Royal Commission
into Aged Care Quality and Safety

THE COST OF RESIDENTIAL AGED CARE

RESEARCH PAPER 9

AUGUST 2020

The Royal Commission into Aged Care Quality and Safety was established by Letters Patent on 8 October 2018. Replacement Letters Patent were issued on 6 December 2018, and amended on 13 September 2019 and 25 June 2020.

The Honourable Tony Pagone QC and Ms Lynelle Briggs AO have been appointed as Royal Commissioners. They are required to provide a final report by 26 February 2021.

The Royal Commission releases consultation, research and background papers. This research paper has been prepared by the University of Queensland for the information of Commissioners and the public. The views expressed in this paper are not necessarily the views of the Commissioners.

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University of Queensland
July 2020

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The cost of residential aged care

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Abbreviations

ABS	Australian Bureau of Statistics
ACFI	Aged Care Funding Instrument
ACQSC	Aged Care Quality and Safety Commission
ALS77	Aigner, Lovell and Schmidt (1977) approach
AN-ACC	Australian National Aged Care Classification
CI	Confidence interval
DEA	Data envelopment analysis
Max	Maximum
Min	Minimum
MM	Modified Monash category
MMM	Modified Monash Model
NWAU	National Weighted Activity Unit
OBD	Occupied bed days
Q1	Quality level 1
Q2	Quality level 2
Q3	Quality level 3
RAC	Residential aged care
ROSA	Registry of Senior Australians
RVU	Relative Value Unit
SFA	Stochastic frontier analysis
TSR1	Technical Supplementary Report 1
TSR2	Technical Supplementary Report 2
WHO	World Health Organization

Key Findings

- The efficient cost of providing residential aged care (RAC) services in Australian facilities was estimated using a flexible log function of the cost frontier that incorporates quality levels found among facilities within the current RAC sector, under current funding levels.
- Facilities were broadly clustered into three quality levels (Q1, Q2 and Q3) based on a composite quality index developed specifically for this project. The index combined seven quality indicators using a latent class model: consumer experience ratings, reported issues, accreditation standards not met, and prescription of four high-risk medicines (sedatives, antipsychotics, opioids and antibiotics). The composite quality index was limited to available data, which we recognise lacked sufficient direct measures of the quality of care recorded in facilities and the coverage across years and facilities.
- The facilities or providers with poorer quality of care (Q3, 11%) had lower customer experience ratings, failed to comply with accreditation standards more often, and received a higher number of complaints and issues. Better quality facilities (Q1, 11%) had a lower use of high-risk medicines, did not fail to meet accreditation standards, received a lower number of issues and complaints, and had a relatively higher customer experience rating score. The middle-quality group (Q2), which includes the majority of facilities (78%), had a low failure of complying with accreditation standards, a moderate level of customer experience score, potentially suboptimal use of high-risk medicines, and a low number of complaints and issues. This may reflect the present reality of prominent potentially suboptimal use of high-risk medicines in aged care.
- Government-owned and small-sized facilities were more likely to demonstrate higher quality of care. The correlation between size and quality of facilities was strong and consistent across ownership and provider types. In the lower quality group (Q3), for-profit providers represented a higher proportion of facilities than their relative importance in the sector.
- We found statistical evidence supporting the hypothesis that an association between the total cost and the quality of RAC services existed, and that the magnitude of such association changes at different levels of output. Similar evidence was found for direct care cost, but not any other non-care cost categories (accommodation, hotelling, administration and other costs).
- A positive association was found between the level of quality care delivered and the cost required to deliver that care at the small-sized (<30 beds) and very large-sized (>200 beds) facilities. For small-sized facilities, the average efficient (total) cost of a resident bed day for Q1, Q2 and Q3 levels were estimated at $274 [95% confidence interval, CI: $268, $279], $267 [95% CI: $263, $271] and $261 [95% CI: $255, $266], respectively. For facilities with more than 30 beds, the average efficient cost per resident bed day in the financial year of 2018/19 were $235 [95% CI: $233, $237], and $224 [95% CI: $223, $225] and $234 [95% CI: $233, 235], respectively. These estimates show statistical evidence of economies of scale (i.e. larger facilities have lower average cost, *ceteris paribus*).
- Based on the estimated efficient cost per resident bed day, it was estimated that if all the facilities were operating without any cost inefficiency, the whole sector would have spent $15.70 billion [95% CI: $15.66 billion, $15.74 billion] in the financial year 2018/19. If all facilities were to operate at Q1 quality level at their current operating size, it is predicted that the RAC sector would have required an additional $621 million [95% CI: $576 million, $687 million] to operate in the financial year 2018/19. If they were to operate at Q1 quality level and with a small-sized model of home, this number would be $3.23 billion [95% CI: $2.89 billion, $3.58 billion].
- There is statistical evidence that inefficiency was associated with total cost and with direct care cost. The average (total cost) efficiency was around 0.88 (min 0.54, max 0.98), while the cost efficiency associated with direct care was 0.91 (min 0.73, max 0.97) for the study period (2014/15 to 2018/19). This level of

inefficiency was lower compared to what has been reported in the aged care efficiency literature (average efficiency of 0.75) and the efficiency levels of other healthcare sectors, such as hospital (average efficiency of 0.83), indicating that the sector operates relatively efficiently. There was insufficient statistical evidence that cost inefficiencies existed in the remaining four cost categories of hotelling, accommodation, administration and other costs.

