 2018, p. 174)</p>

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data
<i>Public protests</i>	0.33 Online petitions/activism set-up in response to project/firm activity	“The program instigated a social media frenzy and almost tripled news media attention.” (Cullen-Knox et al., 2019, p. 309) “The industry division was not only carried through news media, but also social media sites such as Twitter and Facebook with posts indicating a preference to purchase Huon products or an adversity to purchasing from Tassal.” (p. 312)
	0.67 Peaceful protests in response to project/firm activity	“Members of the opposition parties..., the environmental movement, NGOs, and some villagers have collectively demonstrated in various places... They also conducted several rallies and mock voting campaigns, “National Day of Stop Lynas Action” with 99% out of 26,000 people in 19 cities across Malaysia voting against the plant. Legal proceedings also have been initiated in local and higher courts to prevent the operation of LAMP.” (Jamaludin and Lahiri-Dutt, 2017, p. 269)
	1 Violent protests resulting in injuries or deaths in response to project/firm activity	“The policies encountered widespread organized social resistance in the Amazon resulting in the so-called Bagua tragedy of 2009 that made international headlines... resulting in 33 deaths and some 170 injured, at least half by gunfire” (de Jong and Humphreys, 2016, p. 552)
<i>Private firm ownership</i>	0 Proponent of project/activity is a government or government institution	“Also of relevance to how the Amazonian modernization policies were perceived by the affected communities and others is how the García administration obtained its legal licence. Given expected controversy over the plans and anticipated opposition from a majority of the legislature, García sought to bypass normal legislative channels.” (de Jong and Humphreys, 2016, p. 557)
	0.33 Proponent of project/activity is a government-private partnership or state-owned company	“LKAB (Svappavaara, Kiruna, Sweden), Ownership: State-owned” (Koivurova et al., 2015, p. 217)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Condition	Calibrated score and definition	Sample of coded data	
<i>Private firm ownership</i>	0.67	Proponent of project/activity is a private firm supported by government	“When the Saakashvili government came to power in Georgia following the Rose Revolution in 2003, talks about the Khudoni HPP resumed. The Saakashvili government implemented radical reforms to secure swift economic development and to make Georgia attractive for foreign investment. It viewed energy as an essential component of this strategy and thought that recommencement of the Khudoni project could be easily achieved. According to a CEE Bankwatch Network (2015) factsheet on the dam, the Government of Georgia signed a MoU to initiate the project in 2007 with Continental Energy Limited (which later became Trans Electrica), a company first registered in 2006 in Belize.” (Jijelava and Vanclay, 2018, p.35)
	1	Proponent of project/activity is a private firm	“Formed in 2007, Cuadrilla Resources is a private UK-based company involved in the exploration and production of unconventional oil and gas.” (Bradshaw and Waite, 2017, p. 31)
<i>Loss of social licence</i>	0	Project/firm has gained and maintained a high level of social licence (approval)	“LKAB (Svappavaara, Kiruna, Sweden), Indicated level of SLO based on local interviews: Approval/support” (Koivurova et al., 2015, p. 217)
	0.33	Project/firm has gained and maintained a low level of social licence (acceptance)	“Apatity, Russia, Indicated level of SLO based on local interviews: Approval/psychological identification initially, Level decreased to acceptance” (Koivurova et al., 2015, p. 212)
	0.67	Project/firm’s social licence threatened	“A clear majority of non-supporters demonstrated that a social license to operate for Metgasco or any other gas drilling operation was unlikely to be granted even at the most basic level in this region... Survey results demonstrated a high level of identification with the aims of the resistance movement, particularly for those who had invested time or money campaigning.” (Luke, 2017, pp. 276-277)

Table A2.2. Examples of coded text for fuzzy-set conditions and outcomes from the case studies (continued).

Outcome	Calibrated score and definition	Sample of coded data
<i>Loss of social licence</i>	1 Project/firm lost or never obtained a social licence	“The plethora of risks, both environmental and social, that were revealed through stakeholder engagement, proved to seed doubt among stakeholders as to the legitimacy of Enbridge mitigating the project-related risks; the risk of oil spills, threats to wildlife habitat, contributions (sic) to climate change, potential impacts to human health, violations of Indigenous sovereignty, and the project’s long-term economic viability. Although the federal government had much to gain through the approval of the NGP by way of tax revenue and royalties, they chose to reject the project because Enbridge was unable to counter challenges to their legitimacy by stakeholders that the risks (of NGP) outweighed the benefits, thereby failing to secure an SLO.” (Wood and Thistlethwaite, 2018, p. 593)
<i>Change in behaviour/regulation</i>	0 Project went ahead/firm activity continued	“2016: Loss in the second court case. S[uction]D[redging] commences, organized by a neighbouring desa.” (Rosyida et al., 2018, p. 167)
	0.33 Project/firm activity went ahead with adoption of minor changes	“... eventually seven turbines closest to the town were excised from the plan... The project leader feels that sacrificing seven turbines was the best compromise the proponent could offer... Concerning the interests of Urk, there have been alterations to the plan. But it is still a piece in a bigger interest and therefore [their concerns] are not decisive [in this matter]’.” (Langbroek and Vanclay, 2012, p. 176)
	0.67 Firm’s activity was scaled back or, project was mothballed/delayed	“This project originally commenced in the late 1970s, but slowed to a stop in the late 1980s with the decline and eventual collapse of the Soviet Union in 1991. Planning recommenced in the 2000s, with an implementation agreement being signed with Trans Electrica in 2009. However, the project was halted in 2013 due to strong opposition from the local community.” (Jijelava and Vanclay, 2018, p.32)
	1 Regulatory change occurred such that the project/firm activity was no longer permitted or firm/s stopped project/activity	“Unconventional oil and gas became a social and political topic in France in a fortnight because it relied on flash-mobilization... It succeeded in ascribing a new public meaning to hydraulic fracturing as a threat to the environment and public health and in enrolling most the French officials behind that definition... This new public problem led to a ban on hydraulic fracturing within only six months, a very short time in French political processes.” (Chailleux et al., 2018, p. 685)

Table A2.3. Calibrated data matrix for *Loss of social licence*.

	<i>Econ. benefits</i>	<i>Compen- sation</i>	<i>Consult- ation</i>	<i>Social impacts</i>	<i>Environ. change</i>	<i>Well- defined & enforced property rights</i>	<i>Political opps.</i>	<i>Media coverage</i>	<i>Public protests</i>
cs1	0.33	0.33	0	0.67	1	0.33	0.33	0.67	0.67
cs2	0.67	0.33	0.33	0.33	0.67	0.33	1	1	0.67
cs3	0.67	0	0.33	0.33	0.67	0.67	1	1	0.67
cs4	0.67	0.33	0.33	0.33	0.67	0.33	1	1	0.67
cs5	0.33	0.67	0.33	0.33	0.33	0.67	1	0.67	0.67
cs6	0.67	0	0.33	0.33	0.67	0.33	1	1	0.33
cs7	1	0	0.67	0.33	0.67	0.67	0	0.33	0.33
cs8	0.33	0.33	0	0.67	0.67	0.33	0	0.67	1
cs9	1	0.33	0	1	1	0	0.33	1	0.67
cs10	0.67	0	1	0.33	0.67	0.33	0.33	0	0.33
cs11	0.67	0.33	0.33	0.33	0.67	0.67	1	1	0.67
cs12	0.67	0	0.33	0.33	0.33	0.33	1	1	0.67
cs13	0.67	0.33	0.33	0.67	0.67	0.67	1	0.33	0
cs14	0.33	0.67	0	0.67	0.67	0.33	1	1	0.67
cs15	1	1	1	0.33	0.67	0.33	0.33	0	0
cs16	0.67	0.67	1	0.67	0.67	0.33	1	0.33	0
cs17	0	0.33	0.33	0.33	0.67	0.33	0.67	1	0.67
cs18	0.33	0.33	0.33	1	1	0.67	0.33	0.67	0.67
cs19	1	0.67	1	0.33	0.67	0.33	0.33	0.33	0.67
cs20	0.67	0.33	0.67	1	1	0.33	0	0.33	0.67
cs21	0.33	0.33	0	0.67	0.67	0.33	0.33	0	0
cs22	0.33	0	0	0.67	0.67	0.67	0.33	1	0.67
cs23	0	0.67	0.33	0.67	0.33	0.33	1	0.67	0.67
cs24	0.67	0.33	0.33	0.67	0.67	0.33	1	0.67	0.67
cs25	0.33	0	0	0.33	1	0	0.33	0.67	1
cs26	0.67	0.67	0	1	1	0.33	1	0.33	0.33
cs27	0.67	0.67	1	0.67	0.67	0.33	1	0.33	0
cs28	0.33	0.33	0.33	1	1	0.33	0.33	0.67	1
cs29	0.67	0.67	1	0.67	0.67	0.33	0.33	0.33	0.33
cs30	0.67	0	0.33	0.67	0.67	0.33	0.33	0.67	1
cs31	0.33	0.33	0.33	0.67	0.67	0.33	0.33	1	1
cs32	0.67	0.33	0.67	0.67	0.67	0.33	0.33	1	0.67
cs33	0.67	0.67	0.67	0.67	0.67	0.33	0.33	1	1
cs34	0.67	0.33	0	0.33	0.67	0.33	0.33	0.67	0.33
cs35	0.33	0.33	0.33	0.67	1	0.33	0	0.67	0.67
cs36	0.67	0.67	1	0.67	0.67	0.33	0	0.33	0.33
cs37	0.67	0.33	0	0.33	0.67	0.33	0.33	0.67	1
cs38	0.67	0.67	0.67	0.67	0.67	0.33	0.33	0.67	0.33
cs39	0.67	0.33	0	0.33	0.67	0.33	0.33	0.67	0.33
cs40	0.67	0	1	0.67	0	0.67	0.67	0.67	0.67
cs41	0.67	0.67	1	0.67	0.67	0.33	1	0.33	0
cs42	0.67	0.33	0	0.67	0.67	0.33	0	1	1
cs43	1	0.67	1	0.67	0.67	0.33	0	0.33	0.33
cs44	1	0.67	0.67	0.67	0.67	0.33	0	1	1
cs45	1	0.33	0	1	0.33	0.33	0	1	1
cs46	0.33	0.33	0.33	0.67	0.67	0.33	1	0.67	0.33
cs47	0.33	0	0.67	0.67	0.67	0	0.67	1	0.67

Table A2.4. Calibrated data matrix for *Change in behaviour/regulation* and both outcomes.

	<i>Private firm ownership</i>	<i>Loss of social licence</i>	<i>Loss of social licence</i>	<i>Change in behaviour/regulation</i>
cs1	1	1	1	0.33
cs2	1	0.67	0.67	0
cs3	1	0.67	0.67	0
cs4	1	0.67	0.67	0
cs5	0	0.67	0.67	0.33
cs6	1	0.67	0.67	0
cs7	1	0	0	0
cs8	1	1	1	0
cs9	1	1	1	0.33
cs10	1	0	0	0
cs11	1	1	1	0.67
cs12	1	0.67	0.67	0.67
cs13	1	0.67	0.67	0
cs14	1	0.67	0.67	0.33
cs15	1	0	0	0
cs16	1	0	0	0.33
cs17	0	1	1	1
cs18	0.67	1	1	0.67
cs19	1	0	0	0
cs20	1	0.33	0.33	0.33
cs21	0.67	1	1	0
cs22	1	0.67	0.67	0.33
cs23	0.33	0.67	0.67	0.33
cs24	0.33	0.67	0.67	0.33
cs25	1	0.67	0.67	0.67
cs26	1	0.67	0.67	0.33
cs27	1	0	0	0
cs28	0	1	1	0.33
cs29	1	0	0	0
cs30	1	1	1	0.33
cs31	1	1	1	0.33
cs32	1	0.67	0.67	0.33
cs33	1	1	1	0.67
cs34	1	1	1	0.67
cs35	1	0.67	0.67	1
cs36	1	0	0	0.33
cs37	1	0.67	0.67	0.67
cs38	0.67	0.67	0.67	0
cs39	1	1	1	1
cs40	1	0.67	0.67	0.33
cs41	0.33	0	0	0
cs42	1	0.67	0.67	0.67
cs43	1	0.33	0.33	0.33
cs44	1	0.67	0.67	0.33
cs45	1	0.67	0.67	0.67
cs46	1	0.67	0.67	0.67
cs47	1	0.67	0.67	0.33

Table A2.5. Necessary conditions for *Loss of social licence*.

Condition	Consistency	Coverage	Condition	Consistency	Coverage
<i>Economic benefit</i>	0.666	0.690	<i>~Economic benefit</i>	0.573	0.878
<i>Compensation</i>	0.422	0.696	<i>~Compensation</i>	0.782	0.774
<i>Consultation</i>	0.354	0.507	<i>~Consultation</i>	0.828	0.901
<i>Social impacts</i>	0.746	0.774	<i>~Social impacts</i>	0.504	0.772
<i>Environmental change</i>	0.828	0.750	<i>~Environmental change</i>	0.399	0.779
<i>Well-defined & enforced property rights</i>	0.479	0.808	<i>~Well-defined & enforced property rights</i>	0.782	0.764
<i>Political opportunities</i>	0.550	0.659	<i>~Political opportunities</i>	0.529	0.677
<i>Media coverage</i>	0.839	0.7867	<i>~Media coverage</i>	0.308	0.560
<i>Public protests</i>	0.793	0.853	<i>~Public protests</i>	0.423	0.615

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation, i.e. switching scores from “0” to “1” and “1” to “0”.

Table A2.6. Necessary conditions for gaining/maintaining social licence (*~Loss of social licence*).

Condition	Consistency	Coverage	Condition	Consistency	Coverage
<i>Economic benefit</i>	0.871	0.557	<i>~Economic benefit</i>	0.515	0.487
<i>Compensation</i>	0.630	0.641	<i>~Compensation</i>	0.701	0.428
<i>Consultation</i>	0.853	0.753	<i>~Consultation</i>	0.442	0.297
<i>Social impacts</i>	0.759	0.485	<i>~Social impacts</i>	0.647	0.611
<i>Environmental change</i>	0.816	0.456	<i>~Environmental change</i>	0.552	0.664
<i>Well-defined & enforced property rights</i>	0.608	0.632	<i>~Well-defined & enforced property rights</i>	0.815	0.491
<i>Political opportunities</i>	0.591	0.436	<i>~Political opportunities</i>	0.538	0.424736
<i>Media coverage</i>	0.608	0.352	<i>~Media coverage</i>	0.631	0.707942
<i>Public protests</i>	0.572	0.379	<i>~Public protests</i>	0.778	0.699

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation, i.e. switching scores from “0” to “1” and “1” to “0”.

Table A2.7. Necessary conditions for *change in behaviour/regulation*.

Condition	Consistency	Coverage	Condition	Consistency	Coverage
<i>Loss of social licence</i>	0.938	0.515	<i>~Loss of social licence</i>	0.434	0.387
<i>Private firm ownership</i>	0.896	0.349	<i>~Private firm ownership</i>	0.166	0.442

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation, i.e. switching scores from “0” to “1” and “1” to “0”.

Table A2.8. Necessary conditions for continuing current behaviour or regulation (*~Change in behaviour/regulation*).

Condition	Consistency	Coverage	Condition	Consistency	Coverage
<i>Loss of social licence</i>	0.646	0.689	<i>~Loss of social licence</i>	0.546	0.945
<i>Private firm ownership</i>	0.892	0.675	<i>~Private firm ownership</i>	0.140	0.723

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation, i.e. switching scores from “0” to “1” and “1” to “0”.

