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Original article

Fuelling regional development or exporting value? The role of the gas industry on the Limestone Coast, South Australia

Thomas G. Measham\textsuperscript{a,⁎}, Lavinia Poruschi\textsuperscript{a}, Raymundo Marcos-Martinez\textsuperscript{b}

\textsuperscript{a} CSIRO Land and Water, 41 Boggo Road, Dutton Park, QLD, 4102, Australia
\textsuperscript{b} CSIRO Land and Water, 16 Clunies Ross St, Acton, ACT, 2601, Australia

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\textbf{ABSTRACT}

The degree to which host regions benefit from resource extraction is a major issue for research and policy. In Australia, the dominant narrative of resource extraction is that most of the benefits flow away from host regions. This paper draws on evolutionary economic geography, presenting a case study of the Limestone Coast in South Australia, which previously extracted and distributed gas locally to food and fibre manufacturing industries. New policies seeking to renew the gas industry in the region, provide subsidies for exploration. Scenarios were developed to help inform decisions about the role of gas within this region. Qualitative analysis of the scenarios emphasised that gas needs to be affordable and locally accessible. Quantitative modelling showed that using the gas locally by manufacturing industries as part of broader industrial expansion would lead to greater benefits compared with exporting all gas outside the region. We conclude that policy settings have gone some way towards realising increased benefits for the region. Regional stakeholders clearly favoured the local use scenario but saw it as unlikely in the context of current infrastructure limitations. Stakeholders sought policy support for infrastructure to enable the preferred scenario to be realised.

1. Introduction

The sustainability of rural economies continues to be an area of keen interest for geographers and economists as the forces shaping non-metropolitan regions have evolved over recent decades (Markey et al., 2019; Ryser et al., 2019; Tonts et al., 2013). A central focus of this research area is on the dynamics of regional development and the roles of local actors, policy settings and market forces in development pathways (Plummer et al., 2018). Much of this research has been focused on the resources sector and particularly mining and energy extraction and how host communities can retain benefits locally (Halseth et al., 2014; Tonts et al., 2012). At the heart of this research is the extent to which host regions are affected (positively and negatively) from extracting resources. This includes, for example, changes to the structure of the economy, employment, income distribution, gender balance, demographic profile, infrastructure and services (Argent 2013; Measham et al., 2016; Fleming et al., 2015; Ryser et al., 2019).

In Australia, public debates demonstrate the salience of retaining more benefits in host regions, as illustrated by parliamentary inquiries (e.g. House of Representatives Standing Committee on Industry, Innovation, Science and Resources 2018). These inquiries have brought together diverse sets of stakeholders, putting forward multiple and often contrasting perspectives on appropriate mechanisms for benefit retention. Some of these include ‘corporate social responsibility’ initiatives such as local supply chain procedures (Esteves and Barclay 2011) and local labour hire requirements (Jones et al., 2007). Others have recommended benefit-sharing schemes such as the state-operated ‘royalties for regions’ program aimed at redistributing public revenues to regional communities (Argent 2013; Plummer et al., 2018; van Staden and Haslam McKenzie, 2019), either in addition to or separate from corporate social responsibility initiatives. The effectiveness of these mechanisms will vary between contexts, depending to a large extent on what else is going on in the regional economy.

As defined in Staples theory, the potential to derive benefit is related to the demand for inputs and outputs that resource extraction generates to promote economic activity in a region, expressed as forwards and backwards linkages (Watkins 1963, 1977; Gunton, 2003). Moreover, the magnitude of the backward and forward linkages depends on the capacity of the local economy to supply the inputs required by the mining industry or to use the outputs of the industry in a feasible and desirable way (Fleming and Measham 2014). Within this context, the purpose of this paper is to assess the desirability, likelihood and potential economic benefits of using a locally extracted resource (natural gas) within the region.

⁎ Corresponding author.
E-mail address: tom.measham@csiro.au (T.G. Measham).

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When seeking to conceptualise the driving forces influencing the sustainability of regional communities in large, resource-rich countries with relatively low populations such as Australia and Canada, several authors have found evolutionary economic geography to be a useful concept (Plummer et al., 2018; Tonts et al., 2014). This approach emphasises the importance of history and spatial relationships in understanding the development of regional economies and their trajectories for future development. This concept follows a resurgence of interest in ideas from evolutionary and institutional economics which stress the importance of path dependency and the role of institutions in shaping economic development trajectories rather than simply market forces (MacKinnon et al., 2002; 2009; Nelson and Winter 2002). Evolutionary economic geography highlights core-periphery dynamics. At the national scale, resource-rich peripheries such as Australia, New Zealand and Canada have evolved historically along a path of supplying food, fibre and minerals, to distant economic cores such as England and more recently Japan and China (Tonts et al., 2012; Hayter, 2008). On this basis, evolutionary economic geography has been described as a lens through which to view and understand change within economies. Social, political and economic arrangements become embedded around spatially and temporally-bound economies. These can include distinct supply chains, infrastructure investments, labour forces and technologies (Halseth et al., 2014).