- This is the first analysis of its type internationally to use a large sample of facilities and a diverse range of quality indicators. However, as usual with this type of analysis, it was limited by the quality and completeness of the data available. Both better financial and workforce reporting standards, and improvements in quality indicator measurement and reporting are required to drive better measurement of quality of care in the RAC sector, and increase the confidence in these results. On the output side, the development of the Australian National Aged Care Classification (AN-ACC) has the potential to improve output measurement of residential aged care facilities as the system captures residents' frailty and severity of care needed more precisely. We recognised the lack of direct measures of the quality of care recorded in facilities, as well as the measurement of quality of life of the residents, and perspectives of their caregivers and family members, which was only captured partly by the consumer experience report survey in this project.

Executive Summary

The University of Queensland was commissioned by the Royal Commission into Aged Care Quality and Safety (the Royal Commission) to conduct this analysis to:

1. Estimate the efficient cost of delivering residential aged care for the range of output quantities and care qualities observed historically, accounting for the degree of care required by residents and other relevant factors that impact on service delivery costs.
2. Assess the historical level and distribution of inefficiency across service providers, using the estimates.
3. Determine the efficient costs required to achieve the different care qualities for all aged care facilities, using the estimation model(s).

To the best of our knowledge, this is the **first time a large-scale and national study** on residential aged care (RAC) facilities has been conducted in the world. It is also the first efficiency analysis that has been conducted that includes **measurements of both quality and efficiency** in the sector. The study used a comprehensive set of quality indicators, ranging from clinical outcomes of residents, process quality standards and service experience indicators.[1]

Measuring quality

A **composite quality index** was developed for this study using seven quality indicators:

- Consumer experience ratings, reported issues, and accreditation standards not met from the Aged Care Quality and Safety Commission (ACQSC).
- Prescriptions of four high-risk medicines (sedatives, antipsychotics, opioids and antibiotics) from the Registry of Senior Australians (ROSA).

Residential aged care facilities were broadly clustered into three quality levels (Q1, Q2 and Q3) based on the composite index.

- Q1 contains 11% of facilities. These had met all accreditation standards, had no issues or complaints, a higher customer experience rating, and a lower utilisation of high-risk medicines.
- Q2, which includes the majority of facilities (78%), had a low failure of meeting accreditation standards, a moderate level of customer experience ratings, potentially suboptimal use of high-risk medicines and a low number of complaints and issues.
- Q3 contains 11% of facilities. These had a lower customer experience rating, a higher failure of meeting accreditation standards, and higher number of complaints and issues.

These quality levels reflect the quality found among facilities within the current residential aged care system under current funding levels. **These quality levels are not intended to reflect the future quality levels that the Australian community might aspire to achieve or that the Royal Commission is considering.**

When examining the characteristics of facilities in the different quality levels, we found government-owned and small-sized facilities were more likely to be in Q1. The correlation between size and quality of facilities was strong and consistent across ownership and provider types. In the Q3 group, for-profit providers represented a higher proportion of facilities than their relative importance in the sector.

[1] For a summary of prior studies see Tran A, Nguyen K-H, Gray L, Comans T. A Systematic Literature Review of Efficiency Measurement in Nursing Homes. International Journal of Environmental Research and Public Health. 2019 Jan;16(12):2186.

Measuring efficiency

Cost efficiency is measured in this study using stochastic frontier analysis (SFA) which is a standard technique to estimate a 'least-cost' curve for a group of producers with similar characteristics (in this case residential aged care facilities). The SFA was conducted using:

- Financial data about the historical costs of residential aged care facilities from Stewart Brown and about providers from the Department of Health.
- Facility characteristics and occupied bed days from these same sources.
- A measure of the relative care needs of residents in facilities developed by the Royal Commission and the Australian Health Services Research Institute (AHSRI).
- The Composite Quality Index derived specifically for this study.

A **three-stage analysis process** was conducted to explore the data, understand the cost structure of the RAC sector and the association between cost and quality levels. This occurred at the aggregated total cost level and the disaggregated cost components (direct care, accommodation, hotelling, administration and other costs). Multiple cost functions and frontier models were estimated to test the consistency of the results and identify the most appropriate model. The results are highly consistent across models.

After exploring many different cost functions and frontier models, a **flexible log function** with casemix-adjusted occupied bed days as the output variable was chosen as the final model. This accommodates the non-linear relationship between cost and output with respect to different quality levels.

The average total cost efficiency among residential aged care facilities in the study period 2014/15 to 2018/19 was estimated to be around 0.88 (min 0.54, max 0.98). The average cost efficiency associated with direct care was 0.91 (min 0.73, max 0.97) in the same period. This level of efficiency is higher than what has been reported in the aged care efficiency literature (average efficiency of 0.75) and the efficiency levels of other healthcare sectors, such as hospital (average efficiency of 0.83), indicating that the sector operates relatively efficiently.