Table A2.9. Cross tabulation of outcome (*Loss of social licence*) against presence/absence of casual combinations (not otherwise presented in the article).

<i>Outcome 1: Loss of social licence</i>		
Compensation		
	<i>~Compensation</i>	<i>Compensation</i>
<i>Loss of social licence</i>	7	29
<i>~Loss of social licence</i>	3	8
Social impacts		
	<i>~Social impacts</i>	<i>Social impacts</i>
<i>Loss of social licence</i>	12	24
<i>~Loss of social licence</i>	4	7
Well-defined and enforced property rights		
	<i>~Well-defined & enforced property rights</i>	<i>Well-defined & enforced property rights</i>
<i>Loss of social licence</i>	29	7
<i>~Loss of social licence</i>	10	1
Political opportunities		
	<i>~Political opportunities</i>	<i>Political opportunities</i>
<i>Loss of social licence</i>	20	16
<i>~Loss of social licence</i>	8	3
Public protests		
	<i>~Public protests</i>	<i>Public protests</i>
<i>Loss of social licence</i>	8	28
<i>~Loss of social licence</i>	9	2

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” indicates negation, i.e. absence of a condition/outcome. For this table, fuzzy-set condition and outcome scores were grouped such that a condition or outcome with a score of 0 or 0.33 was classed as absent in a case study, and a score of 0.67 or 1 indicated a condition or outcome was present for the case study.

Table A2.10. Sensitivity of the intermediate solution formula to inclusion/exclusion of cases.

Analysis	Solution pathway	Consistency	Coverage
Main analysis	<i>Economic benefits * Consultation* ~Media coverage * (~Well-defined & enforced property rights + ~Public protests) → ~Loss of social licence</i>	0.91	0.56
Only cases where <i>Development = 1</i> (n=11)	<i>Economic benefits * Consultation *~ Media coverage * ~ Well-defined & enforced property rights *~ Public protests → ~Loss of social licence</i>	1.00	0.52
Only cases where <i>Development = 0</i> (n=5)	<i>Economic benefits * Consultation *~ Media coverage * ~ Well-defined & enforced property rights * ~Public protests → ~Loss of social licence</i>	1.00	0.34
Only cases where <i>Political opportunities =</i> <i>1</i> (n=16)	<i>Economic benefits * Consultation *~ Media coverage ~ Well-defined & enforced property rights *~ Public protests → ~ Loss of social licence</i>	1.00	0.48
Only cases where <i>Political opportunities =</i> <i>0</i> (n=9)	<i>Economic benefits * Consultation *~ Media coverage * (~Well-defined & enforced property rights + ~Public protests) → ~Loss of social licence</i>	1.00	0.65
Only cases where industry = mining (n=32)	<i>Economic benefits * Consultation *~ Media coverage * ~ Well-defined & enforced property rights → ~Loss of social licence</i>	0.96	0.57
Only cases where industry = non-mining (n=15)	<i>Economic benefits * Consultation *~ Media coverage * ~ Well-defined & enforced property rights * ~Public protests → ~Loss of social licence</i>	0.86	0.40

Notes: Conditions are defined in Table 3.2 and outcomes are defined in Table 3.3. Notation “~” is used to indicate negation (or absence). All case studies are listed in Table A2.1.

Appendix 3. Interview procedure and survey questions

Interview and pre-testing procedure

Hello [insert name here]

Thank you for your time today. I really appreciate it. Before we get going, in order for me to use this conversation for research purposes, I need to read you some information and ask you a few questions.

For purposes of informed consent this conversation needs to be audio recorded. If at any time you do not wish to participate or give your consent to participate in this study; this audio recording will be permanently deleted. Do you wish to continue?

You have been asked to participate in a study conducted by me, Nikki Dumbrell and my PhD supervisors at The University of Adelaide. This study has been approved by The University of Adelaide Human Research Ethics Committees, approval number H-2020-101. Participation is voluntary and you can choose to cease participation in this study at any time and for any reason and without consequence. Your responses are held in total confidentiality.

Could you please state your full name?

For us to record your consent could you please indicate with a 'yes' or 'no' that:

- I understand that for any concern I can contact The University of Adelaide's Secretariat, Human Research Ethics Committee on 08 8313 6028 (yes/no)
- I freely give my consent to participate in this study (yes/no)

Thank you.

To start, I would like to ask you what you understand by the term "social licence to operate"?

Who do you hear using the term? (e.g. academics, government, industry, journalists, farmers, etc.)

Can you describe issues that you understand to be social licence issues? And using one of those examples, if it is easier, what is it that you think makes them social licence issues?

Can you think of any examples where you have seen businesses change their behaviours to respond to social expectations?

What do you know about the research and investment into hydrogen as future energy source in Australia?

Have you seen examples of tensions between using land for farming vs renewable energy or other energy infrastructure?

Turning to the survey in more detail: the survey has 3 main parts, I will go through the survey now and as we go, I will ask you to indicate if there is anything you do not understand, or think your peers would not understand, or anything confusing or missing.

[Refer to the survey document]

Note: Make sure to ask respondents to indicate:

1. Any issues with framing of income and debt questions (e.g. sensitivity, timeframe, language)
2. Whether they think there was enough information about hydrogen provided in the survey to enable responses to the questions presented

Is there anything else you would like to add?

Thank you very much for your help. If you are interested in any reports that stem from this work I would be happy to share them with you when they are ready. If there is anything important that you think of at a later date that you think I should consider, please do not hesitate to send me an email.

Survey instruments

The online survey completed by members of the public based in South Australia and Victoria is presented first (on the following pages), followed by the phone survey completed farmers based in South Australia and Victoria.

Online survey for public respondents

The participant information sheet was presented as a survey preamble for the respondents of the online survey, as follows.

Dear Participant,

You are invited to participate in a survey that is part of an independent research project, described below.

What is the project about?

This research project is designed to improve understanding of the concept of 'social licence'. A business/activity is said to have a social licence when it is widely perceived to meet expectations of stakeholders and communities who are affected by the business/activity. Community expectations may be that businesses make socially responsible decisions, regardless of whether they are required to do so by law. The following survey includes questions to help us obtain information about what factors influence individuals' decisions to grant or withhold a social licence for the Australian agricultural industry and the development of a hydrogen industry (to replace current energy sources).

Who is undertaking the project?

This research forms part of a PhD project conducted by Ms Nikki Dumbrell under the supervision of Professor Sarah Wheeler, Associate Professor Alec Zuo, and Dr David Adamson in the Centre for Global Food and Resources at The University of Adelaide.

Why am I being invited to participate?

We are interested in Australian's opinions about the allocation of natural resources (e.g. water, land) and the management/use decisions that affect these resources (and consequently communities that value them) in both the Australian agricultural and energy (future fuels) industries. More specifically we are interested in your thoughts and experiences of issues that commonly get described as 'social licence issues' in these industries. You don't need to know anything about the social licence concept or these industries to participate in this study. We are interested in your opinions!

What am I being invited to do?

You are being invited to complete an anonymous online survey.

How much time will my involvement take?

The survey will take about 20 minutes to complete.

Are there any risks associated with participating in this project?

There are no foreseeable risks to participating in this study. However, should you wish, you can choose not to answer questions that make you uncomfortable, or, you can withdraw your participation at any time. All information collected will be kept confidential and only researchers mentioned in the application (listed under 'Who is undertaking the project?') will have access to the data set. The researchers will only publish (de-identified) aggregate or averaged results.

What are the potential benefits of the research project?

This research will generate insights into Australians' concerns about resource management behaviour, including natural resources (e.g. water, land) in the agricultural and energy industries. This research will help us to better understand the expectations of each industry, and relate these to current industry practices and inform future developments, for example, transitions to alternative (future) fuels in the energy industry such as hydrogen. The information obtained about expectations for these industries can be used to improve decision-making and consequently community-industry relations.

Can I withdraw from the project?

Participation in the survey is voluntary. Once you have begun the survey there is no obligation to continue. If you are uncomfortable with any part of the survey you are free to withdraw at any time up until submission of responses.

What will happen to my information?

Only the project researchers will have access to your responses to questions in the survey that follows. Your identity will be kept confidential. Any response you give or statement you make will not be attributed to you. Only (de-identified) aggregate or averaged results will be released publicly. The project outcomes will be reported in a PhD thesis and journal articles. To access the reports the participants can contact Professor Sarah Wheeler or Ms Nikki Dumbrell at Centre for Global Food and Resources, The University of Adelaide (contact information listed below).

All records and materials will be held by the researchers at Centre for Global Food and Resources, The University of Adelaide in a password protected computer and secure server for at least 5 years, consistent with the Australian Code for Responsible Conduct of Research.

By opting to participate in this study you will be agreeing to data from this project potentially being used by the researchers for further research related to this topic.

Your information will only be used as described here and it will only be disclosed according to the consent provided, except as required by law.

Who do I contact if I have questions about the project?

Professor Sarah Wheeler

Centre for Global Food and Resources, The University of Adelaide

Phone: (08) 8313 9130

Email: sarah.wheeler@adelaide.edu.au

Ms Nikki Dumbrell

Centre for Global Food and Resources, The University of Adelaide

Email: nikki.dumbrell@adelaide.edu.au

What if I have a complaint or any concerns?

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2020-101). This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research 2007 (Updated 2018). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. If you wish to speak with an independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:

Phone: (08) 8313 6028

Email: hrec@adelaide.edu.au

Post: Level 4, Rundle Mall Plaza, 50 Rundle Mall, ADELAIDE SA 5000

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

If I want to participate, what do I do?

If you consent to participate in this study, please complete the survey that follows. Submission of your survey responses is considered as your consent to participate in the study, and that you have read and understood the above information.

Yours sincerely,

Ms Nikki Dumbrell and Professor Sarah Wheeler
(on behalf of the research team)

This survey comprises of four main parts:

PART 1: We will ask some questions about you to help make sure we have a representative sample

PART 2: We will ask your opinions on some environmental issues

PART 3: We will ask about your awareness and understanding of some 'social licence' issues

PART 4: We will ask some more questions about you and your experiences

Part 1: Some questions about you

The following three questions were treated as screening questions

Qi What is your residential postcode?

[Open ended question; require a four-digit number]

Qii Which of the following best describes your gender?

- Male
- Female
- Non-binary
- Prefer not to say

Qiii Which of the following best describes your age group?

- 18-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65+ years

Part 2: General environment questions

Q1 Please indicate the extent you agree with the below seven statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Threats to the environment are exaggerated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) A healthy, well protected environment and a prosperous economy go hand in hand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) The environment needs to be protected even if it impacts economic prosperity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) In order to have economic prosperity, the environment is going to suffer a bit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) Climate change will have a negative impact on my household	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) Climate change is largely human-induced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) Climate change is happening	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (g) was randomised for each respondent.

Part 3: Social licence

This section of the survey has two subsections, first we will focus on the Australian agricultural sector and then, the Australian energy sector. We are also interested in the impact of government decisions on these industries.

We focus on these industries as they are arguably facing increasing pressure to adopt new management strategies or policies to align with social expectations. Or, in other words, their social licence to operate is being questioned. There are also concerns about how the two industries co-exist and the role of government in supporting the two industries to co-exist.

Definition of social licence

For this study, a business or activity with a social licence to operate is said to enjoy ongoing acceptance or approval by:

- (1) Stakeholders and communities affected by the business or activity, and
- (2) Stakeholders and communities that can affect the profitability of the business or activity.

Q2 Keeping in mind the definition above, had you heard of the term social licence to operate before starting this survey?

- Yes, and I understood it to mean the same as this definition
- Yes, but I understood it differently to this definition
- No

Q3 Do you think that community decisions to grant or withdraw a social licence to operate can influence the behaviour of businesses and/or governments?

	Yes	No	I don't know
(a) Businesses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Governments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Part 3a: Social licence of agriculture

Q4 Please indicate your main source(s) of information about the agriculture industry in Australia?

Please note, in this question we are most interested in the source of information rather than the means of accessing it (e.g. through mainstream or social media). For example, if you access information through social or mainstream media then we would like you to consider who you notice posting the material on social media or providing interviews/information to the mainstream media, e.g. is it research or government organisations, or farmers?

Select up to three (3) options.

- Friends or family
- Universities and other research organisations, e.g. CSIRO
- Industry associations, e.g. National Farmers Federation
- Government organisations
- Farmers
- Other, please specify: [open ended question]

Q5 Please indicate the extent you agree with the below statement.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
The Australian agricultural industry's social licence to operate is under pressure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SKIP LOGIC

If response to Q5 is (6; I don't know) skip to Q6.

If response to Q5 is (3)(4)(5), ask Q5a.

If response to Q5 is (1)(2), ask Q5b.

Q5a Do you believe the current pressure on the agricultural industry's social licence to operate is justified?

- Yes
- No
- I don't know

Q5b Do you believe the current absence of pressure on the agricultural industry's social licence to operate is justified?

- Yes
- No
- I don't know

Q6 When thinking about the Australian agricultural industry currently, please indicate the extent you agree with the below 15 statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) The treatment of animals on farms is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) The treatment of animals during transport, sale, or processing, i.e. treatment of animals off-farm is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) The volume of greenhouse gas emissions produced by the industry (about 15% of Australia's national emissions) is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) The lack of implementation of Indigenous knowledge and rights into best-practice land and water allocation and management is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) The extent that agricultural activities impact soil health is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(f) Farmers' ability to meet food safety standards is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) The extent that agricultural lobby groups have the ability to advocate for the industry and inform government decisions is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) The extent that farmers and other businesses in the agricultural industry can sell assets (including land) to and/or attract investment from overseas is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(i) The volume of water from common resources (e.g. rivers, groundwater) allocated to and used for irrigation is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(j) Extent and circumstances under which farmers are able to clear land of native vegetation is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(k) The extent and circumstances under which farmers are able to cull pest animals, including native species is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(l) The type, timing of application and/or extent of use of chemical weed and pest controls is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(m) The type, timing of application and/or extent of use of synthetic fertilisers is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(n) Use of genetically modified crops is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(o) Urban sprawl on agricultural land is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (o) was randomised for each respondent.

SKIP LOGIC

If response to Q6 (l) re: chemical weed and pest controls is (1)(2)(3)(6; I don't know) skip to Q8.

If response to Q6 (l) re: chemical weed and pest controls is (4)(5), ask Q7.

Q7 In the previous question you indicated concern about farmers' ability to use some types of, or the extent of use and timing of application of chemical weed and pest controls. Using the scale below, please indicate the extent that your response to that question was driven by concern about food safety and human health consequences, or environmental consequences.

Very much driven by concern for food safety and human health	Somewhat driven by concern for food safety and human health	Equally driven by concern for food safety, human health and the environment	Somewhat driven by concern for the environment	Very much driven by concern for the environment
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q8 Please indicate the extent you agree that governments should do each of the below to address issues that are threatening the social licence status of the agricultural industry.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Governments should educate the general public about agriculture, including through school programs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Governments should educate farmers about communities' and other stakeholders' expectations of the agricultural industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(c) Governments should fund research into causes of social licence issues and potential strategies to overcome them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) Governments should work with industry organisations to develop stricter industry standards and best-practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) Governments should increase monitoring and enforcement of relevant regulations/standards, including through the use of fines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) Governments should establish property rights in socially valuable resources (e.g. water, biodiversity, carbon) and establish markets in which farmers and other stakeholders can trade them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) Governments should provide subsidies and/or tax concessions to those farm businesses that meet higher environmental or social standards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) Governments should support the development of market incentives, such as certification for products that meet high environmental or social standards.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (h) was randomised for each respondent.