A concept that is closely related to evolutionary economic geography is that of regional economic resilience (Martin, 2012; Simmie and Martin, 2010). In accordance with the use of resilience in other disciplines, the emphasis in regional economic geography is on the ability of a regional economy to withstand shocks and to bounce back, such as boom-bust dynamics in extractive economies (Measham et al., 2019). The model of regional economic resilience used in this paper has four components (Martin 2012). The first is resistance, representing the degree of sensitivity of a region to economic downturn. The second is recovery, referring to the speed at which a regional economy can bounce back from a downturn. The third is re-orientation, encompassing the extent to which a regional economy can adapt to new circumstances, and the fourth is renewal which refers to the extent to which a regional economy can resume to grow (Martin 2012.)

Focusing particular on ‘settler societies’ such as Australia and Canada, Argent (2013) emphasises the central role of geography in shaping resource-based economies. Rural economies in settler societies tend to have development histories characterized by established land-use systems, institutional structures, and social and cultural routines that become cumulative and self-reinforcing, resulting in ‘lock-in’ and reduced resilience to economic shocks (Tonts et al., 2012; 2014). At the same time they recognise the role of economic and political shocks in contributing to economic restructuring and the emergence (or closure) of new rural industries, noting de-regulation of the agricultural sector from the 1980s which triggered a series of interrelated changes characterised by severe cost price squeezes, rising debt, consolidation of smaller properties and population decline in affected regions (Lawrence, 1987, Fielke and Wilson 2017; Plummer et al., 2018).

Path dependence has been described as a characteristic of a system or process for which outcomes evolve as a consequence of its own history (Boschma and Frenken 2006). Lock-in isn’t necessarily good or bad, but within the context of regional development, path dependence reflects the notion that processes are locally contingent and that initial events can have long term effects through positive feedback responses at the regional scale. Once established, these processes tend to ‘lock’ a region into a particular development trajectory. Once ‘lock-in’ is established a strong change in policy settings is required to shift the development path of a region (Tonts et al., 2012). Some authors have argued that the focus on ‘lock-in’ is at odds with the notion of evolution, because it implies a stable state (Martin 2010). At its heart evolution implies change over time, influenced by historical circumstances and new opportunities due to changes in demand and technology. Therefore ‘lock-in’ is not absolute in a static sense (Martin, 2010). For this reason, we see in Australia, that regions that have been shaped by similar forces can have quite different outcomes (Tonts et al., 2014; Plummer and Tonts, 2013).

Evolutionary economic geographers have been grappling with questions relating to the effectiveness of policy interventions in achieving regional development pathways. In particular, to what extent do regional development policies promote sustainable rural economies in the context of broader market trends? Are these interventions contributing to the sustainability of rural areas or rather providing a band-aid approach with limited effectiveness against broader structural forces that fundamentally constrain the economic resilience of rural regions (Plummer et al., 2018). In general, regional economists have emphasised the need to understand the extent to which institutional change is required to develop new growth paths in regions (Boschma, 2015). However, in settler societies such as Australia and Canada, geographers argue that attention to even basic infrastructure needs may be required before new economic strategies can be pursued due to decades of missed investments through neoliberal policies (Tonts et al., 2014; Ryser et al., 2019).

For some time, Australia has been the largest exporter of several commodities including coal and iron ore, earning the nation the title of the world’s quarry (Carr, 2010). Since 2018, Australia overtook Qatar as the largest exporter of natural gas (Jaganathan, 2018). As Australian gas exports have soared, domestic wholesale gas prices have risen from around $4 per gigajoule in 2012 to around $10 per gigajoule in 2018. Strong demand for gas exports has raised concerns over potential gas shortages for domestic markets (Grafton et al., 2018; Longbottom, 2019). Increasing domestic gas prices have put pressure on other parts of the economy and the manufacturing sector, which requires a reliable and affordable energy supply. In resilience terms, manufacturing businesses have been close to a threshold of collapse and in some cases have passed it. In the context of meeting global gas export market demands, arguments have been put forward to protect domestic manufacturing from disruptions in gas supply and to keep prices affordable for manufacturing industries in the national interest (Stanford, 2016). Many Australian regions where resource extraction occurs struggle to retain benefits from the resources sector, particularly after the initial construction phase subsides (Tonts et al., 2013; Luke and Emmanouil 2019; Parker and Cox, 2020). Therefore, it is valuable to consider examples of regions that are attempting to overcome this challenge. Focusing on the Limestone Coast region of South Australia, the paper asks what is the best use of locally extracted energy resources as seen through the lens of regional development stakeholders? The paper considers what is required to enable the region to proceed on its preferred path as defined by regional development professionals and industry stakeholders.

2. Case study: the role of gas in the Limestone Coast region of South Australia

The Limestone Coast of South Australia is perhaps best known as a premium wine-producing region due to the presence of Terra Rossa soils (Mee et al., 2004) which are the basis of the Coonawarra terroir and branded wine-growing district (Banks and Sharpe 2006). The region comprises local government areas of Grant, Mount Gambier, Wattle Range, Robe, Naracoorte and Lucindale, Kingston and Tatiara. The largest town in the region is Mount Gambier, recognised for its famous groundwater-fed Blue Lake, which attracts tourists for its impressive colour and supplies drinking water for the town (Alexander et al., 2010). Another important town is Penola surrounded by Coonawarra vineyards. This town is where Mary MacKillop founded a Catholic school and established a religious congregation resulting in her being recognised as a Saint by the Catholic Church. The economy of the region is diverse, including a range of agricultural industries including cereal crops, grape growing, livestock grazing (beef and sheep).
and dairy farming. Forestry also plays a substantial role in the form of pine plantations. Manufacturing in the form of food processing and packaged food production is a substantial part of the regional economy. A wide range of household food items are produced in the region on the site of the former Kraft factory, subsequently operated by global food company ‘Mondelez’. Philadelphia cream cheese from this factory is distributed throughout Asia and the Middle East from the factory in Mount Gambier. A milk processing factory exports powdered milk directly to China. In addition, the region hosts the only remaining Australian factory operated by Kimberly-Clark, supplying paper and fibre products to domestic and international markets.