We found statistical evidence supporting the hypothesis that an association between the total cost and the quality of residential aged care services existed, and that the magnitude of such association changes at different levels of output. Similar evidence was found for direct care cost, but not any other non-care cost categories (accommodation, hotelling, administration and other costs).

The differences are statistically significant but not always large in dollar terms. This may reflect that RAC facilities are largely funded by the Government with a relatively narrow funding range, and that quality depends on many factors other than expenditure (for example, the skills of staff, clinical governance, work processes and organisational culture).

For small-sized facilities, the average efficient (total) cost of a resident bed day was estimated to be:

- Q1: $274 [with a 95% confidence interval of $268 - $279]
- Q2: $267 [with a 95% confidence interval of $263 - $271]
- Q3: $261 [with a 95% confidence interval of $255 - $266]

For facilities with more than 30 beds, the average efficient cost per resident bed day in the financial year of 2018/19 was estimated to be:

- Q1: $235 [with a 95% confidence interval of $233 - $237]
- Q2: $224 [with a 95% confidence interval of $223 - $225]

- Q3: $234 [with a 95% confidence interval of $233 - 235] (note this estimate is higher than for Q2, which may reflect the additional costs that facilities could incur if not meeting regulatory standards or working towards improving their quality attainment processes)

Based on the estimated efficient cost per resident bed day, it was estimated that if all the facilities were operating without any cost inefficiency, the whole sector would have spent $15.70 billion [95% confidence interval, CI: $15.66 billion, $15.74 billion] in the financial year 2018/19. If all facilities were to operate at Q1 quality level at their current operating size, it is predicted that the RAC sector would have required an additional $621 million [95% CI: $576 million, $687 million] to operate in the financial year 2018/19. If they were to operate at Q1 quality level and with a small-sized model of home, this number would be $3.23 billion [95% CI: $2.89 billion, $3.58 billion].

It is very important that these estimates be interpreted correctly by the reader. These estimates are for the quality levels found among facilities within the current residential aged care system under current funding levels. Funding levels might need to be much higher than the estimates if the Australian community and the Royal Commission aspire to achieve a higher quality in the future than facilities have achieved historically.

Focusing on quality improvement may have wider benefits than could be captured in this analysis. It could be argued that shifting the focus from cost-minimisation to quality of care for residential aged care residents may lead to process improvements in the facility and a better workplace culture. The cost to move facilities to a better quality may be offset in other government spending in healthcare and other aged care services. For example, better care for residents may reduce the need for hospitalisations, especially for preventable issues (e.g., pressure injury or falls). Since the data on hospitalisations was not available for this analysis, such hypotheses could not be tested. A stronger focus on resident outcomes, both health and quality of life, may also reduce spending on high-risk medicines, as well as reducing workplace injuries and accidents.

Limitations

As usual with this type of analysis, there are limitations, particularly with the available data in the RAC system. While the data used here is the most comprehensive ever harnessed for research about residential aged care in Australia, or internationally, to the best of our knowledge, there remained significant gaps.

- There were approximately 2,700 active facilities in 2018/19 providing residential aged care services annually in Australia. Not all facilities had complete data items required for the analysis for all five financial years (2014/15 to 2018/19).
- Seven quality indicators were included in the construction of the composite quality index. The ROSA indicators for high-risk medicines and ACQSC data were relatively complete. Consumer experience report data was available for only 3% of the sector (82 facilities) in financial year 2016/17 and approximately 40% of the sector across financial years (2017/18 and 2018/19).
- The costs data from the Department of Health cost data covers the whole sector but was only at the provider level so not well suited to the needs of a facility-level analysis. The Stewart Brown data only covers 34% of facilities.
- Staffing data was sourced from Stewart Brown surveys and additional data acquired by the Royal Commission from the largest providers who do not participate in the Stewart Brown surveys. Data collection on staff hours increased over the five years from 20% to 60% of facilities. However, the reporting quality for a small proportion of facilities was questionable and there was insufficient data available about wages or training for this to be considered useful in the frontier analysis.

Better financial and workforce reporting standards, and improvements in quality monitoring and measurement, would increase the confidence in these results. This is another important issue to address for the future of aged care.

1. Introduction

1.1 Specific aims of this project

The University of Queensland was commissioned by the Royal Commission into Aged Care Quality and Safety to conduct this analysis to understand the cost and resources required to provide different qualities of residential aged care (RAC) services in Australia.

The main aims were:

1. To estimate the efficient cost of delivering residential aged care for the range of output quantities and care qualities observed historically, accounting for the degree of care required by residents and other relevant factors that impact on service delivery costs.
2. To assess the historical level and distribution of inefficiency across service providers, using the estimates.
3. To determine the efficient costs required to achieve the different care qualities for all residential aged care facilities, using the estimation model(s).