Q9 In your opinion, what role should/could agricultural industry organisations (e.g. farmer representative groups) play in managing issues that are threatening the social licence status of the agricultural industry?

If you are unsure, or have no opinions, please write 'N/A' in the box below.

[Open ended question]

Part 3b: Social licence of new energy sources

Transition to a renewable energy future will change the resources in demand by the energy sector. For example, a shift from predominantly coal-fired electricity toward more renewable electricity (e.g. solar and wind) will potentially mean energy will be produced and stored in new locations with ramifications for existing land use and job opportunities.

With this in mind, we are interested in your thoughts about a potential new energy resource being developed and tested in Australia, and that is hydrogen.

The main things to note about hydrogen for the purpose of this survey are described below (from [National Hydrogen Strategy](#), p. 5).

- *Hydrogen can be used, like natural gas, to heat homes and industry, and for cooking.*
- *Delivery of hydrogen for these uses would most likely be via new or existing gas networks.*
- *Hydrogen can also be blended with natural gas for heating and cooking.*
- *Hydrogen can power fuel cell electric cars, trucks, buses and trains.*
- *Hydrogen can also be used to generate electricity (through fuel cells or being burned to drive turbines).*
- *If made when there is surplus or cheap electricity available, hydrogen can be stored and then used to produce electricity when there is insufficient electricity available from other sources.*
- *Hydrogen can also be used in combination with renewable electricity to power remote sites like mines and small regional communities.*

The following section includes some questions about the energy industry, a potential transition to hydrogen energy production and use, and some questions about the co-existence of a hydrogen industry with the agricultural industry.

Q10 Please indicate your knowledge of hydrogen production and its uses before starting this survey.

	I had not heard of it	I had heard of it but know very little or nothing about it	I had heard of it and could explain it to a friend
(a) How hydrogen is produced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) The use of hydrogen in fuel cell vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Burning hydrogen as a replacement for natural gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(d) Hydrogen as an energy storage medium for electricity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) The use of hydrogen fuel cells in homes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (e) was randomised for each respondent.

Q11 Hydrogen can be made from:

Electrolysis powered by renewable energy (solar and wind) to split water into hydrogen and oxygen; or

Coal gasification, that is, applying heat, water and air/oxygen to coal, inducing a chemical reaction that produces carbon monoxide, carbon dioxide, water vapour and hydrogen (this is the process that was used to produce ‘town gas’);

or

Steam methane reforming which is similar to coal gasification except that coal is replaced with natural gas (methane).

Do you have a preference for one method to be adopted over others?

- No preference – they are all acceptable
- No preference – none of them are acceptable
- Electrolysis using renewable energy
- Coal gasification
- Steam methane reforming
- Coal gasification or steam methane reforming paired with carbon capture and storage
- I don't know

Q12 Your willingness to be supportive of Australia producing and using hydrogen as a fuel (to export, and to power transport, industrial processes, and/or domestic appliances in Australia) could depend on a number of factors. The table below includes 6 possible factors. We are interested in whether any of these factors would be more or less important in determining whether you would be willing to see Australia transition toward producing and using hydrogen as a fuel.

To indicate how IMPORTANT each factor would be to you, relative to the others listed, please allocate 100 points among the factors by entering a number in the corresponding box or moving the corresponding slider.

- Allocate more points to factors that are more important to you.
- If a factor is not at all important, assign it zero points.
- If a factor is twice as important as some other factor, allocate it twice as many points.

Factor	Weighting (out of 100)
Secure and reliable supply – Hydrogen needs to be available on-demand (available to households and businesses whenever it is needed)	
Safety – Hydrogen needs to be at least as safe to produce, store, transport and use as existing fuels	

Affordability – Hydrogen and the appliances and vehicles powered by hydrogen need to be at least as affordable as current fuels, vehicles and appliances	
Accessibility – Hydrogen and the appliances and vehicles powered by hydrogen need to be at least as accessible as current fuels, vehicles and appliances	
Climate change mitigation – Hydrogen needs to be produced from renewable energy therefore producing no greenhouse gas emissions	
Job creation – A hydrogen industry needs to create additional jobs in the Australian economy	
Sub-total	(sum to 100)

Note: The order of items was randomised for each respondent.

Q13 Please indicate the extent you agree with the below seven statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Coal seam gas operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Conventional gas (not coal seam or shale gas) operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Metal and mineral mining operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) Nuclear waste disposal and storage facilities should be established in the most appropriate geological locations, including	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
where land is typically used for agriculture						
(f) Wind farms should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) Solar farms should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) Hydrogen production facilities should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (h) was randomised for each respondent.

Q14 Please indicate the extent you agree with the below two statements. Once you make a selection the next statement will automatically appear.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
I am confident that Australian state and federal governments make policy and regulatory decisions based on scientific and economic evidence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am confident that my responses in this survey will influence future policy decisions regarding the development of a hydrogen industry in Australia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Part 4: Respondent information

The following questions are designed to give us a little bit more information about you and to help make sure we have a representative sample. Your responses will be anonymous.

Q15 What is the highest level of education you have completed?

- Year 10 or below
- Year 12 or below
- Advanced diploma, diploma, or certificate (including TAFE)
- Bachelor degree
- Graduate diploma or graduate certificate
- Post-graduate degree

Q16 Which of the following best describes your current employment status?

- Employed (including self-employed), working full time (1)
- Employed (including self-employed), working part-time (2)
- Employed (including self-employed), currently away from work, e.g. in receipt of JobKeeper (3)
- Unemployed, looking for full time work (4)
- Unemployed, looking for part-time work (5)
- Not in the labour force (e.g. retired, homemaker, student not otherwise employed) (6)
- Other, please specify _____ (7)

SKIP LOGIC

If response to Q16 is (4)(5)(6)(7) skip to Q18.

If response to Q16 is (1)(2)(3), ask Q17.

Q17 In what industry are you currently employed? *Select all that apply.*

- Agriculture, Forestry and Fishing
- Mining
- Manufacturing
- Electricity (largely from renewable sources), Gas, Water and Waste Services
- Electricity (largely from non-renewable sources), Gas, Water and Waste Services
- Construction
- Wholesale or Retail Trade
- Accommodation, Arts, Recreation and Food Services
- Transport, Logistics and Communications
- Professional Services (e.g. financial, insurance, scientific, administrative services)
- Education, Health Care and Social Assistance
- Other or not applicable

Q18 Have you worked in any of the below fields in the past, or have close family/friends that do? *Select all that apply.*

- Agriculture
- Mining
- Electricity (largely from renewable sources) and gas production or supply services

- Electricity (largely from non-renewable sources) and gas production or supply services
- No or not applicable

Q19 Including yourself, how many people (including children) usually live in your household?

[Open ended question; maximum number to be entered = 20]

Q20 Which category best describes your household's annual income, before tax?

- \$0 – \$24,500
- \$24,501 – \$38,900
- \$38,901 – \$52,900
- \$52,901 – \$69,500
- \$69,501 – \$88,500
- \$88,501 – \$109,300
- \$109,301 – \$134,800
- \$134,801 – \$168,700
- \$168,701 – \$222,300
- \$222,301 or above
- Prefer not to say

Q21 Which category best describes your current diet?

- Vegan – you do not eat any animal products
- Vegetarian – you do not eat any meat
- Flexitarian – you eat meat and other animal source foods but are consciously reducing your meat consumption
- Omnivore – you eat meat and other animal source foods and are not consciously reducing your meat consumption

Q22 When you make food purchase decisions, how often do you buy the below four foods when they are available?

Note: The use of 'alternatives' here refers to foods that are substitutable, e.g. you could buy one type of fruit such as an apple instead of another type of fruit such as a pear.

	Never	Occasio- nally	About half the time	Most of the time	Always	N/A or I don't know
(a) Foods that are produced with less greenhouse gas emissions than alternatives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Foods that require less land and/or water to produce than alternatives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Foods that have been produced using less chemicals or	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

synthetic inputs than alternatives						
(d) Foods that have been produced using more animal welfare friendly production systems than alternatives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (d) was randomised for each respondent.

Q23 When making energy consumption decisions, how often do you make the below four choices when possible?

	Never	Occasionally	About half the time	Most of the time	Always	N/A
(a) Offset all or part of the greenhouse gas emissions associated with your household electricity/gas bill?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Offset all or part of the greenhouse gas emissions associated with your air travel?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Purchase energy efficient household items e.g. whitegoods with a 5-star energy rating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) Minimise the use of air-conditioning and other energy intensive appliances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (d) was randomised for each respondent.

Q24 Many non-government organisations, charities, and campaigns (e.g. Greenpeace, Animals Australia), use membership and donations as a means of supporting their work and sharing information with interested parties.

Which of the following best describes you in this regard?

- I am a current member of an environmental or social activist group
- I am not a member of an environmental or social activist group but I would consider signing up and/or donating in the future
- I am not a member of an environmental or social activist group, and do not intend to be in the future

SKIP LOGIC

If response to Q24 is (2) or (3) skip to Q25.

If response to Q24 is (1), ask Q24a.

Q24a In the previous question you indicated that you are currently a member of an environmental or social activist charity. Please list the environmental or social activist charities you are a member of in the box below.

[Open ended question]

Q25 When thinking about yourself, please indicate the extent you agree with each of the below six statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) My first impressions of people usually turn out to be correct	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) I always know why I like things	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) I am very confident of my judgements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) I sometimes tell lies if I have to	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) There have been occasions when I have taken advantage of someone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) I have received too much change from a salesperson without telling him or her	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) I don't care to know what other people really think of me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) I don't gossip about other people's business	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (h) was randomised for each respondent.

Final Section

Q26 If you have any comments or questions about this survey or the topics discussed, please share them below.

Please answer in the textbox given below.

[Open ended question]

Thank you very much for your time and help in this survey.

Phone survey for farmer respondents

The introduction to the phone survey included an abridged version of the Participant Information Sheet, as follows.

Good morning/afternoon/evening. My name is [insert name here], I am calling on behalf of researchers at The University of Adelaide. These researchers are conducting an independent survey concerned with 'social licence' issues in the agricultural industry. This research will generate insights into social expectations of agriculture, and the co-existence of agriculture with future energy systems and the role of government in mediating the activities of both industries. The survey is also an opportunity to express concerns about, or opportunities for how the industry can respond to social licence issues.

The researchers are seeking people who are responsible for farm management decisions to share their opinions and experiences in this survey.

Qi Are you responsible for farm management decisions either alone or jointly with others?

*If YES, proceed to ask them about their farm enterprise (to see if they will fit target sample).
If NO, thank them for their time and terminate the interview.*

Qii Also, based on the main land use, how would you describe your farm enterprise? For example, is it:

- Broad-acre cropping with sheep
- Broad-acre cropping with beef
- Broad-acre cropping with sheep and beef
- Broad-acre cropping only
- Specialist sheep production
- Specialist beef production
- Both sheep and beef production

*If within our target sample group, proceed to ask them if they have the time to participate.
If NOT within our target farm-type sample, thank them for their time and terminate the interview.*

Qiii Do you have time to do the survey now? It will take about 20 to 25 minutes.

If YES, thank them for their willingness to participate and continue to read the abridged Participant Information Statement below.

If NO, ask "Would you be willing to make a time for us to speak at a later date? When would be a more convenient time to speak with you?" Collect name and phone number and arrange a call back time. Also offer to send the Participant Information Sheet to them ahead of the arranged a call back time and collect an email address to send it to.

The study has been approved by the Human Research Ethics Committee at The University of Adelaide, approval number H-2020-101. Participation in this survey is voluntary and you can choose to cease participation in this study at any time and for any reason without consequence. Your responses will be held in total confidentiality. Should you have concerns you can contact The University of Adelaide on 08 8313 6028.

At the end of the survey I will provide you an opportunity to share an email address to which we can send you details about the study. If upon reading this information you wish to withdraw your participation (and be assured that all the information obtained in this conversation be destroyed) you will have two business days to reply to that email.

Do you have any questions?

This survey comprises of three main parts:

First, I will ask your opinions on some environmental issues;

Second, I will ask about your awareness and understanding of some 'social licence' issues; and

Third, I will ask some questions about you, and your farm.

Part 1: General environment-related questions

The first question is about environmental issues.

Q1 Using a scale that has 5 points, where 1 is strongly disagree, 5 is strongly agree, and 3 is neither agree nor disagree, or you can say I don't know, please indicate your level of agreement with each of the following seven statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Threats to the environment are exaggerated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) A healthy, well protected environment and a prosperous economy go hand in hand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) The environment needs to be protected even if it impacts economic prosperity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) In order to have economic prosperity, the environment is going to suffer a bit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) Climate change will have a negative impact on my household	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) Climate change is largely human-induced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) Climate change is happening	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (g) was randomised for each respondent.

Part 2: Social licence issues

Now, in this next section we will focus on social licence issues.

First, a definition for social licence.

For this study, a business or activity with a social licence to operate is said to enjoy ongoing acceptance or approval by:

- (1) Stakeholders and communities affected by the business or activity, and
- (2) Stakeholders and communities that can affect the profitability of the business or activity.

Q2 Keeping in mind this definition, had you heard of the term 'social licence to operate' before starting this survey?

- Yes, and I understood it to mean the same as this definition
- Yes, but I understood it differently to this definition
- No

Q2a Do you think that community or stakeholder decisions to grant or withdraw a social licence can influence the behaviour of businesses?

Repeat the definition if necessary: For this study, a business or activity with a social licence to operate is said to enjoy the ongoing acceptance or approval by stakeholders and communities affected by the business or activity, and those stakeholders and communities that can affect the profitability of the business or activity.

- Yes
- No
- I don't know

Q2b Do you think that community or stakeholder decisions to grant or withdraw a social licence can influence the behaviour of governments?

Repeat the definition if necessary: For this study, a business or activity with a social licence to operate is said to enjoy the ongoing acceptance or approval by stakeholders and communities affected by the business or activity, and those stakeholders and communities that can affect the profitability of the business or activity.

- Yes
- No
- I don't know

Q3 To what extent do you agree that the Australian agricultural industry's social licence to operate is under pressure.

Repeat the definition if necessary: For this study, a business or activity with a social licence to operate is said to enjoy the ongoing acceptance or approval by stakeholders and communities affected by the business or activity, and those stakeholders and communities that can affect the profitability of the business or activity.

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree
- I don't know

SKIP LOGIC

If response to Q3 is (6; I don't know) skip to Q4; If response to Q3 is (3)(4)(5), ask Q3a; If response to Q3 is (1)(2), ask Q3b.

Q3a Do you believe the current pressure on the agricultural industry's social licence to operate is justified?

- Yes
- No
- I don't know

Q3b Do you believe the current absence of pressure on the agricultural industry's social licence to operate is justified?