Other food and fibre manufacturing businesses have not fared so well. For example, the chip factory in Penola previously operated by Canadian company McCain was closed in December 2013, citing rising input costs (Hill, 2013). More generally, manufacturing has declined overall in the region, both in real terms and as a share of gross regional product (GRP). In contrast, the value of agriculture has increased making agriculture and forestry the largest contributor to the regional economy since 2005. The health care and social assistance sector has also grown over this time, including hospital, aged care and childcare services. The region also previously had a conventional gas industry for several decades (Poruschi et al., 2020).

The Otway Basin in South East South Australia’s Limestone Coast has been actively explored for gas resources since the 1890s. Part of the geological basin stretches under the Limestone Coast region in the South East of South Australia. The first commercial conventional gas discovery was made at Katnook in 1987, South of Penola, followed by the discovery of the Ladbroke Grove field in 1989. As a result of these discoveries, the southern part of the Limestone Coast had an active onshore gas industry during the 1990s and the 2000s. Demand for gas from Kimberly-Clark played an important role in developing the South East Pipeline System (SEPS) to connect to the local paper mill and supply the energy needs of this facility. Initially, the gas plant and the associated pipeline infrastructure was a completely closed system operating separately from any other pipeline in the country. Gas supplied locally was used by local businesses including timber milling, pulp and paper milling, commercial food preparation, for gas-fired power generation and for domestic use in the Limestone Coast region. Industry activity diminished in 2010 with the official closure of the local Katnook Gas Plant in 2013. The local pipeline was subsequently connected to interstate pipeline infrastructure, which has supplied local gas users since the closure of the Katnook plant (Fig. 1).

Following rising domestic gas prices from around 2012, the South Australian Government introduced the Plan for Accelerating Exploration (PACE) Gas program. This program provides grants to gas development companies to encourage exploration, and to develop commercial arrangements with electricity generators, industrial users and retail consumers within the state. During 2017, the PACE program allocated three grants for onshore exploration in the Otway Basin. These grants resulted in field trials which support new commercially viable gas operations within the region. The new gas operations target ‘conventional’ gas, noting that a 10-year moratorium on hydraulic fracturing (fracking) was introduced in 2018. The following year, Beach Energy (2019) commenced building a new Katnook gas plant capable of processing up to 10 TJ/day to replace the old Katnook facility. In line with the government’s strategy to develop new commercially viable gas operations within the region, the conditions of the PACE grant require the company to offer ‘first right of refusal’ to regional gas users. Prior to conducting this research, it was not clear how a renewed gas industry might affect the economic resilience of the region. To explore these issues, the research adopted a scenarios approach to explore different potential futures.

3. Methods

Given the uncertainties surrounding the development of the gas industry in the region and its potential role in the regional economy, a scenario approach was used to allow a range of potential economic outcomes to be considered. The scenarios considered future possible alternative development pathways of the region depending on how the gas industry develops and its effects on other sectors of the regional economy. The use of scenarios was endorsed by the stakeholder advisory panel which advised the funding body which commissioned this research (GISERA 2019). The methods to carry out the research relied on qualitative and quantitative components. The qualitative component guided the development of quantitative scenarios of potential industrial development in the region.

3.1. Qualitative analysis

3.1.1. Scenario planning

The scenario axes technique was used to carry out the qualitative component of the research (Searce and Fulton, 2004; van’t Klooster and van Asselt, 2006; Taylor et al., 2017). Through constructing scenarios of potential future developments, stakeholders explored potential futures and identified desirable and non-desirable pathways. The focal issue was to consider the potential future role of the gas industry among other local industries. A medium-term planning scenario of 10 years was set to coincide with the 10-year moratorium on hydraulic fracturing (and hence reliance on conventional gas). The authors prepared detailed background materials about the composition of the economy and a historical timeline of how the gas industry had previously evolved within the region. The initial set of background materials comprised around 20 charts and tables and was deemed too detailed for use in communicating with stakeholders. With input from communications professionals, the authors synthesised these materials down to a four-page factsheet which was professionally printed and distributed to stakeholders as an input to the next phase of the project in the form of the stakeholder workshop.