1.2 Structure of this report

This **main report** contains **four sections**:

- **Background** (Section 2): This section includes the background of this study.
- **Methods** (Section 3): This section summarises briefly the available data and analytical methods used to construct the composite quality index and to estimate cost inefficiency of RAC facilities (and providers) in Australia.
- **Results** (Section 4): This section presents the main results of the efficiency analysis, with the incorporation of the composite quality index in the form of three quality levels (Q1, Q2 and Q3). This section describes how the project aims were achieved.
- **Discussion** (Section 5): This section provides interpretations of the results, highlights limitations of the analyses presented and suggests future directions.

This **main report** includes three **appendices**:

- *Appendix A: Data preparation and exploration: Facility level*
- *Appendix B: Direct care cost and workforce data: Facility level*
- *Appendix C: Data preparation and exploration: Provider level*

This **main report** is accompanied by two **technical supplementary reports**:

- ***Technical Supplementary Report 1 (TSR1): Composite index for quality of care in Australian residential aged care facilities.*** This report describes the data on quality used in the analysis, exploratory analyses and the methods to construct the composite quality index. It has two appendices:
    - *TSR1 Appendix A: Literature review on quality in residential aged care facilities*
    - *TSR1 Appendix B: Latent class analysis to construct the quality index at the provider level*

- ***Technical Supplementary Report 2 (TSR2): Cost frontier analysis of Australian residential aged care facilities.*** The report outlines the step-by-step approach to identify the cost functions that best represent the cost structure of the RAC industry in Australia. The main results and the sensitivity analyses conducted to ensure the robustness are described. It has three appendices:
    - *TSR2 Appendix A: Data diagnostics: Identifying and analysing outliers in cost and output data*
    - *TSR2 Appendix B: Robustness check of estimated inefficiency: Semi-parametric least squares stochastic frontier analysis*
    - *TSR2 Appendix C: Additional results from the stochastic frontier analysis*

2. Background

Residential Aged Care (RAC) services face the challenges of increasing expectations of service quality and rising real costs of operation. To maintain business viability as individual operators and for the sustainability of the whole sector, these challenges must be met with improvements in productivity and efficiency through service and process innovations. This must be achieved while maintaining or indeed improving the quality of care delivery.

Efficiency analyses of many service sectors have received attention from both the private and government sectors and policy-makers. Efficiency analysis is a technique that combines the inputs (resources including staff and capital) and outputs of a production unit (firm or facility) in a mathematical function in order to benchmark facilities against peers. The mathematical function can present the production frontier or the cost frontier, depending on the analysis objective and behaviours of the production unit in the sector. If the sector aims at maximising output, then the production frontier will be most appropriate. If the sector aims at minimising cost (or input) in order to meet a given budget, then the cost frontier will be most appropriate. In this project, the cost frontier is chosen as it reflects the behaviour of the sector and is suitable to answer the research questions.

The cost frontier represents the most efficient use of resources in the sector analysed, by using the lowest possible level of input or cost feasible to achieve a desirable level of output. Production units (e.g. facilities) that sit on the frontier are considered efficient (i.e. using the minimum feasible level of input or cost). Those that sit above the frontier are considered to have some level of inefficiency (i.e. using more inputs or costs than the minimum feasible level). These units should be able to move toward the frontier by making better use of their available resources by improving their productivity.

Frontier analysis can help with understanding how a sector as a whole performs and allows a deeper understanding of where improvements can be made in order to maximise the benefits accruable from the available resources. The analysis allows individual facilities to compare themselves to similar units (peers) in the sector, understand their relative strengths and weaknesses, and identify opportunities for productivity and efficiency improvement.

Given the requirement to deliver quality care in RAC facilities, both quality and efficiency are central concerns for policy-makers. It is undesirable to improve efficiency by compromising the quality of services when better health outcomes and improved well-being of the residents are the ultimate goals of a good aged care system. Therefore, measuring efficiency without proper adjustments for quality differences between facilities will not provide accurate information about their relative performance, thereby not facilitating true improvements. For instance, facilities that deliver high-quality care could appear to be relatively inefficient when the high quality of care is driven by a larger, skilled and trained workforce and resources, and the additional quality improvement is not considered and measured properly.

While there has been a range of efficiency studies undertaken previously, they have all lacked reliable and relevant quality indicators used in RAC efficiency measurement. A 2019 systematic review conducted by members of the project team (Tran et al., 2019) found that while 31 of the 39 studies included quality, 19 of these studies included only one indicator. The effect of quality on the ranking of RAC efficiency was rarely reported. Most notably, the practice of benchmarking facilities to their respective quality levels has not previously been undertaken. Studies treated quality as *external factors* that explain inefficiency rather than a *standard of care quality* that facilities ought to achieve.

Every reform proposed to improve the quality of the aged care system requires a starting point of understanding what “quality” means and how to measure it. Without such knowledge, it would be impossible to design the policies, programs and interventions, to select indicators to measure improvements and ultimate outcomes.

