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Lessons from 5 years of GISERA economic research

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Abstract. Scientifically robust analysis of trade-offs for onshore gas activity can inform the design of strategies for socially acceptable and efficient use of energy resources. Here, we present lessons from a portfolio of research spanning three States and different industry stages conducted as part of the Gas Industry Social and Environmental Research Alliance (GISERA). Considering the effects of onshore gas development on regional economies, an important lesson is to look at net changes, considering decreases as well as increases in economic activity. In Queensland, where competing claims about employment effects were raised in public debates, measuring reduced agricultural employment in addition to increases to the number of jobs in other sectors were crucial to providing a balanced analysis. Another lesson is to take a broad view of economic dimensions beyond employment and income. Our research shifted the public debate when we demonstrated that the construction phase in Queensland improved youth retention, gender balance and skill levels. Another lesson is that economic effects of gas development (positive or negative) can occur before stakeholders expect them. In New South Wales, we observed that the exploration phase had a significant positive effect on income (but not employment). A further lesson is that effects differ between domestic and export markets. Research from South Australia has demonstrated that the potential regional benefits of gas development substantially depend on meeting the energy needs of other local industries such as manufacturing. These lessons can inform public debate and policy settings and help balance different priorities such as energy needs, regional development and environmental sustainability.

Keywords: economic-impact assessment, employment, gas, income, resource economics.

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Introduction

Australia's onshore gas industry has expanded rapidly in the past 5 years, to the point that the country has become the world's largest exporter of natural gas since overtaking Qatar in 2018 (Jaganathan 2018). Alongside this rapid expansion, the industry has led to substantial changes in the economies of host communities and exploration regions in several States. Some regions such as Narrabri have experienced the uncertainty associated with the exploration phase of the gas industry (Threadgold *et al.* 2018). Additional communities are coming to terms with the ongoing operations of the industry such as in the Surat Basin (Measham *et al.* 2019). Over a similar timeframe, others have seen the industry contract as it moves into a decommissioning phase, such as around Camden (Huddlestone-Holmes *et al.* 2018).

The gas industry is no stranger to controversy. Unconventional gas, in particular, has been a highly contested industry met with a wide spectrum of views (Rifkin *et al.* 2014; Curran 2017; Grubert and Skinner 2017). Some people have expressed endorsement for new gas developments, whereas others have strongly opposed the industry, and many sit somewhere in between (Leonard *et al.* 2016; Luke 2017; Ransan-Cooper *et al.* 2018). In the case of unconventional gas, the industry has evolved differently across jurisdictions, with different States approaching the industry in diverse ways from outright bans to an evolutionary approach of introducing and amending regulations as the industry has developed (Cronshaw and Grafton 2016; Witt *et al.* 2018). Alongside these diverse approaches, unconventional gas development has led to a long list of parliamentary inquiries and committee processes across multiple Australian States, to consider the relative pros and cons of the industry, bringing together local business interests, agricultural industry bodies and lawyers from multiple backgrounds (Turton 2020). In addition, the industry has also been met with diverse responses from different sectors within the economy. Research has also shown that different

sectors and types of businesses (e.g. agriculture and small business) have experienced different effects (Huth *et al.* 2017; Measham *et al.* 2019; Walsh and Haggerty 2019). Across a range of sectors, economic effects have tended to be interconnected and have been grouped into a hierarchical framework (Measham *et al.* 2016) that draws attention to primary socioeconomic impacts in the form of direct employment and income as well as compensation for access to agricultural land and effects on farmers (Huth *et al.* 2017; Martin and Rice 2019). Direct employment and income have led to secondary effects in the form of spill-overs to other sectors of the economy (Komarek 2016; Marchand and Weber 2018) and related in-migration, resulting in strain on existing infrastructure and services (Grubert 2018).