- Yes
- No
- I don't know

Q4 When thinking about the Australian agricultural industry in general, please indicate the extent you agree with the following 15 statements. Once again, you can answer using a scale that has 5 points, where 1 is strongly disagree, 5 is strongly agree, and 3 is neither agree nor disagree, or you can say I don't know.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) The treatment of animals on farms is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) The treatment of animals during transport, sale, or processing, i.e. treatment of animals off-farm is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) The volume of greenhouse gas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
emissions produced by the industry (about 15% of Australia's national emissions) is a concern to me						
(d) The lack of implementation of Indigenous knowledge and rights into best-practice land and water allocation and management is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) The extent that agricultural activities impact soil health is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) Farmers' ability to meet food safety standards is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) The extent that agricultural lobby groups have the ability to advocate for the industry and inform government decisions is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) The extent that farmers and other businesses in the agricultural industry can sell assets (including land) to and/or attract investment from overseas is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(i) The volume of water from common resources (e.g. rivers, groundwater) allocated to and used for irrigation is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(j) Extent and circumstances under which farmers are able to clear land of native vegetation is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(k) The extent and circumstances under which farmers are able to cull pest animals, including native species is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(l) The type, timing of application and/or extent of use of chemical weed and pest controls is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(m) The type, timing of application and/or extent of use of synthetic fertilisers is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(n) Use of genetically modified crops is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(o) Urban sprawl on agricultural land is a concern to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (o) was randomised for each respondent.

Q5 Have you made any of the following changes to your management in response to social licence pressure, or intend to do so in the near future?

Response to Q ii needed here such that livestock questions are only presented to those respondents that have said they run livestock

- Converted to certified organic production
- Signed up to a third-party certification scheme, e.g. Meat Standards Australia (MSA), Sedex
- Reduced chemical use by adopting precision farming, new varieties, new technologies, or other management changes
- Reduced water use by adopting new varieties, new technologies, or other management changes
- Changed the crop, pasture or livestock mix on farm
- Allocated land to revegetation
- Refrained from clearing land that would otherwise be allowed to clear
- Adopted carbon farming practices to reduce or offset greenhouse gas emissions
- Installed solar-only, or hybrid solar-diesel water pumps and/or solar panels on farm shed(s) or house(s)
- Fenced waterways and remnant vegetation
- Other, please specify: [Open ended question]
- No changes made in response to social licence pressure

Only present the below options to respondents that nominated they have livestock in response to Q ii

- Found domestic buyers for livestock that were previously destined for the export market
- Buying or selectively breeding for polled animals, or using pain relief when dehorning/disbudding
- Stopped using growth promoting hormones

Only present the below options to respondents that nominated they have sheep in response to Q ii

- Stopped mulesing sheep or started using pain relief when mulesing sheep

The next question is about the role of government in responding to social licence problems, followed by a question about roles for industry organisations.

Q6 So, once again using a scale that has 5 points, where 1 is strongly disagree, 5 is strongly agree, and 3 is neither agree nor disagree, or you can say I don't know, please indicate to what extent you agree that governments should do each of the following to address social licence issues in the agricultural industry.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Governments should educate the general public about agriculture, including through school programs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Governments should educate farmers about the community's and other stakeholders' expectations of the agricultural industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Governments should fund research into causes of social licence issues and potential strategies to overcome them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) Governments should work with industry organisations to develop stricter industry standards and best-practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) Governments should increase monitoring and enforcement of relevant regulations/standards,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
including through the use of fines						
(f) Governments should establish property rights in socially valuable resources (e.g. water, biodiversity, carbon) and establish markets in which farmers and other stakeholders can trade them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(g) Governments should provide subsidies and/or tax concessions to those farm businesses that meet higher environmental or social standards	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(h) Governments should support the development of market incentives, such as certification for products that meet high environmental or social standards.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (h) was randomised for each respondent.

Q7 In your opinion, what role should/could agricultural industry organisations (e.g. Farmers Federation, industry peak bodies) play in managing issues that are threatening the social licence status of the agricultural industry?

[Open ended question]

Do not prompt respondents but use these tick boxes if respondents state one of these options.

- Educate the public about agriculture, including through school programs
- Educate farmers about the community's and other stakeholders' expectations of the agricultural industry
- Fund research into causes of social licence issues and potential strategies to overcome them
- Work with governments to develop stricter industry standards and best-practices
- Support the development of market incentives, such as certification for products that meet high environmental or social standards

Ok, now we are going to move to some questions about the coexistence of the agricultural industry with the energy industry.

Transition to a renewable energy future will change the resources in demand by the energy sector. For example, a shift from predominantly coal-fired electricity toward more renewable electricity (e.g. solar and wind) will potentially mean energy will be produced and stored in new locations with ramifications for existing land use and job opportunities.

With this in mind, we are interested in your thoughts about a potential new energy resource being developed and tested in Australia, and that **is hydrogen**.

The main things to note about hydrogen for the purpose of this survey, as quoted from page 5 of the *National Hydrogen Strategy* are that:

Hydrogen can be used, like natural gas, to heat homes and industry, and for cooking. Delivery of hydrogen for these uses would most likely be via new or existing gas networks... Hydrogen can also be used to generate electricity (through fuel cells or being burned to drive turbines)... Burning hydrogen does not produce greenhouse gas emissions.

Q8 Before starting this survey, were you aware of efforts to research and test hydrogen as a future energy source in Australia?

- I had not heard about it
- I had heard about it but know very little or nothing about it
- I had heard about it and could explain what is happening to a friend

Q9 Hydrogen can be made from:

Electrolysis powered by renewable energy (solar and wind) to split water into hydrogen and oxygen; or

Coal gasification, that is, applying heat, water and air/oxygen to coal, inducing a chemical reaction that produces carbon monoxide, carbon dioxide, water vapour and hydrogen (this is the process that was used to produce 'town gas');

or

Steam methane reforming which is similar to coal gasification except that coal is replaced with natural gas (methane).

Do you have a preference for one method to be adopted over others?

- No preference – they are all acceptable
- No preference – none of them are acceptable
- Electrolysis using renewable energy
- Coal gasification
- Steam methane reforming
- Coal gasification or steam methane reforming paired with carbon capture and storage
- I don't know

The following questions relate to the co-existence of the agricultural industry with the energy industry.

Q10 Using a scale that has 5 points, where 1 equals strongly disagree, 5 equals strongly agree, and 3 is neither agree nor disagree, or you can say I don't know, please indicate your level of agreement with each of the following 7 statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(a) Coal seam gas operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(b) Conventional gas (not coal seam or shale gas) operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(c) Mineral/ore mining operations should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(d) Nuclear waste disposal and storage facilities should be established in the most appropriate geological locations, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(e) Wind farms should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(f) Solar farms should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I don't know
(g) Hydrogen production facilities should be established in locations that are most productive/efficient, including where land is typically used for agriculture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Note: The order of items (a) through (g) was randomised for each respondent.

Q11 What is the main factor influencing your attitude towards the co-existence of the energy industry and agriculture in your local area?

[Open ended question, response of unsure or multiple responses can be recorded]

Q12 Does a natural gas transmission pipeline run through your property?

- Yes
- No
- I don't know

Q13 If Australia started producing hydrogen at scale, and had to lay transmission pipelines to carry it from the site of production to the end user, would you be willing to have a pipeline run through your property? Compensation would be paid annually as rent (as long as the pipeline is operational). The rent would be calculated based on the area of land used for the pipeline easement and the value of that land as determined by an independent party.

- Yes
- No
- I don't know

SKIP LOGIC

If response to Q13 is 'Yes' or 'I don't know' skip to Q15.

If response to Q13 is 'No' ask Q14.

Q14 What factors contribute to your hesitation to have a hydrogen pipeline run through your property?

- Concern that I would be inadequately compensated
- Safety concerns associated with pipeline leaks
- Loss of productive land area taken up by easement and access roads
- Erosion concerns associated with easement and access roads
- Limitations on where trees can be planted or allowed to grow
- Limitations on where farm infrastructure can be built
- Biosecurity concerns associated with different vehicles and maintenance crews accessing the pipeline
- Security concerns associated with different vehicles and maintenance crews accessing the pipeline
- Other, please specify: [open ended question]

Part 3: Respondent information

Now we are up to the final part of the survey, and it starts with some questions about your farm.

Q15 What is the total land area (owned and leased) operated by your farm business? Your best estimate is fine.

[Open ended question, providing it is a number]

Q15a Indicate the units the respondent used in quoting their land area

- Hectares (1)
- Acres (2)

Q16 What percentage of your farm area is irrigated?

[A number ≤ 100]

Q17 Please can you list the grower groups or industry organisations that you are an active member of (by that I mean you attend meetings and actively engage with events or issues). The types of groups I mean are the state-based Farmers Federation, or a local grower group or Landcare group.

[Open ended question, response of N/A can be recorded]

Q17a Broadly speaking do you think these groups represent and share your views regarding social licence issues facing the agricultural industry, and ways to address these?

- Rarely
- Sometimes
- About half the time
- Most of the time
- Always

Q18 What would you say is the greatest issue facing your farm business at the moment?

Prompt if needed with: climate change, biosecurity, market access, succession planning

[Open ended question, response of unsure or multiple responses can be recorded]

Q19 For how many years have you been involved in the management decisions for your farm business?

_____ Years

Q20 Which of the following categories best describes your gender?

- Male
- Female
- Non-binary
- Prefer not to say

Q21 Which of the following categories best describes your age group?

- 18-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65+ years

Q22 Which of the following categories best describes the highest level of education you have completed?

- Year 10 or below
- Year 12 or below
- Advanced diploma, diploma or certificate (including TAFE)
- Bachelor degree
- Graduate diploma or graduate certificate
- Post-graduate degree

Q23 Do you expect that any family members will take over the farm when you retire?

- Yes
- No
- I don't know

Q24 Which of the following categories best describes your farm's net income or gross margin (revenue or cash receipts, minus variable costs) in the 2018-19 financial year?

- Less than \$0
- \$0 to \$50 thousand
- \$50 thousand to \$100 thousand
- \$100 thousand to \$200 thousand
- \$200 thousand to \$300 thousand
- \$300 thousand to \$500 thousand
- \$500 thousand to \$1 million
- More than \$1 million
- Prefer not to say

Q25 Over the past five years, would you say the productivity of your farm has been ...

- Strongly decreasing
- Decreasing
- Stable
- Increasing
- Strongly increasing

Q26 Which of the following categories best describes your total farm business debt (including debt on land, machinery, etc.) at 30 June 2019?

- Nil debt
- Less than \$50 thousand
- \$50 thousand to \$100 thousand
- \$100 thousand to \$200 thousand
- \$200 thousand to \$500 thousand
- \$500 thousand to \$1 million
- \$1 million to \$1.5 million
- \$1.5 million to \$2 million
- More than \$2 million
- Prefer not to say

Q27 Finally, what percent of your household income in the 2018-19 financial year was generated off-farm?

[Record a number <100]

Final Section

Thank you very much for your time and help in this survey.

Q28 Do you have any comments or questions about the survey or the topics discussed?

[Open ended question]

Finally, as mentioned at the beginning, if you provide us with an email address we can send you details about the study, what your information will be used for, and contact details to request more information or make a complaint. If upon reading this information you wish to withdraw your participation (and be assured that all the information obtained in this conversation be destroyed) you will have two business days to notify us. Details to do this will be included in the email with the Information Sheet. Your email address will not be stored and will not be linked to your responses or phone number.

If YES, proceed to record the email address.

If NO, thank them for their time and terminate the interview.

Appendix 4. Supplementary information for Chapter 6

Table A4.1 presents the mean concern scores, as per Table 6.3. However, where Table 6.3 presented mean comparisons *across* respondent groups, Table A4.1 presents mean comparisons *within* respondent groups.

Figure A4.1 shows the distribution of total social licence concern scores for the public and farmers. The total social licence concern scores were calculated by summing individuals' agreement with 15 statements that stated [issue] is a concern, on a Likert scale from: 1=Strongly disagree to 5=Strongly agree. The total score was then rescaled to start at zero. The 15 statements describing issues are included in Table 6.3. Likewise, Figure A4.2 shows the distribution of component scores for the public and farmers. The component scores as graphed in Figure A4.2 are composite variables, providing information about how individuals' responses compare to others. In Figure A4.2, respondents with a mean component score less than zero were less concerned about social licence issues than the average respondent. The issues captured in each component are listed in Table 6.4.

Table A4.2 provides the results of an ordinary least squares model estimation where the total concern score, as graphed in Figure A4.1, was the dependent variable. The explanatory variables included in the analysis were the same as the seemingly unrelated regression analysis, and described in Table 6.1 and Table 6.2. Table A4.3 and Table A4.4 provide results of ordered probit model estimates for the public, and farmer samples, respectively. The dependent variable for the ordered probit models ranged from 1=Strongly disagree to 5=Strongly agree that [issue] is a concern.

Further, Table A4.5 to Table A4.7 show the correlation coefficients and variable inflation factors for all explanatory variables included in the public and farmer seemingly unrelated regression (results in Table 6.6 and Table 6.7), ordinary least squares and ordered probit model estimates.

A series of variables and variable forms were explored before the seemingly unrelated regression model estimates, as reported in the analysis, were finalised. Summary statistics for the alternative forms of explanatory variables and additional explanatory variables are included in Table A4.8–Table A4.11

Table A4.1. Comparison of the mean score for 15 agricultural industry issues, reflecting the relative concern held, by each respondent group.

Public (n=2032)			Crop-livestock farmers (n=131)		
Foreign investment	4.14 ^a	(0.94)	Foreign investment	4.21 ^a	(1.16)
Off-farm animal welfare	3.93 ^b	(1.03)	Urban sprawl	4.07 ^a	(1.25)
Chemical use	3.90 ^b	(0.92)	Irrigation water extraction	3.66 ^b	(1.25)
Urban sprawl	3.89 ^b	(0.92)	Lobby groups	3.58 ^{bc}	(1.27)
Irrigation water extraction	3.80 ^c	(1.01)	Soil health	3.40 ^{cd}	(1.33)
Clearing native vegetation	3.74 ^d	(0.98)	Clearing native vegetation	3.38 ^{cd}	(1.27)
Synthetic fertiliser use	3.72 ^d	(0.96)	Culling pest animals	3.18 ^{de}	(1.37)
Soil health	3.66 ^e	(0.97)	On-farm animal welfare	3.17 ^{de}	(1.43)
Use of GM crops	3.63 ^e	(1.17)	Off-farm animal welfare	3.16 ^{de}	(1.42)
On-farm animal welfare	3.63 ^e	(1.14)	Chemical use	3.14 ^{de}	(1.29)
Indigenous knowledge and rights	3.62 ^e	(1.10)	Food safety	3.05 ^e	(1.35)
Volume of GHG emissions	3.56 ^f	(1.10)	Synthetic fertiliser use	2.96 ^e	(1.30)
Culling pest animals	3.44 ^g	(1.08)	Use of GM crops	2.90 ^e	(1.45)
Lobby groups	3.36 ^h	(0.96)	Indigenous knowledge and rights	2.83 ^e	(1.14)
Food safety	3.34 ^h	(1.06)	Volume of GHG emissions	2.56 ^f	(1.26)
Cropping-only farmers (n=37)			Livestock-only farmers (n=183)		
Urban sprawl	3.86 ^a	(1.13)	Urban sprawl	4.14 ^a	(1.14)
Foreign investment	3.86 ^a	(1.23)	Foreign investment	4.05 ^a	(1.26)
Irrigation water extraction	3.76 ^{ab}	(1.21)	Soil health	3.65 ^b	(1.22)
Soil health	3.32 ^{bc}	(1.42)	Irrigation water extraction	3.64 ^b	(1.28)
Lobby groups	3.30 ^{bc}	(1.31)	Clearing native vegetation	3.64 ^{bc}	(1.21)
Clearing native vegetation	3.22 ^{bcd}	(1.46)	Off-farm animal welfare	3.50 ^{bc}	(1.37)
Off-farm animal welfare	3.16 ^{bcd}	(1.36)	Chemical use	3.45 ^{bc}	(1.27)
Chemical use	3.05 ^{bcdde}	(1.54)	Lobby groups	3.43 ^{cd}	(1.36)
Culling pest animals	3.00 ^{bcdde}	(1.45)	On-farm animal welfare	3.42 ^{cd}	(1.48)
On-farm animal welfare	2.84 ^{cde}	(1.52)	Culling pest animals	3.26 ^{de}	(1.44)
Volume of GHG emissions	2.84 ^{cde}	(1.38)	Use of GM crops	3.12 ^{ef}	(1.49)
Indigenous knowledge and rights	2.78 ^{de}	(1.13)	Food safety	3.10 ^{ef}	(1.48)
Food safety	2.68 ^{def}	(1.36)	Synthetic fertiliser use	3.07 ^{ef}	(1.40)
Synthetic fertiliser use	2.54 ^{ef}	(1.43)	Indigenous knowledge and rights	2.93 ^{efg}	(1.31)
Use of GM crops	2.16 ^f	(1.48)	Volume of GHG emissions	2.71 ^g	(1.24)

Notes: Issues are defined in Table 6.3. Agreement with statements measured on a 5-point Likert scale where: 1=Strongly disagree, 2=Disagree, 3=Neither agree nor disagree or I don't know, 4=Agree, 5=Strongly agree. Standard deviation is in brackets. Within respondent groups, issues are listed such that means are in descending order and means with different superscript letters are statistically significantly different ($p \leq 0.05$) based on Wilcoxon signed-rank tests.