Quality of care is a complex and multidimensional concept (Donabedian, 1988, 1966; Ovretveit, 1992; Wilcock, 1996). The concept of quality care has been examined from both macro (system-wide) and micro (provider unit) perspectives, dating back over half a century (OECD, 2013; Spector and Mukamel, 1998). From a system (macro) point of view, the World Health Organization (WHO) defines quality along six dimensions: effective, efficient, accessible, acceptable/patient-centred, equitable and safe (World Health Organization (WHO), 2006). The roles and responsibilities in quality improvement are shared amongst service providers, communities and service users (patients, residents), and policy-makers. This framework is most relevant to drive system-wide changes by highlighting the interconnectedness of quality dimensions and to guide the process of selecting new interventions and building strategies for quality improvement. However, a micro (provider unit) perspective, such as the Donabedian model, is most appropriate to conceptualise and construct quality of care for this project.

The Donabedian model remains the dominant theoretical framework for assessing the quality of health care (Donabedian, 1988, 1966). The model has been widely used over the last 50 years to assess quality in health care and has been extended to measure the quality of aged care (Castle and Ferguson, 2010; OECD, 2013). In this model, Donabedian proposes a three-dimensional approach to assessing the quality of care, which include structure, process and outcomes (Donabedian, 2003). *Structure* refers to the attributes of the setting in which care is provided. *Process* refers to the components of care delivery. *Outcome* refers to the changes in care recipients that can be attributable to the care. As Donabedian indicates, these three dimensions are interlinked, and a comprehensive assessment of the quality of care should be assessed based on a combination of all three dimensions, rather than relying on a single dimension (Donabedian, 2003).

In the context of the Royal Commission into Aged Care Quality and Safety, **it is essential to understand the performance of the aged care sector, in both overall quality and efficiency**. This report comes 16 years after the last previous efficiency analysis of the RAC sector in Australia, reported in the Hogan Review of Pricing Arrangements in Residential Aged Care (2004). That analysis was unable to incorporate quality due to lack of data available on quality indicators.

This study represents the first time that a large-scale and national study on RAC facilities (and providers) has been conducted in Australia and internationally, with an extensive linked dataset. It is also the first efficiency analysis that has been conducted which includes comprehensive measurements of both quality and efficiency in the sector. This study used a comprehensive set of quality indicators, ranging from clinical health outcomes of residents, process accreditation standards and service experience indicators. The proposed new national casemix classification for residential aged care (Australian National Aged Care Classification, AN-ACC) and financial data sourced from two sources were included in this study. First, a composite quality index was developed from the comprehensive set of quality indicators and was used to group facilities into categories of differing levels of quality (details are provided in the *Technical Supplementary Report 1*). Subsequently, the RAC facilities in Australia were benchmarked against their quality-level efficiency group (or frontier) (Section 3 below, and more detail in the *Technical Supplementary Report 2*).

3. Methods

3.1 Data

3.1.1 Data sources

This report draws on de-identified facility and provider-level data provided by the Royal Commission under its legal authority. The data were held in a secure, restricted access IT environment by the University of Queensland and used only by staff for the purpose of this project.

Data on the characteristics of the facilities and providers was sourced from the Department of Health. The quality data was sourced from the Aged Care Quality and Safety Commission, Australian Institute of Health and Welfare and the Registry of Senior Australians (ROSA) project (Inacio et al., 2020). Financial information on the cost of care data was drawn from financial reports from Stewart Brown and the Department of Health. Casemix adjustment was included based on the mapping of the Aged Care Funding Instrument (ACFI) to the AN-ACC, developed by the Australian Health Services Research Institute at the University of Wollongong (Kobel and Eagar, 2020). The data on bed days was sourced from individual facilities.

The University of Queensland project team received the data items in multiple databases from the Royal Commission. The databases supplied to conduct the quality-adjusted efficiency analysis of aged care facilities and providers in Australia is detailed below (Table 1). Preliminary data screening and visualisation were performed to check the data quality and completeness and to identify outliers before conducting the main analysis.

Table 1. Data sources

Database	Data sources/ custodians	Data quality and completeness	Description of the data sources and its role in the analysis
Characteristics	Department of Health	Complete residential aged care sector; five years 2014/15 to 2018/19	Data (facility and provider level) contains locations, organisational types, provider types, number of available beds, number of facilities per provider, ABS description for remoteness, MMM classification, and state/territory.
Complaints and issues	Aged Care Quality and Safety Commission	All facilities that had complaints; five years 2014/15 to 2018/19	Data (facility level) contains complaints count, issues count (one complaint may comprise multiple issues), count for each of the 29 issue types.
Sanctions	Aged Care Quality and Safety Commission	All facilities that had sanctions; five years 2014/15 to 2018/19	Data (facility level) contains sanction count.
Accreditation standards	Aged Care Quality and Safety Commission	All facilities that had not met accreditation standards; All five years 2014/15 to 2018/19	Data (facility level) contains compliance with accreditation standards (flags, not met accreditation standards, serious risk).[a]