Flow-on effects from gas development can include changes to housing values and rents (Rifkin *et al.* 2014; Bennett and Loomis 2015), construction of new infrastructure, demographic changes, potential for increased conflict (Hindmarsh and Alidoust 2019) and changes to income distribution (Fleming and Measham 2015*a*). An important observation across all these studies is that the impacts of gas development vary enormously across space and time; hence, the relevance of robust research tailored to particular contexts (Haggerty *et al.* 2018). Although there is no universal experience of gas development, there are, nonetheless, patterns of experiences for different types of regions and different stages of development. The present paper contributes to understanding these patterns by looking at the development of the gas industry in Australia.

GISERA economic research

The research that underpins the present paper covers the 5 years since 2014. It was conducted as part of the Gas Industry Social and Environmental Research Alliance (GISERA), which is a collaboration between CSIRO, Commonwealth and State governments and gas companies established to undertake independent research. With the expansion of the gas industry in Australia over the past decade, CSIRO identified a need to conduct independent research about the social, economic and environmental aspects of the gas industry. The aim of GISERA is to provide high-quality scientific research and information to communities living in regions where gas development occurs. The governance structure of GISERA was developed to maintain and protect research independence through establishing independent committees to prioritise research needs in each jurisdiction and a separate committee to oversee the delivery of projects. The integrity of these measures has stood up to public scrutiny and has provided confidence for a range of public- and private-sector stakeholders. Transparency is a key principle of the GISERA model, with all research results being publicly reported, committee structures and decision making all being publicly accessible alongside all funding details of research projects. Along with transparency, a strong focus on communicating research to share the findings is a core principle of the GISERA model. The research is communicated to a wide range of audiences including local communities where the gas industry operates, the institutions of governance, including regulators and policy makers, gas companies and other researchers to ensure that the findings from the research program are exposed to quality control through peer review processes, thereby contributing to broader knowledge nationally and internationally. To address these broad audiences, a diverse set of communication outputs is provided, including written formats such as fact sheets, videos, working papers, reports, journal papers, popular press articles and verbal formats such as workshops; community forums, knowledge-transfer sessions and conference presentations.

By the end of 2019, GISERA had undertaken 53 research projects, with a cumulative value over AU$25 million across a wide range of topics including economic impacts, health effects, social impacts including community wellbeing, groundwater and surface water, biodiversity, land management and the marine environment (GISERA 2019). Among these, four completed projects have focused on economic research, with another project having recently commenced. Because of space limitations, the paper does not consider a set of sibling research projects focused on social sciences (GISERA 2019). The completed economics projects considered in the paper spanned three States at different stages of the industry lifecycle, with a focus on analysing past economic outcomes and modelling future economic effects for communities hosting gas extraction. This consideration of effects at different stages of the industry lifecycle is important because differences have been observed in terms of the experience of the industry and how people have responded to it across exploration, construction, operations and decommissioning phases (Walton *et al.* 2017; Luke and Emmanouil 2019). The paper presents key lessons from across these economic projects, including a summary of the key findings followed by a discussion of their uptake and impact on stakeholders. Additional details about each project, including all reports, is available at https://gisera.csiro.au/research/social-and-economic-impacts-and-opportunities/, accessed 16 February 2020.

Lesson 1: assessing net effects, including decreases as well as increases

A key lesson from GISERA economic research is the importance of looking at net changes rather than simply an increase in a fundamental indicator such as employment. During the construction phase for the coal seam gas (CSG) industry in the Surat Basin, there were wide-ranging claims and counter claims made by different stakeholders and interest groups on the number of jobs, from very high numbers (up to 14 000 jobs) through to negative numbers (job losses). The bases for these various estimates were unclear and it was very difficult for industry, government and residents to form an accurate understanding of what was going on. Employees dressed in high-vis vests provided a visible sign of employment in towns such as Chinchilla, whereas, at the same time, employers from other parts of the economy were losing staff. A related issue was the degree to which jobs were held by local residents in contrast to long-distance commuting workforces that were viewed in public debates as diminishing the benefit that accrued to local residents. In the absence of clear

information about what proportion of the workforce comprised local and non-local workers, speculation was rampant.