Drawing on the background materials, draft scenarios were initially sketched as an input into a workshop with stakeholders to explore and develop the scenarios. The objective of the scenarios was to analyse potential future outcomes for industries in the Limestone Coast region where the gas industry could develop. Four draft scenarios were prepared to reflect potential economic outcomes of regional gas industry development to 2030 and were presented to stakeholders for validation and refinement, with:

- Horizontal axis: the speed of investment in local gas resources development (fast or slow)
- Vertical axis: the level of economic diversity. (decreasing or growing)

The combinations of these axes provided four possible combinations as shown in fig. 2:

- Fast investment in gas with growing economic diversity
- Fast investment in gas with decreasing economic diversity
- Slow investment in gas with growing economic diversity
- Slow investment in gas with decreasing economic diversity

These four combinations formed the basis of the scenarios which were fleshed out with stakeholders.

3.1.2. Stakeholder workshop

The scenarios were refined through a participatory stakeholder workshop which allowed the incorporation of regional insights about potential regional economic trajectories related to gas industry development. The workshop lasted 5 hours and commenced with a verbal briefing of the background material prepared by the authors. The purpose of the workshop was to help stakeholders reach agreement on preferred scenarios and consider actions to help bring about preferred scenarios and ways to avoid undesirable outcomes. The workshop took
place in March 2019 in Mt Gambier. A total of 13 participants took part in the workshop representing:

- Packaged food and cheese manufacturing
- Paper and fibre products manufacturing
- Powdered milk manufacturing
- Local government (elected officials and professionals)
- Gas industry
- Locally based regional development professionals
- Geologists
- State Government energy policy staff
- State government regional development staff

Representatives from forestry, agriculture and viticulture declined an invitation to participate in the workshop.

Participants were asked to reflect on the validity of the main assumptions underpinning the scenarios and discuss the potential outcomes of each scenario for the local economy. Following a rich discussion of what each scenario would look like for the region, participants scored the desirability and likelihood of each scenario. The questions used to guide the scenario discussion are presented in Table 1.

Coloured stickers were applied by participants to express their preferences for each scenario and for the perceived likelihood of each scenario. After the workshop, names were applied to the four fleshed out scenarios presented in Fig. 2.

Following the input of the participants on which scenarios were the most and least desirable, as well as which was the most likely scenario, feedback was sought during the workshop to clarify the reasons behind these perspectives and to identify key steps needed to bring about the most desired scenario and avoid the least desired outcomes.

3.2. Quantitative analysis

3.2.1. Rise model

The Regional Industry Structure and Employment (RISE) input-output (IO) model developed by EconSearch (2017) for the Limestone Coast region was used to parametrise scenarios and explore their possible outcomes. The RISE model is a quantitative representation of the structure, interlinkages, and dependencies between industries in the study area during the period 2015-2016. This model has 78 industries covering the industrial structure of the standard Australian classification, ANZSIC (Australian Bureau of Statistics, 2006). This approach has been used to assess regional economic impacts of a series of projects ranging from alternative irrigation scenarios to airport infrastructure upgrades (Australian Institute for Social Research, 2011; Iron Road Limited, 2015; Kangaroo Island Council, 2015; PIRSA Fisheries and Aquaculture, 2016). A more detailed presentation of the IO analysis concept, methods and assumptions can be found in EconSearch (2017).

Input-Output analyses adopt a perspective which considers all industries within an economy to be interconnected, i.e. they are part of a supply chain with some industries supplying a set of production inputs and other industries being the customers of their outputs. Consumers of outputs can be the producing industry itself, other industries or final consumers. Following this principle, the RISE model is used to estimate effects of different levels of intermediate and final demand by 2030 on two key indicators of regional economic performance: GRP and full-time equivalent employment (FTE). Intermediate demand is the total of all inputs, from all industries, that go into the production of an industry’s products. Final demand is the sum of regional household and government consumption expenditure, gross capital formation, changes in inventories, tourism expenditure and exports. The GRP indicates the total value of outputs minus the cost of production inputs per industry.
(i.e. the added value). This information can be used to measure the net industry contribution to the performance of a regional economy. Changes in the size and distribution of the regional workforce across economic activities were assessed through changes in FTEs.

The annual value change in GRP was assumed to be the yearly change in total demand for the output of an industry, and it was used as the trigger of a ‘shock’ to the economy. This effect can be thought of as a change in the components of total local demand. For example, the effect can originate from a change in the final demand due to a change in volumes of exports to other regions, an increase in local household consumption or a change in the intermediate demand of other industries.

The RISE modelling tool inputs relied on projections of regional industry input demand indicators based on historical data from statistical models for compositional time series data (Mills 2010). To estimate potential changes in intermediate and final demand, we modelled changes in added value, employment, local sales, imports, and exports from 2000 to 2017 using data from the Limestone Coast region’s economic profile (RDA Limestone Coast 2018). Annual data for these variables were converted to compositional time series data by dividing each industry value by the total value for all industries in the study region. Afterwards, a log-ratio transformation was applied using Other services as a normalising industry (any industry can be used to generate ratios without changing the results). The resulting log-ratio time series were analysed through exponential smoothing state space (ETS) models (Hyndman, Koehler, Ord, and Snyder, 2008). Fitted ETS models were used to project trends and 95% confidence intervals (C.I.) for the selected regional economic indicators from 2018 to 2030, which informed the parameterisation of industry changes in the RISE model. See Mills (2010) for a comprehensive description of the method used for compositional time series data projection.