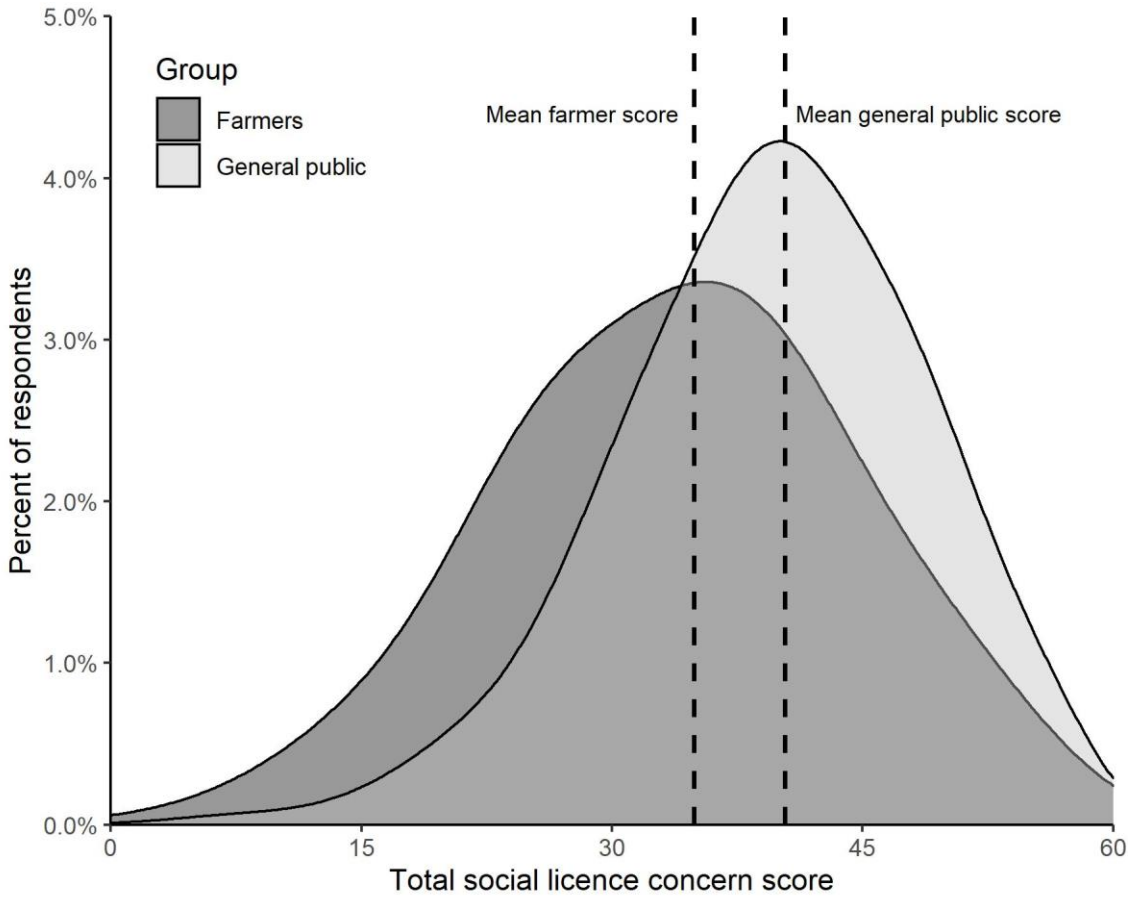


Figure A4.1. Distribution of public (n=2,032) and farmer (n=351) total social licence concern scores, calculated based on agreement with all statements about social licence concerns in the agricultural industry (0=Strongly disagree with all 15 statements to 60=Strongly agree with all 15 statements).

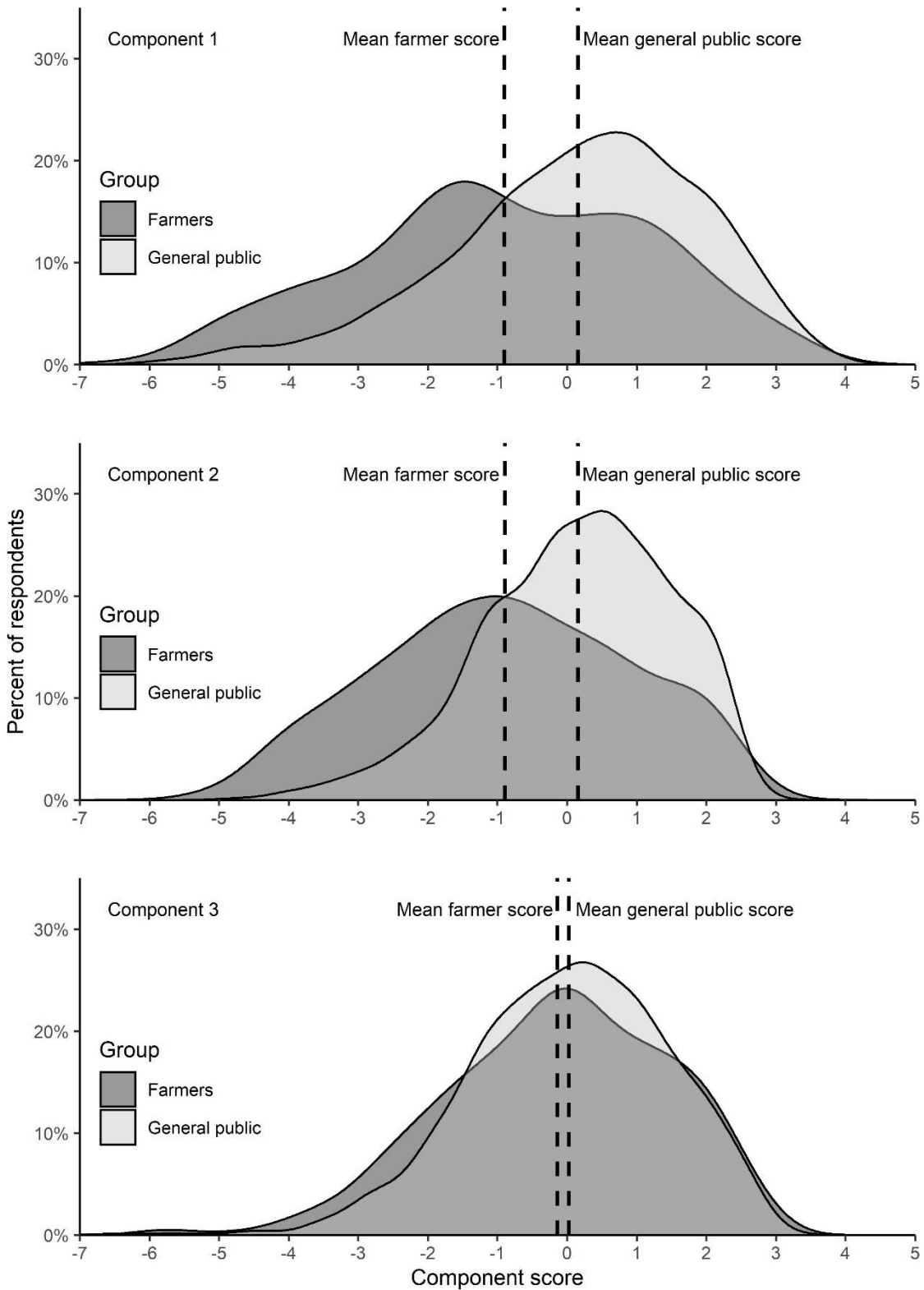


Figure A4.2. Percentage of respondents with different component scores for Component 1 – undersupply of public goods; Component 2 – negative externalities; and Component 3 – use of socially valuable assets, for the public (n=2,032) and farmer samples (n=351).

Table A4.2. Results from ordinary least squares model on the public (n=1,824) and farmer sample (n=351) agreement with all statements about agricultural issues.

	Public		Farmers	
	Coefficient		Coefficient	
	(Standard error)		(Standard error)	
State (Victoria)	-0.158	(0.377)	-0.765	(1.171)
Agriculture main industry	-0.657	(0.761)	-1.566	(1.130)
Male	-1.487***	(0.386)	-1.728	(1.159)
Age	0.039***	(0.014)	0.085	(0.058)
University educated	-0.264	(0.419)	-2.729**	(1.377)
Climate change is happening	2.345***	(0.580)	2.072	(1.334)
Climate change is largely human induced	1.757***	(0.491)	0.988	(1.241)
Climate change will have negative impact	3.488***	(0.415)	2.411**	(1.203)
Pro-environmental trade-offs	3.319***	(0.318)	2.164**	(0.874)
Confidence in government decisions	-0.308	(0.379)		
Urban	0.429	(0.463)		
Household income	-0.018***	(0.004)		
Unemployed	0.933	(0.820)		
Agricultural industry experience	-2.137***	(0.543)		
Information from farmers	-0.017	(0.393)		
Information from industry organisations	0.123	(0.401)		
Information from friends and family	0.597	(0.404)		
Information from government	0.146	(0.382)		
Information from research organisations	0.822**	(0.397)		
Activist group member	5.547***	(0.828)		
Omnivore	-3.823***	(0.384)		
Farm area			-0.015	(0.012)
Crop-only farm			-2.328	(1.887)
Livestock-only farm			0.996	(1.288)
Organic			6.610***	(2.108)
Irrigator			0.729	(1.454)
Off-farm income			0.048**	(0.019)
Farm productivity trend			-1.505**	(0.619)
Farm group member			2.084*	(1.148)
Succession plan			1.733	(1.131)
Constant	26.252***	(1.582)	24.303***	(5.609)
Number of observations	1824		351	
Adjusted R squared	0.323		0.132	
F Statistic	42.37***		3.95***	

Notes: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1; Dependent variable ranged from 0=Strongly disagree with all 15 statements to 60=Strongly agree with all 15 statements.

Table A4.3. Results from ordered probit models for the public's (n=1,824) concern about 15 agricultural issues.

	Foreign investment	Off-farm animal welfare	Chemical use	Urban sprawl	Irrigation water extraction	Clearing native vegetation	Synthetic fertiliser use	Soil health	Use of GM crops	On-farm animal welfare	Indigenous knowledge and rights	Volume of GHG emissions	Culling pests	Lobby groups	Food safety
State (Victoria)	0.030	-0.138***	0.064	0.050	-0.425***	-0.099*	0.136***	-0.033	0.114**	0.000	0.150***	-0.004	-0.003	-0.026	-0.053
Agriculture main industry	0.197**	-0.386***	-0.293***	0.361***	-0.028	-0.081	-0.192**	-0.222**	-0.032	-0.411***	-0.077	-0.245***	-0.423***	-0.080	-0.230***
Urban	-0.078	0.032	0.001	-0.056	0.017	-0.017	0.038	0.054	-0.022	0.050	0.028	0.072	0.051	0.130**	0.100
Male	-0.262***	-0.328***	-0.093*	-0.090	0.112**	-0.049	-0.140***	-0.025	-0.225***	-0.235***	-0.233***	-0.072	-0.114	0.161***	0.035
Age	0.018***	0.000	0.009***	0.014***	0.011***	0.008***	0.008***	0.005***	0.004**	-0.008***	0.003*	-0.005***	-0.003	-0.004*	-0.007***
University educated	-0.130**	-0.138**	-0.002	0.086	0.112*	0.048	-0.071	0.115**	-0.123**	-0.124**	0.002	0.052	-0.061	0.050	-0.068
Household income	-0.001**	-0.001	-0.001**	-0.002***	-0.001*	-0.001	-0.001***	-0.001	-0.002***	-0.001*	-0.002***	-0.001	-0.002***	-0.002***	-0.002***
Unemployed	0.089	-0.066	0.274	0.063	0.090	-0.054	0.091	0.193*	0.161	-0.001	0.017	0.047	0.080	0.036	0.083
Omnivore	-0.028	-0.378***	-0.421***	-0.201***	-0.212*	-0.232***	-0.372***	-0.318***	-0.307***	-0.361***	-0.334***	-0.374***	-0.346***	-0.228***	-0.267***
Activist member	0.352***	0.697***	0.712***	0.399***	0.369***	0.422***	0.498***	0.435***	0.372***	0.609***	0.547***	0.238**	0.582***	0.489***	0.610***
Agriculture experience	0.197**	-0.386***	-0.293***	0.361***	-0.028	-0.081	-0.192**	-0.222**	-0.032	-0.411***	-0.077	-0.245***	-0.423***	-0.080	-0.230***
Information–farmers	0.112*	0.023	0.099*	0.180***	0.010	0.012	0.066	0.008	0.123**	-0.113**	-0.028	-0.074	-0.038	-0.161***	-0.107*
Information–industry	0.050	0.002	-0.047	0.055	0.020	-0.062	-0.010	0.017	0.063	0.004	-0.025	-0.066	-0.045	0.010	0.069
Information–friends/family	0.039	0.066	-0.011	0.082	0.002	-0.066	0.077	0.089	0.109*	0.019	0.053	0.078	-0.005	0.036	0.018
Information–government	0.049	-0.001	-0.020	-0.013	-0.041	0.040	-0.083	0.064	-0.032	-0.031	-0.012	0.077	0.037	0.096*	-0.028
Information–research orgs.	-0.007	0.086	0.061	0.114**	0.054	0.065	0.056	0.023	-0.017	0.127**	0.112**	0.128**	0.124**	0.076	-0.004
Confidence in government	-0.131**	-0.094*	0.034	-0.038	-0.158***	-0.202***	-0.035	-0.061	0.029	0.026	-0.065	-0.018	0.086	-0.039	0.098**
Climate change (CC) is happening	0.023	0.283***	0.131	0.043	0.108	0.301***	0.106	0.249***	0.038	0.168**	0.190**	0.522***	0.164**	-0.065	0.090
CC is largely human induced	-0.071	0.113	0.099	-0.117*	0.255***	0.170**	0.111	0.167***	0.043	0.191***	0.142**	0.518***	0.128*	0.038	0.123*
CC will have negative impact	0.284***	0.233***	0.231***	0.264***	0.346***	0.365***	0.260***	0.211***	0.154***	0.251***	0.264***	0.439***	0.218***	0.316***	0.171***
Pro-environmental trade-offs	0.209***	0.246***	0.397***	0.271***	0.259***	0.404***	0.310***	0.377***	0.193***	0.234***	0.369***	0.383***	0.274***	0.154***	0.045
/cut1	-1.017	-1.440	-0.601	-0.809	-0.790	-0.306	-0.747	-0.390	-1.032	-1.610	-0.337	-0.318	-1.135	-1.628	-2.069
/cut2	-0.131	-0.575	0.291	0.173	0.253	0.745	0.123	0.681	-0.130	-0.523	0.475	0.849	-0.053	-0.542	-0.881
/cut3	0.630	0.154	1.198	1.068	1.107	1.669	1.169	1.580	0.461	0.178	1.327	1.766	0.759	0.625	-0.168
/cut4	1.633	1.234	2.516	2.315	2.208	2.889	2.348	2.875	1.356	1.174	2.388	2.975	1.868	1.650	1.007
Chi squared statistic	220.2***	374.1***	784.0***	243.0***	342.3***	396.8***	296.3***	340.4***	185.6***	427.2***	376.2***	784.0***	352.4***	188.0***	184.3***
McKelvey & Zavoina R ²	0.141	0.216	0.213	0.146	0.196	0.221	0.169	0.191	0.109	0.231	0.208	0.382	0.194	0.109	0.107

Notes: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1. Issues defined in Table 6.3. Dependent variable range: 1=Strongly disagree to 5=Strongly agree [issue] is a concern.