Overview of research findings

The labour dynamics of a rapid construction phase are known to be complex. To address this concern our research set about accurately measuring fundamental economic indicators including direct jobs, indirect jobs and income. To measure these accurately, we focused on Australian Bureau of Statistics Census records, which provided the most comprehensive measures at a fine scale. Moreover, we controlled for resident and non-resident populations to determine how many of the jobs were held by local residents. For income effects, we measured family income that excluded non-residents. A crucial consideration here was how to attribute changes in these indicators to the gas industry. To resolve this question, we needed a counterfactual: what would have happened if there was no gas industry development? We achieved this by comparing the populations of locations with development with a control group of comparable regions that did not experience gas development and tested for statistical differences in their rates of employment change. To ensure that we were measuring net effects, we considered changes in jobs across the whole economy, including reductions. Importantly, one sector (agriculture) had experienced a statistically significant reduction in employment that partly offset statistically significant increases in other parts of the economy. Taking this approach, we provided robust evidence of net local employment increases after controlling for long-distance commuting workforces. The results for the Surat Basin showed that there were

- 1400 net new jobs 2006–2011,
- 600 of these were direct industry jobs,
- 800 of these were indirect jobs (spillovers to other parts of the economy), and
- family income increased by 15%,

Findings were relative to the control group for rural Queensland regions where gas development did not occur (Fleming and Measham 2015*b*).

Impact of findings

In Queensland, where competing claims about employment effects were raised in public debates, measuring reduced agricultural employment in addition to increases in other sectors was crucial for providing credible evidence of industry effects. By reporting decreases as well as increases, the research was more thorough, and this increased the overall credibility of the research. The findings filled in the previous void of reliable measures of employment effects and became the go-to measure of local employment effects.

Beyond Queensland, the rest of the country was keeping a keen eye on the experience of the Surat Basin as multiple jurisdictions considered whether the CSG industry was appropriate for different States. At the national level, amid a background of highly contested claims and counter claims, a landmark assessment of the Queensland experience was conducted by the federal Department of Industry, substantially on the basis of the findings from the GISERA research project, finding that the headline economic impacts of CSG development in Queensland were net positive (Department of Industry 2015). The research did not end the debate around the economic effects of the CSG industry. Rather, it replaced speculative numbers with a reliable yard stick by which to conduct a better informed discussion. Therefore, the key impact of this project was to improve the quality of the public debate.

Lesson 2: taking a broad view beyond core economic variables

Another lesson is the importance of considering additional factors beyond employment and income. It is important to understand the overall drivers of social and economic change in regions where the gas industry occurs. Alongside neighbouring regions and like much of rural Australia, before gas development, the Surat Basin had been experiencing a trend of rural decline (Measham and Fleming 2014). An important dimension to this stems from a broader issue of whether the resource sector leads to different outcomes for women and men (Pini and Mayes 2012; Reeson *et al.* 2012; Measham and Zhang 2019; Wozniak and Jurczyk 2020).

Overview of research findings

The construction phase for the gas development in the Surat and Bowen basins presented a marked shift in the overall demographic trends of these regions. Using a ‘counterfactual analysis’ approach similar to the analysis of jobs and income presented in Lesson 1, our findings demonstrated growth in youth populations and skill levels during the construction phase of the gas industry in these regions. In contrast to other rural areas of Queensland, where the youth population was not growing, those two regions saw their youth population grow. Moreover, the results demonstrated an increase in female youth in similar proportions to the increase in young men, helping address gender imbalance in these regions. The data for female youth share of population provided clear evidence of mitigating youth out-migration, showing increases in some age categories. In particular, there was a reversal of population decline in the age category of 25–29 years old during the period 2006–2011 (Measham and Fleming 2014).