Database	Data sources/ custodians	Data quality and completeness	Description of the data sources and its role in the analysis
Financial information of providers	Department of Health	Complete residential aged care sector; four years 2014/15 to 2017/18	Data (provider level) contains incomes and expenditures for individual providers (labour, services, outsources, utilities, building, equipment, assets, and others). Costs can be decomposed into direct care, hotelling, administration, finance and other costs.
Financial information of facilities	Stewart Brown	Approximately 35% of residential aged care facilities; five years 2014/15 to 2018/19	Data (facility level) contains income/revenue and expenditure for individual facilities (labour, quality and education, services, outsources, utilities, building, and others). Cost can be decomposed into cost of care, hotelling, administration, finance, or other.
Registry of Senior Australians (ROSA) Monitoring Outcome indicators	Registry of Senior Australians (ROSA)	12 indicators: 5 indicators available for all states/territories; 7 indicators available for South Australia; five years 2012/13 to 2016/17	Data (facility level) contains 12 clinical outcome indicators, estimated using a variety of data sources (Commonwealth and State Government of South Australia), including crude and casemix-adjusted proportions and rates. Additional covariates, including dementia or osteoporosis, are included in the specifications of some indicators.
Provider survey: Consumer experience rating	Aged Care Quality and Safety Commission	Small number of facilities; three years 2016/17 to 2018/19	Data (facility level) contains the count of consumer rating responses for each of 10 questions regarding their experience.
Provider survey: workforce	Royal Commission into Aged Care Quality and Safety	Not all the residential aged care sector; five years 2014/15 to 2018/19	Data (facility level) contains paid hours of labour per resident per day by category (by specialty and service area such as care, hotelling, administration).
Australian National Aged Care Classification (AN-ACC): Casemix	Centre for Health Service Development, University of Wollongong	Complete residential aged care sector; five years 2014/15 to 2018/19	Data (facility level) contains the casemix indices, National Weighted Activity Unit (NWAU) and Relative Value Unit (RVU), for individual facilities each year. This is the result of a mapping from the Aged Care Funding Instrument (ACFI) to the AN-ACC.
Bed days	Facilities reported	Quite complete; five years 2014/15 to 2018/19	Data (facility level) contains the number of days in residential care, respite, transition care, hospital, and with social leave.

All databases were provided at the facility level, except for the financial information of providers from the Department of Health.
ABS: Australian Bureau of Statistics; ACFI: The Aged Care Funding Instrument; AN-ACC: Australian National Aged Care Classification; NWAU: National Weighted Activity Unit; MMM: Modified Monash Model Remoteness Classifications; RVU: Relative Value Unit
[a] There are 44 expected outcomes across four Accreditation Standards.

After the preliminary screening on face validity (variable definitions), the most relevant data items were selected to construct the composite quality index, and estimate the cost frontier. Each data group (output, cost, inputs and quality) was merged with the relevant facility and provider characteristics database. This enabled further screening for data completeness across data items and financial years.

3.1.2 Description of data used in the analysis

Over the past five years, there have been over 2,700 active facilities providing residential aged care services each year in Australia.

Seven quality indicators were included in the construction of the composite quality index (Table 2): four *ROSA indicators representing high-risk medicine use*, *not met accreditation standards*, *complaints/issues*, and *consumer experience*. *Sanctions* was analysed during the construction of the composite quality index; however, it was not used in the final index as it was correlated with the indicator of *not met accreditation standards*.

Not all facilities had complete data items required for the analysis for the 5-year study period (financial years 2014/15 to 2018/19). The *issues* (complaints) and *sanctions* data were complete for the whole sector; more than half of facilities (50–70%) had received *issues* (*complaints*) and only a handful of facilities had *sanctions* imposed across the 5-year period. The *ROSA indicators* and the *not met accreditation standards* data were complete for approximately 95% of the whole sector for the 3 and 5 years of available data, respectively. *Consumer experience report* data were available for only 3% of the sector (82 facilities) in financial year 2016/17 and approximately 40% of the sector across financial years (2017/18 and 2018/19).

Table 2. Quality indicators used to construct the composite quality index

Indicator and description	Domain	Number of facilities per financial year				
		2014/15	2015/16	2016/17	2017/18	2018/19
Whole sector		***2,811***	***2,813***	***2,801***	***2,782***	***2,762***
Registry of Senior Australians (ROSA)						
Antibiotics use (adjusted rate)	Outcome	2,697	2,687	2,682	-	-
Antipsychotics use (adjusted proportion)	Outcome	2,695	2,686	2,680	-	-
Chronic opioid use (adjusted proportion)	Outcome	2,696	2,686	2,682	-	-
High sedative load (adjusted proportion)	Outcome	2,693	2,684	2,679	-	-
Compliance with accreditation standards						
Number of accreditation standards not met [a]	All domains [b]	All facilities across all five financial years [c]				
Issues (complaints)						
Number of issues from complaints (count)	Outcome	All facilities across all five financial years [c]				
Sanctions						
Number of sanctions (count) [d]	All domains [b]	All facilities across all five financial years [c]				
Consumer experience						
Consumer experience report (10 items)	Outcome	-	-	82	1,071	1,124

[a] Failure to comply with any of the 44 expected outcomes across the four Accreditation Standards. Between 2 to 25 facilities were excluded per year from accreditation standards dataset as there were more observations in the accreditation standards database than the official list of operational residential aged care facilities in the characteristics database from the Department of Health.
[b] This indicator can be considered either a structure, process or outcome domain depending on the nature of the indicator.
[c] Data for these three indicators was provided only for the facilities (across the whole sector) that had (i) not met accreditation standards, (ii) official complaints (and issues) recorded, and (iii) sanctions imposed, respectively.
[d] This measure was not used in the final index as it was correlated with the not met accreditation standards indicator.