Table A4.4. Results from ordered probit models for farmers' (n=351) concern about 15 agricultural issues.

	Foreign investment	Off-farm animal welfare	Chemical use	Urban sprawl	Irrigation water extraction	Clearing native vegetation	Synthetic fertiliser use	Soil health	Use of GM crops	On-farm animal welfare	Indigenous knowledge and rights	Volume of GHG emissions	Culling pests	Lobby groups	Food safety
State (Victoria)	-0.032	0.042	0.009	-0.368***	-0.399**	0.041	0.127	-0.104	0.155	0.030	-0.145	-0.035	0.085	-0.099	-0.109
Agriculture main industry	0.005	-0.076	0.105	-0.068	-0.106	0.032	-0.108	-0.004	-0.111	-0.202*	-0.021	-0.208*	-0.187	-0.272**	-0.161
Male	-0.540***	0.041	-0.215*	0.146	-0.162	-0.156	-0.372***	0.099	-0.476***	0.113	-0.355***	0.037	-0.011	0.082	0.208*
Age	0.004	0.005	0.001	0.017***	-0.001	0.014**	0.006	0.006	0.001	0.005	0.007	0.007	0.005	0.001	-0.001
University educated	-0.257	-0.071	-0.335**	0.074	0.113	-0.093	-0.280*	0.130	-0.352**	-0.132	-0.387***	0.025	-0.289**	-0.364**	-0.161
Farm area	-0.002*	0.001	-0.001	-0.003**	0.000	-0.001	0.000	-0.002	-0.001	-0.001	-0.002*	0.000	-0.001	-0.002	0.000
Crop-only farm	-0.227	-0.020	-0.006	-0.065	0.187	-0.098	-0.402**	-0.022	-0.618***	-0.179	0.009	0.281	-0.092	-0.217	-0.153
Livestock-only farm	-0.175	0.162	0.328**	0.142	-0.007	0.166	-0.050	0.166	0.008	0.118	0.178	0.003	0.016	-0.115	0.019
Organic	-0.083	-0.083	0.139***	0.251	-0.097	0.292	0.927***	0.742***	1.150***	0.215	0.463**	0.373	0.101	0.495**	0.195
Irrigator	0.306*	0.241	-0.084	0.276	-0.009	-0.154	-0.058	0.100	-0.028	0.145	-0.150	0.086	-0.053	0.075	0.041
Off-farm income	0.003	0.002	0.003	0.000	0.000	0.001	0.005**	0.002	0.005**	0.004*	-0.002	0.003	0.003	0.006***	0.004**
Farm productivity trend	-0.123*	0.041	-0.169**	-0.149**	-0.185***	0.002	-0.075	-0.095	-0.127*	-0.049	-0.099	-0.078	-0.066	0.021	-0.159**
Farm group member	-0.062	0.190	0.357***	0.153	0.010	0.101	0.066	0.332***	-0.040	0.055	0.387***	0.235*	0.019	0.112	-0.003
Succession plan	0.232*	0.042	0.113	0.340***	0.011	0.158	0.174	0.110	-0.150	0.007	-0.042	0.186	-0.016	0.293**	0.116
Climate change (CC) is happening	-0.248	0.114	0.068	-0.164	0.159	0.297**	0.101	0.199	-0.188	0.193	0.264*	0.639***	0.164	0.017	0.051
CC is largely human induced	0.021	-0.168	-0.046	0.119	0.146	0.125	0.177	0.091	0.153	0.064	0.085	0.389***	0.112	-0.034	-0.075
CC will have negative impact	0.297**	0.150	0.121	0.303**	0.176	0.256**	0.021	0.188	0.046	0.069	0.324**	0.062	-0.018	-0.078	0.236*
Pro-environmental trade-offs	0.095	0.422*	0.153	0.151	0.326***	0.049	0.129	0.166*	0.126	0.148	0.055	0.363***	-0.150	0.025	-0.027
/cut1	-1.896	1.231	-0.664	-0.551	-1.100	0.173	-0.261	0.007	-1.077	0.003	-0.590	1.582	-1.409	-1.040	-1.379
/cut2	-1.443	1.795	-0.085	0.072	-0.510	0.611	0.372	0.592	-0.516	0.577	0.012	2.288	-0.858	-0.477	-0.809
/cut3	-0.976	2.191	0.519	0.592	0.165	1.420	1.095	1.202	0.067	0.937	0.993	3.132	-0.316	0.106	-0.361
/cut4	-0.322	3.054	1.431	1.243	0.933	2.167	1.658	2.019	0.527	1.581	1.734	3.981	0.283	0.858	0.393
Chi squared statistic	42.57***	36.11***	57.01***	44.48***	53.17***	37.72***	55.48***	45.46***	73.49***	25.03	51.96***	94.63***	19.31	33.78	24.21
McKelvey & Zavoina R ²	0.147	0.110	0.171	0.151	0.161	0.113	0.166	0.138	0.215	0.078	0.153	0.261	0.059	0.104	0.075

Notes: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1. Issues defined in Table 6.3. Dependent variable range: 1=Strongly disagree to 5=Strongly agree [issue] is a concern.

Table A4.5. Correlation coefficients for explanatory variables included in the public seemingly unrelated regression model (n=1,824).

Explanatory variables	State (Victoria)	Ag main industry	Urban	Male	Age	University educated	Household income	Unemployed	Omnivore	Activist member	Ag experience	Info–farmers	Info–industry	Info–friends/family	Info–govt	Info–research orgs	Confidence in govt	Climate change (CC) is happening	CC is largely human induced	CC will have negative impact	Pro-environmental trade-offs	
State (Victoria)	1																					
Ag main industry	-0.13	1																				
Urban	-0.05	-0.40	1																			
Male	-0.04	-0.02	0.02	1																		
Age	-0.18	0.08	-0.15	0.27	1																	
University educated	0.13	-0.13	0.24	-0.03	-0.30	1																
Household income	0.07	-0.08	0.19	-0.01	-0.30	0.36	1															
Unemployed	-0.01	0.02	-0.01	-0.05	-0.09	-0.05	-0.17	1														
Omnivore	-0.05	0.05	-0.06	0.15	0.11	-0.11	0.00	-0.01	1													
Activist member	0.01	-0.03	0.02	0.03	-0.02	0.10	0.01	-0.01	-0.11	1												
Ag experience	-0.10	0.18	-0.19	0.06	0.08	-0.05	-0.03	-0.03	0.03	0.05	1											
Info–farmers	-0.05	0.15	-0.20	0.02	0.15	-0.18	-0.09	-0.01	0.04	0.02	0.13	1										
Info–industry	0.00	0.01	0.00	0.10	0.05	0.01	-0.01	-0.01	0.00	0.01	0.01	0.15	1									
Info–friends/family	0.01	0.06	-0.09	-0.13	-0.13	-0.01	0.04	0.01	-0.07	0.03	0.06	-0.01	-0.26	1								
Info–govt	0.03	-0.07	0.11	0.00	-0.14	0.13	0.09	-0.01	-0.03	-0.04	-0.10	-0.15	0.08	-0.16	1							
Info–research orgs	-0.03	-0.03	0.06	0.04	-0.01	0.09	0.03	0.02	-0.12	0.03	-0.02	-0.07	0.15	-0.21	0.09	1						
Confidence in govt	0.07	-0.04	0.02	-0.02	-0.13	0.01	-0.03	0.01	-0.02	0.01	-0.07	0.01	0.08	0.01	0.06	0.00	1					
Climate change (CC) is happening	0.03	-0.09	0.10	-0.09	-0.17	0.12	0.08	0.03	-0.13	0.07	-0.07	-0.14	-0.03	-0.02	0.06	0.10	0.04	1				
CC is largely human induced	0.07	-0.07	0.08	-0.14	-0.23	0.14	0.10	0.02	-0.11	0.08	-0.11	-0.13	-0.01	-0.01	0.06	0.08	0.03	0.47	1			
CC will have negative impact	0.06	-0.06	0.08	-0.10	-0.21	0.17	0.12	0.03	-0.15	0.12	-0.02	-0.10	0.01	-0.01	0.06	0.08	0.01	0.37	0.38	1		
Pro-environmental trade-offs	-0.02	-0.04	0.04	-0.09	-0.08	0.09	0.02	0.05	-0.15	0.08	-0.04	-0.07	-0.02	-0.03	0.03	0.10	-0.06	0.35	0.31	0.31	1	

Table A4.6. Correlation coefficients for explanatory variables included in the farmer seemingly unrelated regression model (n=351).

Explanatory variables	State (Victoria)	Ag main industry	Male	Age	University educated	Farm area	Crop-only farm	Livestock-only farm	Organic	Irrigator	Off-farm income	Farm productivity trend	Member of group	Succession plan	CC is happening	CC is happening	CC is happening	Pro-environmental trade-offs
State (Victoria)	1																	
Ag main industry	-0.12	1																
Male	-0.03	0.05	1															
Age	0.01	-0.13	0.01	1														
University educated	0.10	-0.03	-0.24	-0.16	1													
Farm area	-0.14	0.01	-0.05	-0.10	0.08	1												
Crop-only farm	-0.02	0.05	0.01	-0.11	-0.02	-0.03	1											
Livestock-only farm	0.26	-0.15	-0.03	0.18	0.16	0.06	-0.36	1										
Organic	-0.05	0.09	-0.01	0.02	0.00	0.33	0.03	0.02	1									
Irrigator	0.03	-0.02	0.00	-0.07	0.04	-0.05	-0.06	0.04	0.02	1								
Off-farm income	0.08	-0.06	-0.08	0.05	0.20	0.01	-0.11	0.28	0.00	0.00	1							
Farm productivity trend	0.19	-0.08	0.08	-0.17	0.07	-0.03	0.09	-0.01	0.06	0.10	-0.07	1						
Farm group member	0.08	-0.10	-0.02	-0.09	0.24	0.01	0.04	-0.10	-0.06	-0.02	0.01	0.08	1					
Succession plan	-0.10	0.09	-0.03	-0.07	-0.14	-0.02	0.05	-0.15	0.03	0.00	-0.14	0.10	0.00	1				
Climate change (CC) is happening	0.03	-0.06	-0.07	-0.06	0.14	0.00	0.02	0.03	0.10	0.07	0.05	0.04	0.10	-0.10	1			
CC is largely human induced	0.03	0.00	-0.19	-0.05	0.18	0.03	-0.04	0.04	0.00	-0.12	0.07	-0.03	0.08	-0.08	0.37	1		
CC will have negative impact	0.06	0.00	-0.01	0.02	0.18	0.05	-0.09	0.13	-0.01	-0.02	0.04	0.04	0.06	0.01	0.28	0.31	1	
Pro-environmental trade-offs	0.02	0.03	-0.05	-0.02	0.17	-0.01	0.02	0.07	0.06	-0.14	0.02	-0.02	0.04	-0.06	0.19	0.22	0.16	1

Table A4.7. Variance inflations factors for each explanatory variable included in the seemingly unrelated regression models on the public sample (n=1,824) and farmer sample (n=351).

Explanatory variables	Public Variance inflation factors	Farmers Variance inflation factors
State (Victoria)	1.10	1.18
Agriculture main industry	1.24	1.09
Male	1.14	1.12
Age	1.43	1.16
University educated	1.30	1.32
Climate change is happening	1.44	1.31
Climate change is largely human induced	1.45	1.35
Climate change will have negative impact	1.34	1.22
Pro-environmental trade-offs	1.25	1.12
Urban	1.35	
Household income	1.28	
Unemployed	1.06	
Agricultural industry experience	1.10	
Information from farmers	1.14	
Information from industry organisations	1.13	
Information from friends and family	1.18	
Information from government	1.09	
Information from research organisations	1.11	
Confidence in government decisions	1.05	
Activist group member	1.05	
Omnivore	1.15	
Farm area		1.20
Crop-only farm		1.18
Livestock-only farm		1.46
Organic		1.19
Irrigator		1.08
Off-farm income		1.13
Farm productivity trend		1.14
Farm group member		1.12
Succession plan		1.10
Mean variance inflation factor	1.22	1.19

Table A4.8. Alternative forms of socio-demographic variables tested but not used in the public seemingly unrelated regression model (n=1,824).

Variable	Definition	Percent or Mean	Min	Max
Household income (percent)	\$0–\$24,500	7.82		
	\$24,501–\$38,900	11.47		
	\$38,901–\$52,900	12.70		
	\$52,901–\$69,500	10.68		
	\$69,501–\$88,500	9.65		
	\$88,501–\$109,300	11.66		
	\$109,301–\$134,800	9.01		
	\$134,801–\$168,700	8.56		
	\$168,70 –\$222,300	5.41		
	\$222,301 or above	2.81		
Household income	Semi-continuous variable as used in model presented (thousands of AUD per year)	86.76 (53.68)	24.5	222.3
Household income ²	Square of semi-continuous variable above			
High household income	1=Household income reported by respondent is greater than median income for postcode ^a ; 0=Otherwise	0.59 (0.49)	0	1
Substituted household income ^a	Thousands of AUD per year, median household income for postcode ^a used when income information missing (n=208)	85.10 (51.41)	24.5	222.3
Age (percent)	18–34 years	28.13		
	35–44 years	18.15		
	45–54 years	13.27		
	55–64 years	17.38		
	65, plus years	23.08		
Age	Semi-continuous variable as used in model presented (Years)	46.47 (15.36)	26	65
Age ²	Square of semi-continuous variable above			
Highest level of education completed (percent)	Year 10 or below	7.73		
	Year 12 or below	18.97		
	Advanced diploma, diploma, or certificate (incl. TAFE)	33.33		
	Bachelor degree	23.46		
	Graduate diploma or certificate	6.58		
	Post-graduate degree	9.92		
Post-school education	1=Post-school education; 0=Otherwise	0.73 (0.44)	0	1
Employed	1=Employed; 0=Otherwise	0.61 (0.49)	0	1
Not in labour force	1= Not in labour force; 0=Otherwise	0.34 (0.47)	0	1
Vegan	1= Nominated vegan diet; 0=Otherwise	0.02 (0.13)	0	1
Vegetarian	1= Nominated vegetarian diet; 0=Otherwise	0.05 (0.21)	0	1
Flexitarian	1= Nominated flexitarian diet; 0=Otherwise	0.34 (0.47)	0	1

Notes: Standard deviation in brackets. AUD is Australian dollars. ^a Data for median household income for postcode from Australian Bureau of Statistics (2018a).