### 3.2.2. Scenario parameterisation

Scenario 1 Diversified Energy Mix economic modelling input follows the lower boundary of the 95% confidence interval for the added value projected trend of the gas supply and extraction industry and the industries which are gas users as presented in Table 2. Other industries follow the upper boundary line of the 95% confidence interval trend projections. As scenario 2 Gas and General Industrial Expansion describes a case where growth in the Limestone Coast Region of economic activity occurs across all industries, for the model input this is interpreted as an evolution of the local industries along with the upper boundary trend. Scenario 3, Gas Supply Chain Expansion, projects a continued growth of the gas industry and industries that were previously heavy users of gas. Growth is also expected in industries that could benefit.

### Table 1

Questions guiding group-based discussions on each scenario

| Question | Type 1 | Type 2 |
|----------|--------|--------|
| Employment (direct and indirect) | | |
| Agriculture | | |
| Forestry | | |
| Manufacturing and food processing | | |
| Other sectors (e.g. caring services) | | |
| What would be the role of locally produced gas in this scenario? (for different sectors) | | e.g. energy demand/mix; influencing investment across sectors |
| Other relevant implications | | e.g. population growth, services and facilities |

![Fig. 2. Scenarios of local gas demand and evolution of the economy for the Limestone Coast region](image-url)
Table 2
Alignment between scenarios and economic parametrisation of the scenarios

| Scenario                                      | Data input and assumptions                                      |
|-----------------------------------------------|----------------------------------------------------------------|
| Scenario 1. Diversified Energy Mix            | Gas industry – lower boundary trend                            |
|                                                | Gas users – lower boundary trend                               |
|                                                | Other industries – upper boundary trend                        |
| Scenario 2. Gas and General Industrial Expansion | Gas industry – upper boundary trend                           |
|                                                | Gas users – upper boundary trend                               |
|                                                | Other industries – upper boundary trend                        |
| Scenario 3. Gas Supply Chain Expansion        | Gas industry – upper boundary trend                            |
|                                                | Gas users – upper boundary trend                               |
|                                                | Gas supply chain - upper boundary trend                        |
|                                                | Other industries – average trend                               |
| Scenario 4. Business-as-usual (BAU) scenario  | Gas industry – average trend                                   |
|                                                | Gas users – average trend                                      |
|                                                | Other industries – average trend                               |

From capital investment for infrastructure development, that is the local construction industries and exploration and other mining support services. This latter industry, for exploration and mining services contributed almost 20% of its output in 2015–16 to the oil and gas extraction industry, which represents 5% out of the total industrial input into that industry for 2015–16. Thus, the parametrisation of this scenario uses the upper boundary trend for the gas industry and industrial gas users, while the input data for other industries follow the average trend. Given Scenario 4 is the Business-as-usual scenario, for the quantitative interpretation of this scenario, each of the individual industries follows the average trend.

The data used for the trend analysis has a different industrial structure to the RISE model data, although both map out the whole economy according to the ANZSIC standard. For this reason, a concordance of the sectors is included in Appendix 1. This concordance was used for the trend analysis data to determine the industry level effects, in other words, to derive the input data used as the ‘economic shock’ in the RISE model. The concordance was used to apply the ratio of change indicated by the trend analysis to industries in the RISE model. Where more sub-categories of industry trends were available for a broader category in the RISE data, the yearly change in the GRP value was derived for each detailed industry. Then the yearly effect (‘economic shock’) was calculated as a sum of all industry-level effects.

The Consumer Price Index (CPI) for Adelaide for the base year and year one was calculated and found to be 1.01, hence the default value of 1 was used (Australian Bureau of Statistics, 2019). It is worth noting that the RISE model version 5.0, unlike its previous versions and other IO models, considers market responses (e.g. version 3.0 used for Australian Institute for Social Research, 2011). In other words, the model incorporates price sensitivity, which accounts for the possibility of non-linear production (EconSearch, 2017; West and Jackson, 2005). This means that an industry may be able to increase output in the short term without increasing wages and employment. The outcome of price-adjusted models is more conservative in the projections of flow-on effects on GRP and employment. Given the underlying RISE model IO data is for the financial year of 2015–16, to carry out the forecast for the 10 year period from 2021 to 2030, the change modelled in the first year was an average of the dollar value changes in the GRP for the six-year period between 2016 and 2020.

3.2.3. Communication of analysis results to stakeholders

After the modelling was complete, two additional activities were conducted in November and December 2019. The first of these was an interactive presentation to all participants originally invited to the Stakeholder workshop held in March 2019. The purpose of this presentation was to share the output of the modelling to regional stakeholders and discuss any feedback they had about the project and implications of the results. The second was a similar presentation of the findings to South Australian Government policy makers in the State capital of Adelaide.

4. Results

4.1. Scenario analysis

A clear outcome of the workshop preference voting identified Scenario 2 to be the most desirable but at the same time the least likely. While Scenario 2 Gas and General Industrial Expansion was seen as the most desirable overall, Scenario 1 Diversified Energy Mix ranked high in terms of desirability. Scenario 2 was most popular due to the potential to provide cheaper gas, particularly for those businesses which cannot readily switch to another energy source. However, participants recalled historical examples of locally supplied gas being unreliable, which helps explain the relative desirability of Scenario 1.