There were three types of service providers for residential aged care facilities in the data: not-for-profit, for-profit and government. Across the 5-year period, not-for-profit providers accounted for over half (57%) of the residential aged care market, followed by for-profit (34%) and government (9%) providers. Most of the selected quality indicators had good coverage for each of the three types of service providers. *Issues* (complaints) and *sanctions* were provided for all three service provider types, covering the whole sector. Issues (complaints) were recorded for approximately one-third of government, half of not-for-profit, and two-thirds of for-profit operated facilities across the 5-year period. *Sanctions* were imposed on less than one percent of facilities across the three service provider types over the 5-year period. The *ROSA indicators* and *not met accreditation standards* were available for most not-for-profit (95–97%) and government (97–99%)

facilities, and for the majority of for-profit (91–93%) facilities for the 3 and 5 years of available data, respectively. Consumer experience ratings were consistent across all three service provider types and were available for approximately 40% of facilities in the latest 2-year period and less than 5% of facilities in financial year 2016/17.

The costs and outputs used in the analysis by financial year are presented in Table 3.

Table 3. Number of observations for each data items of costs and outputs available for the analysis

		Number of observations per financial year				
Data items		**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**
Costs						
Total cost	*Sum of all cost components:*					
	Department of Health data	566	552	516	506	-
	Stewart Brown data	791	814	938	956	1,025
Direct care	Sum of all cost items for providing care [a]					
Hotelling	Sum of all cost items for hotel services [b]					
Accommodation	Sum of all cost items for accommodation services [c]					
Administration	Sum of all cost items for administrative services [d]					
Others	Sum of the remaining cost items including finances [e]					
Outputs						
Casemix	RVU, NWAU	2,678	2,662	2,669	2,691	2,714
Bed days [f]	Days in hospital social leave; Days in residential care, respite, transition care	2,676; 2,803	2,668; 2,796	2,650; 2,824	2,718; 2,859	2,737; 2,881
OBD	Number of OBD (Stewart Brown data)	791	814	938	956	1,025

NWAU: National Weighted Activity Unit; OBD: occupied bed days; RVU: Relative Value Unit
[a] Department of Health data: Labour cost and other care costs. Stewart Brown data: Labour cost in detail (care management, registered nurses; enrolled/licenced nurses, unlicensed personal care staff, allied health and lifestyle, agency, worker's compensation, chaplaincy), and other care costs (medical supplements, other resident care)
[b] Department of Health data: Labour, internal service, external service, and other hotel costs. Stewart Brown data: Labour cost in detail (catering, clean, laundry, worker's compensation), internal services and external services for catering, clean, laundry.
[c] Department of Health data: Labour, repair and maintenance, building rent, and other accommodation costs. Stewart Brown data: Labour, utilities, rates, repair and maintenance, rental, refurbishment.
[d] Department of Health data: Labour, repair and maintenance, building rent, and other accommodation costs. Stewart Brown data: Management recharges, labour, worker's compensation, insurance and other costs.
[e] Department of Health and Stewart Brown data: Sum of the remaining cost items including finances (interest, etc.)
[f] Data reported by facilities and provider

The costs were used in two ways in the analyses; the primary analysis used the aggregated (total) costs and the secondary analyses used the disaggregated costs (direct care, accommodation, hotel services, administration, and others). A detailed description of each cost category is provided in *Appendix C* of this report. The cost data were provided from two different sources, the Department of Health and Stewart Brown. The Department of Health cost data had full coverage of the whole sector and contained data at the provider level only. The Stewart Brown cost data had coverage of 34% of the sector and contained data at the facility level. As the Department of Health cost data did not contain facility-level data, the Department of Health cost data for single-facility providers, that were not already included in the Stewart Brown data, were used in the facility-level analysis. There were between 430 and 500 single-facility providers (approximately 15% to 18% of all facilities) across the four financial years 2014/15 to 207/18 (see *Appendix A* of this report). The cost data from the two sources were examined and compared prior to being used in the efficiency analysis. For more details on the data preparation and exploration of the cost data, refer to *Appendices A and C* of this report.

The output data includes several items including *casemix*, *bed days* and *occupied bed days*. The casemix data contained two types of casemix indices derived from the AN-ACC classification. The first index, the National Weighted Activity Unit (NWAU), is calibrated against the individualised care and the base care tariff together. The second index, the Relative Value Unit (RVU), is calibrated against the individualised care

alone. The casemix data represented over 95% of the sector. In this report, the RVU was used to reflect the resource associated with the care complexity of individual residents alone. *Bed days* consisted of the number of days spent in hospital, with social leave and in residential care. The number of bed days was reported by facilities and covered over 95% of the sector. *Occupied bed days* were sourced from Stewart Brown and only covers around 28–37% of the sector depending on the financial years.