Table A4.9. Alternative forms of socio-demographic and farm variables tested but not used in the farmer seemingly unrelated regression model (n=351).

Variable	Definition	Percent or Mean	Min	Max
Irrigated area	Percent of farm area under irrigation in typical year	4.84 (16.38)	0	100
Off-farm income	1=Reported having off-farm income; 0=Otherwise	0.95 (0.22)	0	1
Age (percent)	18–34 years	3.70		
	35–44 years	9.12		
	45–54 years	18.80		
	55–64 years	32.19		
	65, plus years	36.18		
Age	Semi-continuous variable as used in model presented (Years)	56.55 (9.97)	26	65
Age ²	Square of semi-continuous variable above			
Highest level of education completed (percent)	Year 10 or below	17.66		
	Year 12 or below	26.21		
	Advanced diploma, diploma, or certificate (incl. TAFE)	29.06		
	Bachelor degree	17.38		
	Graduate diploma or certificate	2.85		
Post-school education	1=Post-school education; 0=Otherwise	0.56 (0.50)	0	1

Note: Standard deviation in brackets.

Table A4.10. Alternative forms of attitudinal variables tested but not used in the public seemingly unrelated regression model (n=1,824).

Variable	Definition	Mean	Min	Max
No confidence in government decisions	1=Disagree or strongly disagree Australian governments make policy and regulatory decisions based on scientific and economic evidence; 0=Otherwise	0.34 (0.47)	0	1
Climate change not happening	1=Disagree or strongly disagree that climate change is happening; 0=Otherwise	0.06 (0.24)	0	1
Climate change not largely human induced	1=Disagree or strongly disagree climate change is largely human-induced; 0=Otherwise	0.11 (0.32)	0	1
Climate change will not have negative impact	1=Disagree or strongly disagree that climate change will have a negative impact on household; 0=Otherwise	0.17 (0.37)	0	1
Different forms of the construction variables used to create Pro-Environmental trade-offs (average index)	1=Agree or strongly agree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.76 (0.43)	0	1
	1= Agree or strongly agree that the environment needs to be protected even if it impacts economic prosperity	0.79 (0.41)	0	1
	1=Agree or strongly agree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.41 (0.49)	0	1
	1=Disagree or strongly disagree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.05 (0.21)	0	1
	1= Disagree or strongly disagree that the environment needs to be protected even if it impacts economic prosperity	0.06 (0.23)	0	1
	1=Disagree or strongly disagree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.32 (0.47)	0	1

Note: Standard deviation in brackets.

Table A4.11. Alternative forms of attitudinal variables tested but not used in the farmer seemingly unrelated regression model (n=351).

Variable	Definition	Mean	Min	Max
Climate change not happening	1=Disagree or strongly disagree that climate change is happening; 0=Otherwise	0.15 (0.36)	0	1
Climate change not largely human induced	1=Disagree or strongly disagree climate change is largely human-induced; 0=Otherwise	0.25 (0.43)	0	1
Climate change will not have negative impact	1=Disagree or strongly disagree that climate change will have a negative impact on household; 0=Otherwise	0.19 (0.40)	0	1
Different forms of the construction variables used to create Pro-Environmental trade-offs (average index)	1=Agree or strongly agree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.84 (0.36)	0	1
	1= Agree or strongly agree that the environment needs to be protected even if it impacts economic prosperity	0.76 (0.43)	0	1
	1=Agree or strongly agree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.39 (0.49)	0	1
	1=Disagree or strongly disagree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.04 (0.20)	0	1
	1= Disagree or strongly disagree that the environment needs to be protected even if it impacts economic prosperity	0.07 (0.25)	0	1
	1=Disagree or strongly disagree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.33 (0.47)	0	1

Note: Standard deviation in brackets.

Appendix 5. Supplementary information for Chapter 7

Figure A5.1 shows the distribution of weighting scores allocated across the six characteristics, and Figure A5.2 is a graphical representation of the summary statistics presented in Table 7.1 in Chapter 7.

Table A5.1 presents and compares the mean importance point allocation for different subgroups of the sample, and Table A5.2 presents the results of the fractional multinomial logit model analysis (whereas the results in Table 7.3 in Chapter 7 are average marginal effects). Further, Table A5.3 and Table A5.4 report the correlation coefficients and variance inflation factors for all explanatory variables included in the fractional multinomial logit model analysis.

A series of variables and variable forms were explored before the fractional multinomial logit model, as reported in the analysis, was finalised. Summary statistics for the alternative forms of explanatory variables and additional explanatory variables are included in Table A5.5–Table A5.8. Interaction terms were also examined where the literature and preliminary results from the fractional multinomial logit models indicated that meaningful relationships could exist. This was particularly the case for the proportion of importance weighting allocated to ‘job creation’ by respondents that were living in regional areas (urban=0), unemployed (unemployed=1), and not university educated (university education=0). The interaction terms were not included in the final model due to a number of reasons. The most important reason was small sample size. For example, only four respondents reported living in a regional area, being unemployed, and not having a university education.

Using the postcode reported by survey respondents, it was possible to access information about the community they were living in at the time of the survey from the Australian Bureau of Statistics. Information available included: unemployment and employment rates; median household incomes; relative socioeconomic advantage; and the main industries and occupations of employment in the reported postcodes. The socioeconomic advantage variable included in the final model (Table 7.2), accounts for the level of unemployment, the proportion of the workforce employed in certain occupations, and other postcode specific information (Australian Bureau of Statistics, 2018b). For this reason, the characteristics captured in the Socio-Economic Advantage and Disadvantage Index (i.e. employment and unemployment rates and occupations of employment) were not included separately in the analysis (Table A5.6).

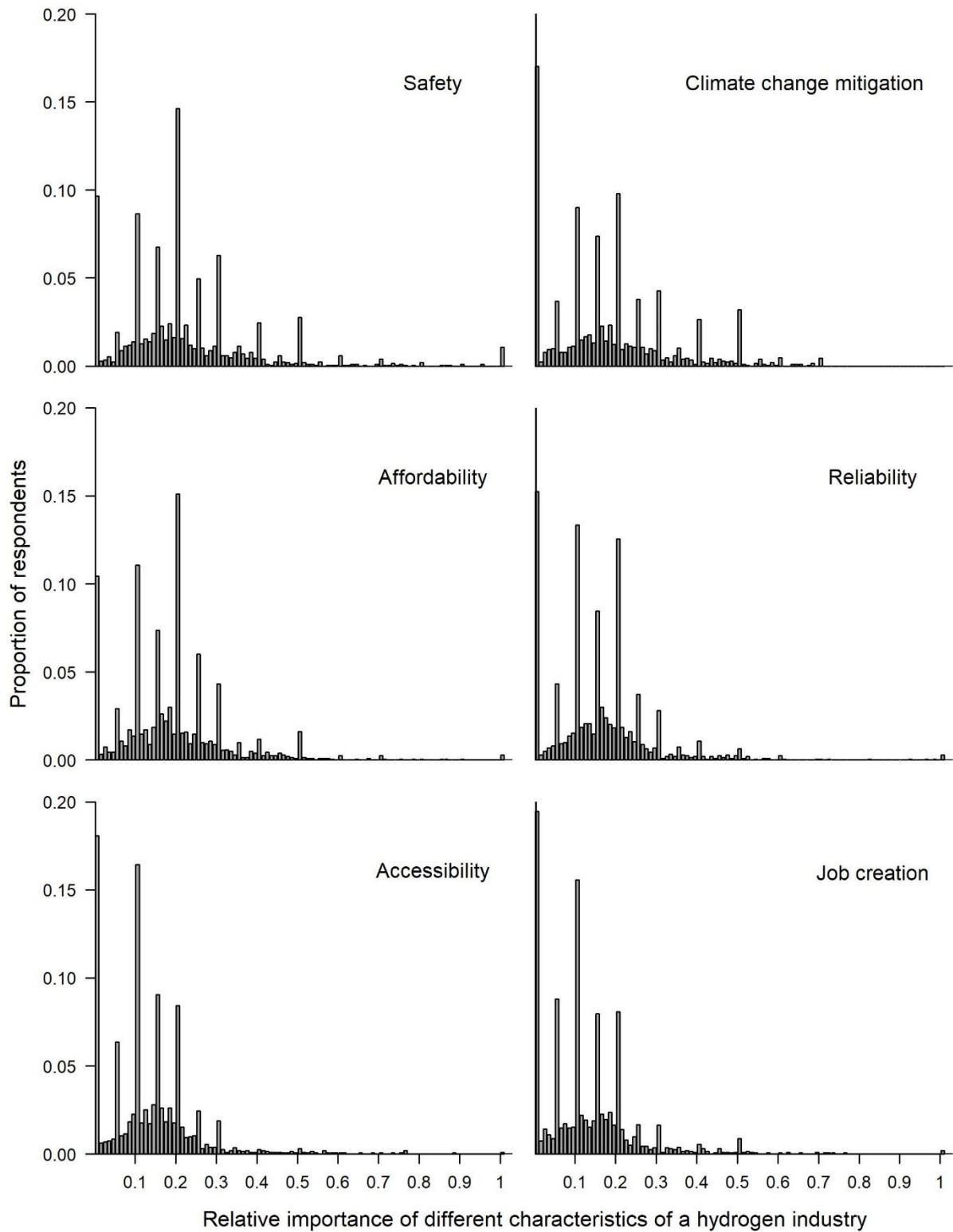


Figure A5.1. Distribution of weighting allocated to six characteristics indicating the importance of each to respondents' willingness to support a hydrogen industry (n=1,824). Characteristics are defined in Q 12 in Appendix 3 and Table 7.1.

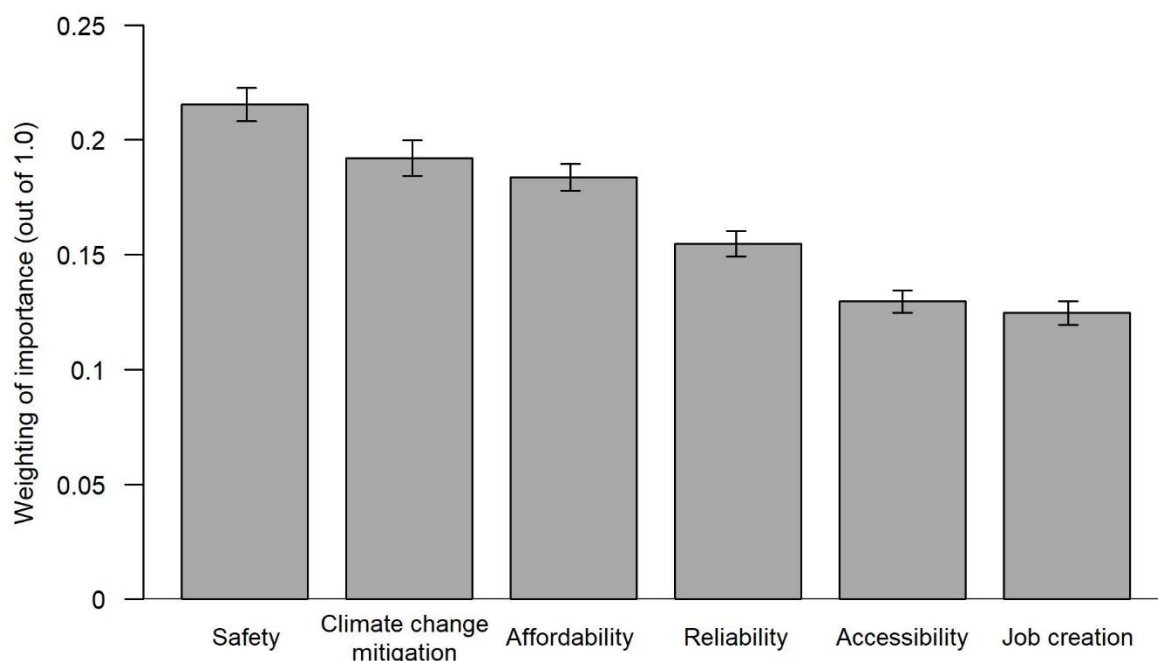


Figure A5.2. Mean weighting (based on importance) respondents' (n=1,824) allocated to each of six characteristics considered important for willingness to support a hydrogen industry. Error bars depict 95% confidence interval. Characteristics are defined in Q 12 in Appendix 3 and Table 7.1.

Table A5.1. Mean proportion of points allocated to each of six factors by survey respondents across states and regions (n=1824).

Variables	South Australia		Victoria	
	Regional respondents	Urban respondents	Regional respondents	Urban respondents
Safety	0.24 ^b (0.19)	0.21 ^{ab} (0.16)	0.23 ^b (0.19)	0.20 ^a (0.16)
Climate change mitigation	0.19 ^a (0.21)	0.19 ^a (0.17)	0.18 ^a (0.17)	0.20 ^a (0.18)
Affordability	0.17 ^a (0.14)	0.19 ^a (0.14)	0.18 ^a (0.14)	0.18 ^a (0.13)
Reliability	0.14 ^a (0.12)	0.16 ^b (0.14)	0.15 ^{ab} (0.14)	0.16 ^{ab} (0.12)
Accessibility	0.13 ^a (0.12)	0.12 ^a (0.10)	0.13 ^a (0.11)	0.14 ^a (0.12)
Job creation	0.14 ^a (0.14)	0.12 ^a (0.12)	0.13 ^a (0.13)	0.12 ^a (0.10)

Notes: Standard deviation is in brackets. Across rows, means denoted with different superscript letters are significantly different at $p \leq 0.05$, based on Tukey's Honestly Significance Difference Test.

Table A5.2. Fractional multinomial logit model estimates for importance weighting (as a proportion of 1.00) allocated to each of the characteristics of a hydrogen industry, by survey respondents (n=1,824). 'Reliability' was used as a reference.