The education data demonstrated that regions with CSG development generally had higher proportions of youth with university degrees and certificate III and IV qualifications (Measham and Fleming 2014). As with the employment data considered in Lesson 1, the analysis controlled for the impact of long-distance commuting workforces by focusing specifically on place-of-residence census data.

By broadening the focus beyond the core indicators of employment and income, the research demonstrated that gas development had a positive effect on addressing rural decline during the construction phase, particularly in regard to rural youth migration and skills increases, which are important to the broader economic vitality of rural Australia.

Impact of findings

A key impact of these findings was to broaden the public debate about gas development and its effects on rural regions. Prior to this research being released, there was a tendency for public debates to present a simplistic trade-off between jobs and negative social impacts. The idea that gas development could have flow-on effects in terms of demographic benefits was a revelation in the rural press and enabled a more constructive discussion about the broader role of gas in regional economies and communities.

The findings were highlighted by the Queensland GasFields Commission and by the Mayor of the Western Downs Regional Council. In addition, the findings contributed to parliamentary inquiries in the States of Western Australia, Victoria, and Northern Territory, helping those jurisdictions decide whether it was appropriate to proceed with the gas industry (State Government of Victoria 2015; Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia 2018; Scientific Inquiry into Hydraulic Fracturing in the Northern Territory 2018).

Lesson 3: effects of gas development can occur before they are expected

The development of the CSG industry in New South Wales (NSW) has been marginal relative to the activity observed in Queensland. From 2001 to 2011, ~430 wells were drilled in NSW, which represents ~10% of the wells drilled in Queensland by 2011 (Department of Natural Resources and Mines 2017). Given the spatial concentration of industry activity in NSW, we investigated whether industry expenditures during the exploration phase (e.g. compensations for drilling in private properties, construction of access tracks) had an impact on regional economies.

Human and natural capital influence the response of regional economies to changing environmental and socioeconomic conditions. We combined a comprehensive database of topographic, socioeconomic and environmental variables with statistical models to estimate the causal impact of early CSG industry development on income and employment in NSW regions with industry presence (Marcos-Martinez *et al.* 2019). This approach allowed for the control of regional differences in key parameters that influence agricultural, labour and conventional mining returns, as well as for economic interdependencies among regions.

Overview of research findings

Results from spatial econometric regressions and genetic matching causal inference algorithms indicated that regions with CSG activity from 2001 to 2011 had ~7% (±6%, 95% confidence interval) higher median weekly family income than did regions without industry presence. The results also indicated that family income changes within regions were highly dependent on the economic performance of neighbouring regions. The income effect was about half the documented effect in CSG regions in Queensland, which is consistent with differences in gas industry development in the two States. About 12% of the CSG wells drilled in NSW remained operational by 2014, and more than half had been permanently sealed. The gradual decline in industry activity suggested that the income effect could be short-lived.

Our analysis showed that changes in employment in the *Rental, hiring and real estate services* and the *Professional, scientific and technical services* industries were positively correlated with employment in the mining sector. However, the employment spill-over effect was not associated with CSG activity. The slow industry development in NSW, and the need for highly specialised labour and capital from outside NSW regions during the exploration phase were some factors that explain the lack of employment spill-over effects.

Impact of findings

Uncertainty around stakeholder expectations on the net effect of CSG industries could result in socially inefficient decisions, such as, for example, unregulated growth or banning industry activity. Estimates of the economic effects of the CSG industry at different stages of development and investment could result in better policies and community decisions to achieve sustainability targets (e.g. energy security, environmental health). However, further research is needed to assess the net welfare implications of the multiple socioeconomic and environmental impacts of the CSG industry in NSW.

The analysis demonstrated that causal assessments of the impacts of gas extraction require comprehensive consideration of the factors influencing the socioeconomic structure, performance and spatial dependencies of affected regions. The findings also highlighted the importance of the exploration phase and needs for effective policies and appropriate compensation mechanisms for landholders and communities hosting CSG wells (Martin and Rice 2019).