In explaining their voting preferences, stakeholders expressed a view that it was unclear whether an increase in gas investment or availability would result in an increase in economic diversity. Despite having a local gas extraction industry present, the delivery costs could still be high, and this presence would not necessarily translate to a reduction in gas prices. If local gas resources were available, affordable and reliable, then additional industries would potentially be attracted to the region. However, other factors may still inhibit the continued presence of diverse industries, especially infrastructure limitations, because not all food processing plants in the region are connected to existing gas pipelines.

The least preferred scenario was Scenario 4, Business-as-usual. The stakeholders universally wanted to avoid reduced economic diversity, which implied a less resilient region and therefore decreased economic sustainability in the long term. Under this scenario, the local economy would go through a reduction in economic activity. In this potential scenario, a slow gas investment would mean even less economic diversity than Scenario 3 Gas Supply Chain Expansion.

When considering the explanation for Scenario 3 being perceived as the most likely scenario, stakeholders said that this scenario reflects current technology use and the expected costs involved in changing away from this technology, which makes it unlikely that users will shift to other production processes in the near future. The dependence on gas resources was strongest for dairy products manufacturing, where gas is not just an energy input, but also part of the technology used to transform milk into milk powder.

However, in Scenario 3 the implication is that for industries to continue to use gas, they would have to be able to afford this resource, focusing on the cost to users inclusive of delivery charges. If gas continues to be an expensive input, its use may not expand in the region, particularly in the context of other input costs being high compared with international competitors (e.g. labour).

To bring about Scenario 2, two obstacles to overcome were put forward: (1) more gas would need to be found; and (2) more of this gas
would need to be made available locally. Government investment in infrastructure was noted by stakeholders to bring about this desired outcome. If this doesn’t eventuate, gas companies may still be able to supply additional gas users if they could develop an alternative distribution model where a virtual gas network based on truck-delivery of the resources could achieve higher local gas use. However, the feasibility of truck transport may wane for larger amounts of gas. In general, understanding the technical and practical constraints of potential gas growth is essential. Participants thought that public perception of conventional gas could be seen as another barrier to bring about Scenario 2 if the gas industry is affected by broader concerns about fossil fuels in general.

Stakeholders expressed the view that alternative ways to increase competition in supply through policies targeting pipeline regulation should be explored. Some participants argued that this should be a priority for the region, as this would enable a broader understanding of what the true costs of gas access and supply are and contribute to maintaining the region’s advantage and long-term access to local gas. PACE has incentivised exploration and local supply, and more policies of this type can help set the course for Scenario 2. In terms of government policy, stakeholders expressed that policies need to be reasonably detailed yet cognisant of their limitations to avoid creating perverse outcomes.

4.2. Industry trends

The added value of the Limestone Coast’s industries increased from $2.7 billion in 2000 to $3.3 billion in 2017 (2016–17 Australian dollars) (Fig. 3A). Continuation of historical trends could result in a total regional added value of around $3.7 billion (+0.9 billion 95% C.I.) by 2030. Around 24% of the total added value in the year 2000 was generated by manufacturing industries, however this share dropped to 8% by 2017 (Fig. 3C). The agricultural sector has gradually consolidated its role as a key driver of the regional economy generating around 37% of the total added value in 2017. If the growing economic relevance of Agriculture, Forestry, and Fishing businesses continues at observed trends, by 2030 around 40% of the regional added value would be generated by this industry (Fig. 3C). On the other hand, the contribution of the Health Care and Social Assistance Services industry has gradually increased from 2000 to 2017 – possibly due to an increasing demand for services for an ageing population (Fig. 3C). By 2030, this sector could account for around 8% of the total regional added value. The added value of other industries remained almost unchanged from 2000 to 2017, a trend that remains in the projections to 2030.

4.3. Input-output analysis

As noted in the previous section the modelled changes are based on projected changes in Gross Regional Product based on the added value trend analysis. Results of the total effects over the period to 2030 are given in Table 3. All the scenarios show an increase in the GRP over 10 years and that employment grows in three out of four scenarios.

A notable difference between the scenarios is that the first two scenarios, where economic diversity is growing, show a larger increase in GRP and total employment figures than the last two (where economic diversity is decreasing). Within the first two scenarios, the increased role of gas in scenario 2 represents an additional benefit to the diversified economy compared with scenario 1. The growth in GRP from Scenario 1 and Scenario 2 are equivalent to an estimated growth of 5.1% and 5.8% respectively from the total 2015–16 figures in the RISE model. In employment terms, these two scenarios lead to 1.9% and 2.2% growth in employment over a ten-year period to 2030 from the baseline of about 22,700 FTEs.

In the scenarios where economic diversity is decreasing (3 and 4), economic growth in terms of GDP are much lower than scenarios 1 and 2. Scenario 3 (with increased gas) leads to a 1.2% increase in GRP, while Scenario 4 is estimated to lead to a 0.9% increase in total GRP. In terms of employment the modelling of Scenario 3 leads to a very small increase in employment while Scenario 4 leads to a decrease in employment (13 FTEs).

It is unsurprising that the two scenarios with increasing economic diversity lead to higher growth and employment increases. What is interesting is that when investment in the gas industry is also growing, there is an additional benefit in terms of GRP and employment. In the two scenarios where diversity is decreasing, gas investment also makes a difference, most notably for employment whereby scenario 3 has a slight increase in employment and scenario 4 has a slight decrease employment over the modelled timeframe. These results suggest that gas investment can make a higher contribution to a more diversified economy.