Variable	Safety		Climate change mitigation		Affordability		Accessibility		Job creation	
State (Victoria)	-0.012	(0.059)	0.026	(0.064)	-0.015	(0.054)	0.065	(0.056)	-0.034	(0.062)
Urban	-0.182**	(0.072)	-0.151*	(0.082)	0.042	(0.067)	-0.076	(0.071)	-0.151*	(0.079)
Older respondents	-0.136*	(0.076)	-0.177**	(0.088)	-0.223***	(0.073)	-0.125	(0.073)	-0.255***	(0.079)
Male	-0.059	(0.065)	-0.100	(0.071)	0.000	(0.059)	-0.053	(0.062)	-0.067	(0.066)
University educated	-0.055	(0.066)	0.072	(0.072)	-0.063	(0.060)	-0.049	(0.065)	-0.182**	(0.071)
Household income	0.002	(0.001)	-0.001	(0.001)	0.001	(0.001)	-0.003	(0.001)	0.002	(0.001)
Household residents	-0.001	(0.027)	-0.037	(0.029)	-0.051**	(0.024)	-0.031	(0.027)	-0.015	(0.029)
Employed energy industry	-0.020	(0.098)	0.119	(0.129)	-0.125	(0.105)	0.063	(0.113)	0.060	(0.115)
Unemployed	-0.067	(0.138)	-0.080	(0.145)	-0.108	(0.115)	-0.167	(0.147)	-0.068	(0.143)
Low socio-economic advantage	0.020	(0.079)	-0.144	(0.090)	0.021	(0.070)	-0.030	(0.076)	-0.051	(0.086)
Confidence in government decisions	-0.096	(0.059)	-0.272***	(0.065)	-0.088	(0.053)	0.021	(0.057)	0.089	(0.061)
Climate change is happening	-0.016	(0.103)	0.318**	(0.125)	-0.068	(0.088)	-0.019	(0.097)	-0.099	(0.107)
Climate change is largely human induced	0.054	(0.080)	0.310***	(0.097)	-0.083	(0.071)	-0.024	(0.077)	-0.045	(0.082)
Climate change will have negative impact	-0.086	(0.067)	0.195**	(0.073)	0.034	(0.060)	0.060	(0.065)	-0.013	(0.071)
Pro-environmental trade-offs	0.098*	(0.052)	0.415***	(0.057)	-0.037	(0.048)	0.070	(0.047)	-0.024	(0.054)
Knowledge of hydrogen industry	-0.044***	(0.012)	-0.018	(0.014)	-0.011	(0.012)	0.019	(0.012)	-0.017	(0.013)
Constant	0.347	(0.229)	-1.491**	(0.264)	0.658	(0.219)	-0.287	(0.217)	0.324	(0.256)
Number of observations	1824									
Wald χ^2	472.58									
Log pseudolikelihood	-3,193.33									

Notes: ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.1; Robust standard errors in brackets.

Table A5.3. Correlation coefficients for each explanatory variable included in the fractional multinomial logit model.

Explanatory variables	State (Victoria)	Urban	Older respondents	Male	University educated	Household income	Household residents	Employed in energy industry	Unemployed	Low socio-economic advantage	Confidence in government decisions	Climate change is happening	Climate change is largely human-induced	Climate change will have negative impact	Pro-environmental trade-offs	Knowledge of hydrogen industry
	State (Victoria)	1														
Urban	-0.05	1														
Older respondents	-0.02	-0.14	1													
Male	-0.04	0.02	0.19	1												
University educated	0.13	0.24	-0.21	-0.03	1											
Household income	0.07	0.19	-0.33	-0.01	0.36	1										
Household residents	0.04	0.08	-0.3	-0.07	0.09	0.33	1									
Employed energy industry	0.05	0.02	-0.02	0.08	0.08	0.07	0.04	1								
Unemployed	-0.01	-0.01	-0.08	-0.05	-0.05	-0.17	-0.01	-0.03	1							
Low socio-economic advantage	-0.08	-0.31	0.03	-0.02	-0.21	-0.19	-0.01	-0.05	0.04	1						
Confidence in government decisions	0.07	0.02	-0.09	-0.02	0.01	-0.03	0.08	0.02	0.01	-0	1					
Climate change is happening	0.03	0.10	-0.09	-0.09	0.12	0.08	0.04	0.03	0.03	-0.07	0.04	1				
Climate change is largely human induced	0.07	0.09	-0.15	-0.14	0.14	0.10	0.10	0.01	0.02	-0.05	0.03	0.47	1			
Climate change will have negative impact	0.06	0.08	-0.14	-0.10	0.17	0.12	0.13	0.05	0.03	-0.07	0.01	0.37	0.38	1		
Pro-environmental trade-offs	-0.02	0.04	-0.04	-0.09	0.09	0.02	-0.05	0.01	0.05	-0.06	-0.06	0.35	0.31	0.31	1	
Knowledge of hydrogen industry	-0.01	0.04	0.05	0.30	0.14	0.07	0.06	0.17	0.02	-0.05	0.05	0.03	-0.00	0.10	0.02	1

Table A5.4. Variance inflations factors for each explanatory variable included in the fractional multinomial logit model.

Explanatory variables	Variance inflation factors
State (Victoria)	1.05
Urban	1.19
Older respondents	1.30
Male	1.18
University educated	1.28
Household income	1.43
Household residents	1.21
Employed energy industry	1.05
Unemployed	1.06
Low socio-economic advantage	1.16
Confidence in government decisions	1.03
Climate change is happening	1.42
Climate change is largely human induced	1.43
Climate change will have negative impact	1.33
Pro-environmental trade-offs	1.24
Knowledge of hydrogen industry	1.19
Mean variance inflation factor	1.22

Table A5.5. Community characteristics tested but not used in the fractional multinomial logit model (n=1824).

Variable	Definition	Mean	Min	Max
Unemployment rate	Unemployment rate for postcode ^a recorded by respondent	7.38 (2.91)	0	21.7
High regional unemployment	1=Unemployment rate for postcode ^a greater than unemployment rate for state; 0=Otherwise	0.46 (0.50)	0	1
Socio-economic advantage	Socio-Economic Advantage and Disadvantage Index score ^b for postcode recorded by respondent	988.58 (74.55)	635	1160
Socio-economic advantage percentile (percent)	0-10 th percentile	11.79		
	11-20 th percentile	9.98		
	21-30 th percentile	8.83		
	31-40 th percentile	7.73		
	41-50 th percentile	9.11		
	51-60 th percentile	7.62		
	61-70 th percentile	9.43		
	71-80 th percentile	11.79		
	81-90 th percentile	12.34		
	91-100 th percentile	11.35		

Notes: Standard deviation in brackets. ^a Data for unemployment rate for postcode from Australian Bureau of Statistics (2018a); ^b As per the Socio-Economic Advantage and Disadvantage Index, 2016 for postcode nominated by respondent (Australian Bureau of Statistics, 2018b).

Table A5.6. Alternative forms of socio-demographic variables tested but not used in the fractional multinomial logit model (n=1,824).

Variable	Definition	Percent or Mean	Min	Max
Household income (percent)	\$0–\$24,500	7.82		
	\$24,501–\$38,900	11.47		
	\$38,901–\$52,900	12.70		
	\$52,901–\$69,500	10.68		
	\$69,501–\$88,500	9.65		
	\$88,501–\$109,300	11.66		
	\$109,301–\$134,800	9.01		
	\$134,801–\$168,700	8.56		
	\$168,70 –\$222,300	5.41		
	\$222,301 or above	2.81		
Household income	Semi-continuous variable as used in model presented (tens of thousands of AUD per year)	8.68 (5.37)	2.45	22.23
Household income ²	Square of semi-continuous variable above			
High household income	1=Household income reported by respondent is greater than median income for postcode ^a ; 0=Otherwise	0.59 (0.49)	0	1
Substituted household income ^a	Tens of thousands of AUD per year, median household income for postcode ^a used when income information missing (n=208)	8.51 (5.14)	2.45	22.23
Age (percent)	18–34 years	28.13		
	35–44 years	18.15		
	45–54 years	13.27		
	55–64 years	17.38		
	65, plus years	23.08		
Age ^b	Years	46.47 (15.36)	26	65
Age ²	Square of semi-continuous variable above			
	Highest level of education completed (percent)	Year 10 or below	7.73	
		Year 12 or below	18.97	
		Advanced diploma, diploma, or certificate (incl. TAFE)	33.33	
		Bachelor degree	23.46	
		Graduate diploma or certificate	6.58	
	Post-graduate degree	9.92		
Post-school education	1=Post-school education; 0=Otherwise	0.73 (0.44)	0	1
Employed	1=Employed; 0=Otherwise	0.61 (0.49)	0	1
Not in labour force	1= Not in labour force; 0=Otherwise	0.34 (0.47)	0	1

Notes: Standard deviation in brackets. AUD is Australian dollars. ^aData for median household income for postcode from Australian Bureau of Statistics (2018a); ^bAge is a semi-continuous variable.

Table A5.7. Alternative forms of attitudinal variables tested but not used in the fractional multinomial logit model (n=1,824).

Variable	Definition	Mean	Min	Max
No confidence in government decisions	1=Disagree or strongly disagree Australian governments make policy and regulatory decisions based on scientific and economic evidence; 0=Otherwise	0.34 (0.47)	0	1
Climate change not happening	1=Disagree or strongly disagree that climate change is happening; 0=Otherwise	0.06 (0.24)	0	1
Climate change not largely human induced	1=Disagree or strongly disagree climate change is largely human-induced; 0=Otherwise	0.11 (0.32)	0	1
Climate change will not have negative impact	1=Disagree or strongly disagree that climate change will have a negative impact on household; 0=Otherwise	0.17 (0.37)	0	1
Different forms of the construction variables used to create Pro-Environmental trade-offs (average index)	1=Agree or strongly agree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.76 (0.43)	0	1
	1= Agree or strongly agree that the environment needs to be protected even if it impacts economic prosperity	0.79 (0.41)	0	1
	1=Agree or strongly agree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.41 (0.49)	0	1
	1=Disagree or strongly disagree that a healthy, well protected environment and a prosperous economy go hand in hand; 0=Otherwise	0.05 (0.21)	0	1
	1= Disagree or strongly disagree that the environment needs to be protected even if it impacts economic prosperity	0.06 (0.23)	0	1
	1=Disagree or strongly disagree that in order to have economic prosperity, the environment is going to suffer a bit (reverse coded); 0=Otherwise	0.32 (0.47)	0	1

Note: Standard deviation in brackets.

Table A5.8. Alternative forms of self-rated knowledge variables tested but not used in the fractional multinomial logit model (n=1,824).

Variable	Definition	Mean	Min	Max
Different forms of the construction variables used to create Knowledge of hydrogen industry (additive index)	1=Have at least heard of how hydrogen is produced; 0 Otherwise	0.59 (0.49)	0	1
	1=Have at least heard of the use of hydrogen in fuel cell vehicles; 0=Otherwise	0.60 (0.49)	0	1
	1=Have at least heard of burning hydrogen as a replacement for natural gas; 0=Otherwise	0.56 (0.50)	0	1
	1=Have at least heard of hydrogen as an energy storage medium for electricity;0=Otherwise	0.54 (0.50)	0	1
	1=Have at least heard of the use of hydrogen fuel cells in homes; 0=Otherwise	0.46 (0.50)	0	1
	1=Have heard of and can explain to a friend how hydrogen is produced; 0 Otherwise	0.11 (0.31)	0	1
	1= Have heard of and can explain to a friend the use of hydrogen in fuel cell vehicles; 0=Otherwise	0.10 (0.30)	0	1
	1= Have heard of and can explain to a friend burning hydrogen as a replacement for natural gas; 0=Otherwise	0.11 (0.31)	0	1
	1= Have heard of and can explain to a friend hydrogen as an energy storage medium for electricity;0=Otherwise	0.09 (0.29)	0	1
	1= Have heard of and can explain to a friend the use of hydrogen fuel cells in homes; 0=Otherwise	0.07 (0.25)	0	1

Note: Standard deviation in brackets.

Appendix 6. Additional publications

This appendix includes details of two additional publications that the candidate authored and co-authored during PhD candidature. These publications contributed to the background thinking and conceptual development of this thesis (as outlined below).

Dumbrell, N.P. (2018) *To what extent should society determine the right to farm?* *Farm Policy Journal*, 15 (4), 19-26.

Summary of essay, and relevance to thesis

This essay was a response to the topic set by the Australian Farm Institute for their annual John Ralph Essay competition. The essay question was: *Should society determine the right to farm?*

As indicated by the title and the summary below, the essay argued, not whether society should determine the right to farm, rather the extent to which it is allowed and encouraged.

The essay was written in the first three months of my PhD program and captures some early attempts to identify cross-over between core elements of the social licence concept and welfare economics. This essay offered an agricultural industry readership an alternative lens through which to examine social licence (i.e. welfare economics). The ideas in the essay were further researched and refined in the development of Chapter 2 and Chapter 6 in this thesis.

The essay made clear that society already determines the right to farm. For example, through government institutions that grant, repeal, enforce and protect property rights, and through regulations designed to prevent irreversible damage, or limit impacts of farmers' actions on third parties. It was argued, society's expectations and social pressures should be employed to encourage compliance with these regulations, on-farm and wherever else relevant, e.g. in the supply chain upstream and downstream of the farm. The role of, and extent that consumers could create market signals was also described. Consumer preferences were shown to reflect a number of factors, and more readily expressed by certain sectors of the community (e.g. high-income groups), and as a result, it was argued they should not be used to reflect a stance on an issue that may be attracting social licence attention or calls for regulation. This is not to say that consumer preferences have no impact on farmers' actions. For example, failure to meet social expectations can result in profitability consequences for farmers and/or the agricultural industry. However, the essay cautioned the use of consumer preferences to understand society's expectations of agriculture and then to guide regulation. Ultimately, it was argued that society should continue to make changes to the parameters within which farmers operate through expectations and regulations but only regulate when the result of the regulation is in the best interest of society as a whole and when regulation is a cost-effective option to achieve the desired outcome.

Loch, A., Adamson, D., **Dumbrell, N.P.** (2020) *The fifth stage in water management: Policy lessons for water governance*, *Water Resources Research*, 56 (5), <https://doi.org/10.1029/2019WR026714>

Abstract of paper, my contribution, and relevance to thesis

Effective management of water resources is a critical policy issue globally. Using a framework developed by Turton, and a common set of characteristics describing key stages of water demand, we examine the effectiveness of isolated technical (e.g., irrigation upgrades) and allocative (e.g., buyback) efficiency for reducing water demand to sustainable levels. We base our analysis on Australia's water reform context which offers an advanced example of applying these levers to achieve allocative and technical efficiency. The study is motivated by appreciation of the benefits from increased policy flexibility and adaptability in response to the following: potential transformations toward inflexible production systems; uncertainty associated with impacts of climate change on future water reliability; and the need for increased possible future equity between uses/users (productive/consumptive, environmental, cultural). Our results highlight that a balance between technical and allocative efficiency mechanisms is necessary, as neither is sufficient in isolation, when seeking to reduce total water use. This approach also enables a clearer representation of uncertainty in future policy choices in many global settings with respect to water demand reduction.

My contribution to this paper included detailing the role and impact of community expectations on water policy decisions. Further to the key points in the abstract above, the study also demonstrated a need for economists and water managers to work with others to identify suitable transition pathways and learn from other industries that are arguably further ahead with respect to balancing the demands and expectations of different stakeholders (e.g., energy supply and renewables). This thesis argues for a similar multidisciplinary approach to understanding and tackling social licence issues.

This paper offers a case study where policy can be designed to adapt to and account for social expectations and therefore potentially avoid costly and lengthy debates that have played out in other cases when a social licence has been under threat. Further, this water policy case study is an example of a government policy area that is struggling to obtain or maintain a social licence from some stakeholder groups. While much social licence research focuses on private firms or industries, this research as well as that reported in Chapters 2 and 3, indicates that governments: (1) have a critical role in the governance structures that enable attempts from stakeholders to grant or withhold a social licence; and (2) themselves are increasingly under pressure to gain or maintain a social licence else risk voter backlash, especially in democratic countries.

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