Lesson 4: there are different effects for domestic and export-oriented extraction

Research from south-eastern South Australia has demonstrated that the potential benefits of gas development in the Limestone Coast substantially depend on meeting the energy needs of other local industries. In contrast to the size of the CSG industry in Queensland, gas development in the Limestone Coast region is relatively modest compared with, and has a smaller workforce than that in other gas-extracting regions. For this reason, the employment and income effects of the industry by itself are lower than those in other parts of the country. However, the region has a diverse economy including several manufacturing plants, resulting in a higher local demand for energy than that in other gas-producing regions in the northern States where gas is predominantly an export industry.

During the 1990s and 2000s, the Limestone Coast area had an active, small gas-extraction industry that supplied mostly for local manufacturing-industry needs during the 1990s and 2000s. In this area, further conventional onshore gas development occurred during 2019. The project was developed following an exploration program, leading to a resurgence in the ability to provide local gas to the local industry. The research pointed out the complex nature of the inter-industrial relationships that need to be taken into account to ensure access to locally extracted

resources and to maximise economic benefits in terms of gross regional product and employment.

Overview of research findings

The research had an exploratory nature and had to contend with uncertain futures of the region and the role of the gas industry within it. This included consideration of different scenarios representing potential futures with different investment levels for the local gas industry. An initial qualitative phase of the research developed a series of narratives around the future evolution of the regional economy. These scenarios were further developed and validated with local industry stakeholders in a workshop in Mount Gambier in March 2019. Subsequently, the qualitative scenario-building process was followed up with a quantitative phase to conduct robust economic modelling of the projected outcomes of each scenario in terms of increases to gross regional product and changes to regional employment. The results showed that investing in the gas industry would have modest benefits for the region, including growth in those sectors involved in the gas-industry supply chain. However, benefits would be much higher if Limestone Coast gas was used locally by other industries as part of a diversified economy. Under this scenario, a renewed gas industry providing cheaper local gas would alleviate energy costs for local industries, support job creation in multiple sectors and help avoid future job losses among heavy gas users such as food and fibre manufacturing, in addition to employment in the gas industry and its supply chain.

Impact of findings

As one of the most recent projects, the impact of the findings is still emerging. Regional economic-development professionals working in the region have stated that the project has provided a much better understanding of how gas might affect development in this region. As a result of the research, stakeholders realised that decreases in the local gas price should not be automatically assumed and that additional actions would be required to realise the benefit of cheaper gas for the local region. One of the key factors here is gas distribution and, at the time of writing, a separate report had been commissioned to look into gas-transmission options for this region, which represents a step towards enabling benefits from locally extracted gas.

Conclusions

These lessons have informed public debate and policy settings and have helped balance different priorities such as energy needs, regional development and environmental sustainability. Considering the lessons together, the paper has demonstrated that investing in robust economic analysis is beneficial for the industry overall, by providing increased confidence in the net effects. The lessons also demonstrated the importance of considering effects across different stages of the life cycle, noting that some effects may surprise stakeholders, as was evident from the research conducted on the exploration phase. Contested industries such as gas extraction will always be met with a wide range of views to demonstrate diverse positions. Investing in robust research may not convince those who have committed to a given position for or against a contested industry; however, it provides a mechanism for those in the middle to form a balanced perspective and consider whether the benefits outweigh costs. These lessons go some way towards this purpose and offer insights for addressing contested industries in the future.

Conflicts of interest

The authors declare no conflicts of interest.

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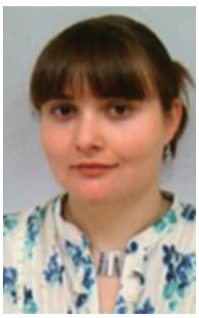

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