5. Discussion

The qualitative results show that workshop participants sought an increased role for the gas industry in the region, but not at the expense of a diverse economy. Rather they would like to see gas fuelling diverse industries. However, the workshop discussions brought to light that stakeholders see this scenario as relatively unlikely due to current infrastructure limitations. The quantitative modelling strongly aligned to the principles of forward and backward linkages and their role in regional development outcomes (Watkins 1963, 1977; Gunton, 2003). Specifically, the modelling clearly demonstrated that the preferred scenario, where gas development fuels a diverse regional economy, would indeed lead to the greatest increases in jobs and regional economic growth. The modelling also showed that if growth were limited to the gas industry and its direct supply chain then growth in the regional economy and employment would be lower.

With the return of the gas industry, the Limestone Coast region represents a potentially different narrative compared to the more recognised experience of resource extraction in Australia. Unlike the development experience of export-oriented mining towns such as Roxby Downs in South Australia, Port Hedland in Western Australia or the towns scattered across the Surat Basin in Queensland, Mount Gambier and the surrounding Limestone Coast region are considering very different options. The policy incentives provided by the South Australian Government through the PACE Program which are intended to tie the extraction of the gas to local users supports an important alternative path compared to those regions locked into overseas supply chains. The potential for an alternative narrative is partly due to previous investments in local infrastructure during the 1990s before the gas industry wound down from 2010. With renewed potential for gas to play in important role in the regional development, this aging infrastructure needs to be updated and expanded to fully realise local benefits. State Government policies have gone a long way towards reopening the gas industry and encouraging local distribution, however the assumption is that infrastructure upgrades will be provided by the private sector. The lessons from other contexts show that infrastructure investment to underpin regional development has experienced a degree of market failure, with some regions struggling even to supply basic infrastructure (Tonts et al., 2014; Ryser et al., 2019), leave alone regional pipeline networks to support gas users such as food and fibre processing facilities.

As researchers, we are not advocating for any particular course of action. Rather the research facilitated a process by which stakeholders came together to jointly discuss the desirability and likelihood of different scenarios, and to model the economic outcomes of each scenario. Following the completion of modelling, the research team returned to the region and communicated the projections to the same group of stakeholders. We also communicated the results to policy audiences in the State capital. In this way, the research provided important input into the planning processes that seek to influence the ways that
resource extraction affects host communities including changes to the structure of the economy and employment, demographics among others (Argent 2013; Measham et al., 2016; Fleming et al., 2015; Ryser et al., 2019).

In the introduction to this paper, four dimensions of resilience were highlighted: resistance, representing the degree of sensitivity of a region to economic downturn; recovery, referring to the speed at which a regional economy can bounce back; re-orientation, the extent to which a regional economy can adapt to new circumstances; and renewal, the extent to which a regional economy resumes growth (Martin 2012). In the case of the Limestone Coast, the economy is continuing to grow, however stakeholders were concerned about the degree of resistance to future downturns. Following the stakeholder workshop conducted as part of this research, regional stakeholders looked for ways to build resistance and to encourage re-orientation and how the gas industry can increase resilience in these key dimensions. In particular, stakeholders conducted a regional infrastructure audit which highlighted the role of increasing gas distribution networks as emphasised in the stakeholder

Fig. 3. Long-term trends in regional added value (A), employment (B), and percent composition of added value by industry (C). Historical data from 2000 to 2017 were used to project long-term trends and 95% confidence interval (green area in A and B) from 2018 to 2030.

Table 3
Summary of scenario desirability, perceived likelihood and total economic outcomes over 10 years

| Scenario                                           | Desirability | Perceived likelihood | GRP* total ($m) | GRP change (%) | Employment FTE total | Employment FTE (%) |
|----------------------------------------------------|--------------|----------------------|------------------|-----------------|----------------------|-------------------|
| 1 Diversified Energy Mix                           | 2nd          | 2nd                  | 132              | 5.1%            | 429                  | 1.9%              |
| 2 Gas and General Industrial Expansion             | 1st (highest)| 4th (less likely)    | 150              | 5.8%            | 497                  | 2.2%              |
| 3 Gas Supply Chain Expansion                       | 3rd          | 1st (more likely)    | 35               | 1.3%            | 32                   | 0.14%             |
| 4 Business-as-usual                                | 4th (lowest) | 3rd                  | 24               | 0.9%            | -13                  | -0.06%            |

* modelled addition to Gross Regional Product (GRP) in millions of dollars. Desirability and perceived likelihood based on stakeholder preferences.
workshop (RDA Limestone Coast 2019). In so doing, they sought to reduce path dependence for the region (Boschma and Frenken 2006; Tonts et al., 2012).

The findings from this study provides lessons for other regions facing new (or renewed) resource extraction industries and where lock-in may not have yet occurred (Tonts et al., 2012). In particular, it is important to think through how the industry may play out. Taking a scenario approach is of great value because it highlights different potential pathways for a given region and can show that preferred scenarios may not be automatic or even likely (Sceare and Fulton, 2004; van’t Klooster and van Asselt, 2006). However, taking a scenario approach can help regional stakeholders think through how they may be affected by resource extraction, clarify their preferences and identify actions to best position themselves to make the most of the situation before them (Taylor et al., 2017). More broadly, the findings of this research remind us that lock-in is not a forgone conclusion in all cases. Using resources locally to support a diversified regional economy may not be likely in many cases, but the narrative provided by this case study shows that it is possible.

While acknowledging that the findings of this study provide a generally positive narrative, it is important to recognise that regional development is complex and many factors may affect regional outcomes. Even if the preferred scenario for the gas industry in the Limestone Coast is realised and the region can overcome the challenges of providing appropriate infrastructure to avoid lock-in (Plummer et al. 2018), it is also important to remember that the economic resilience of the region is intrinsically linked to global markets. The foreign-owned powdered milk factory, which represents a forward linkage for the dairy industry, exports a packaged product to distant consumers in China. The former Kraft factory currently owned by Mondelez with headquarters in Illinois USA, manufactures an astounding range of products for supermarket shelves in many countries. All of these linkages are vulnerable to multiple influences affecting international supply chains including foreign exchange rates and more recently global disease pandemics such as the Coronavirus COVID-19 (Manolo et al., 2015; Oxford Analytica 2020). While it is impossible to foresee all the ways that global forces may play out for different regions, this study reminds us that scenario processes are a useful way of helping stakeholders to navigate better outcomes in regional economies (Measham et al., 2012; Taylor et al. 2017).

6. Conclusion

Realising benefits for regional economies and communities from resource extraction is likely to remain a key area of interest for geographers and regional economists. The potential to use resources within the region through value-adding industries remains an elusive goal for many countries, including Australia and Canada. The research presented in this paper suggests that using locally extracted gas is plausible scenario for the Limestone Coast region of Australia. Moreover, modelling results show that the scenario in which gas is used locally, and thereby providing an additional energy source to local manufacturing industries, would provide more benefits in the form of jobs and economic growth compared with scenarios where gas would develop in isolation of those industries. To increase gas supply to local markets, new infrastructure would need to be developed. State Government policies have already gone a long way towards re-opening the gas industry, and regional stakeholders aspire to seeing policy settings extended to support gas distribution infrastructure to increase the use of gas locally in order to fuel growth in other sectors of the regional economy.

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Appendix 1. Gas-using industries

This Appendix details the method used to identify industries to include in the modelling as ‘gas users’. Since manufacturing processes are some of the highest users of gas, the scenarios explore alternative futures of Limestone Coast manufacturing industries and regional implications of these futures. Manufacturing industries which represent the main industrial uses of natural gas and gas-derived products in Australia are non-ferrous metals (e.g. aluminium, copper, zinc, tin); chemicals, polymers and rubber (e.g. fertilisers, antifreeze); non-metallic mineral products (e.g. glass, ceramics, cement, bricks); and plastic packaging for foods and beverages (Department of Environment and Energy 2018).

Table A.1

| Major uses of gas in manufacturing | ANZSIC industries | RISE Model industries |
|-----------------------------------|-------------------|----------------------|
| 213–214 Basic non-ferrous metals | 213. Primary Metal and Metal Product Manufacturing | Basic Non-Ferrous Metals |
| 18–19 Basic Chemical and Chemical, Polymer and Rubber Product Manufacturing | 18. Basic Chemical and Chemical Product Manufacturing | Pharma & Other Chemical Products |
| 20 Non-metallic mineral products | 20. Non-Metallic Mineral Product Manufacturing | Non-metal Mineral Products |
| 11–12 Food, beverages and tobacco | 11. Food Product Manufacturing | Food Product Manufacturing; |
| 15–16 Pulp, paper and printing within the Wood, paper and printing classification | 15. Pulp, Paper and Converted Paper Product Manufacturing | Beer, Wine and Spirits |
| 211–212 Iron and steel | 16. Printing | Pulp, Paper & Paperboard; Paper Products; Printing (incl Recordings) |
| 1709 Other petroleum and coal product manufacturing; 1701 Petroleum refining | 211. Basic Ferrous Metal Manufacturing | Iron & Steel |
| 13 Textile, clothing, footwear and leather | 17. Petroleum and coal product manufacturing | Petroleum & Coal Products |
| 23–24 Machinery and equipment | 13. Textile, leather, clothing and footwear manufacturing | Textiles, Clothing & Footwear |
| | 23. Transport Equipment Manufacturing | Motor Vehicles & Parts |
| | 24. Machinery and Equipment Manufacturing | Other Machinery & Equipment |
First, to identify these industries in RISE a correspondence was drawn between major uses of gas in manufacturing and the standard ANZSIC classification.¹ Manufacturing industries with highest use of natural gas were identified based on their national levels of natural gas consumption for 2016–17 from Table F in the Australian Energy Update (Department of Environment and Energy 2018). The first column in Table A.1 identifies the industries which account for 99% of the natural gas use in manufacturing in Australia.

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²Although some manufacturing uses of gas fit under specific groups or class codes, due to the aggregated nature of the RISE models the change in production was assumed at a broader industry level, mostly at subdivision levels. For more on the classifications of industries as divisions, subdivisions, groups or classes see the
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