Additional data provided for this project includes *labour* (*staff hours)* and the *number of places (beds)*. Staff hours were sourced from Stewart Brown surveys and additional data acquired by the Royal Commission from providers who do not participate in the Stewart Brown surveys. This data contained paid hours of labour per resident per day by category. Data collection of staff hours increased over the five years from 20% to 60%. The data coverage was low, and the reporting quality for a small proportion of facilities was questionable. Therefore, it was not used in the frontier analysis. The *number of places (beds)* were sourced from the Department of Health and were representative of the whole sector. The number of places was not used directly in the frontier analysis, but was used in subsequent analysis to calculate the efficient cost of the whole RAC sector.

The characteristics dataset sourced from the Department of Health had full coverage for the whole sector at both facility and provider levels. The characteristics of facilities and providers are presented in Table 4.

Table 4. Data items that capture characteristics of facilities

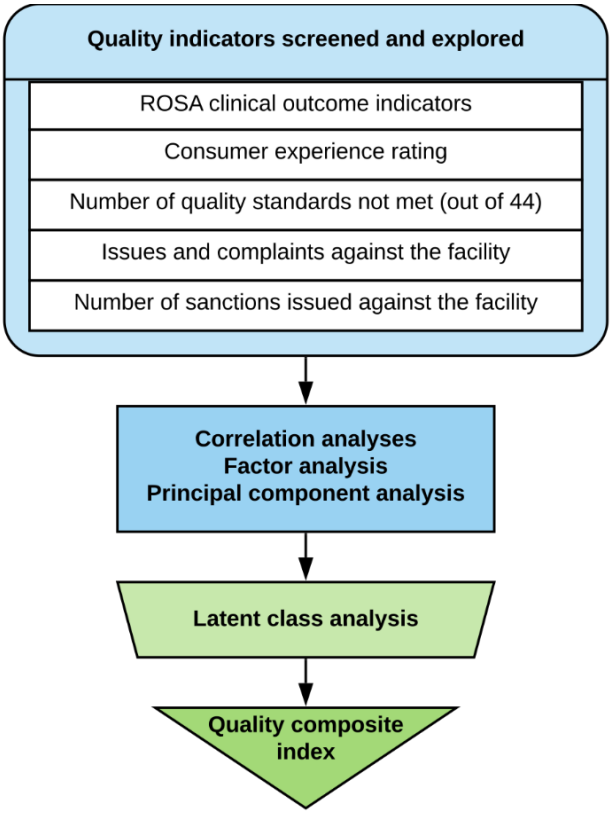
	Number of observations per financial year				
Data items	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**
Ownership and profit motivation	3,203	3,240	3,269	3,246	3,261
Size [a]	3,203	3,240	3,269	3,246	3,261
State/territory [b]	4,981 (across the five financial years)				
Geographical classification [c]	4,975 (across the five financial years)				

Data were provided at the facility and provider level, except state/territory and geographical classification which were provided at the facility-level only.
Data contained all residential aged care facilities, including facilities currently in operation as well as facilities considered to be redundant as they are no longer in operation or changed.
[a] Facility size was derived from the input item, number of places, as a binary variable: a facility is classified as small if it has fewer than 30 places.
[b] State/territory in which the facility was located
[c] Modified Monash Model (MMM) geographical classification system

The data quality and integrity of all selected data items were further examined in-depth prior to commencing the construction of the quality composite index and frontier estimation. The construction of quality composite indices and frontier estimations are influenced by the quality of the data and, in particular, by outliers that may introduce potential bias in the estimates. Details of the data preparation and exploration are provided in the *Appendices A, B and C* of this report.

3.2 Construction of the quality composite index

The quality indicators were drawn from multiple data sources and analysed in the construction of the quality indices. A multi-staged approach to derive the quality of residential aged care facilities was undertaken (Figure 1). Firstly, a comprehensive data exploration was conducted on the available quality variables to examine data completeness, distributions, and their correlations with each other. This was followed by a multivariate analysis (correlation and factor analyses). The factor analysis identified the underlying constructs and variables that captured the quality of care. Secondly, a latent class analysis was performed to group the facilities into categories representing different levels of quality. Details of these analyses are provided in the *Technical Supplementary Report 1.*



Abbreviations: ROSA: Registry of Senior Australians

Figure 1. Process chart of the multi-staged approach to derive the quality

Not all facilities had sufficient annual data for all quality indicators, especially for the consumer experience ratings. Due to the nature of the available quality indicators data, a set of annual quality indices for the whole 5-year period was unable to be developed. Instead, a set of 5-year quality indices were developed, which involved pooling the data across years to maximise the number of facilities.[2] Details of the construction of the composite quality indices are presented in the *Technical Supplementary Report 1*.

The final set of 5-year composite quality indices based on the latent class analysis is presented by three levels: Q1, Q2 and Q3. Q1 represents a higher level of quality while Q3 represents the lowest level of quality. It should be noted that the Q1 quality level may not be what considered the highest quality in aged care by international standards, or consistent with the quality that the Australian community and Royal Commission aspire to achieve for the future. Rather it is what is considered the highest relative to the current standard of the Australia RAC sector that is distinguishable, according to the available indicators. A composite quality index was able to be developed for each facility as all facilities had at least some observations over the 5-year period and the latent class analysis methodology was able to deal with missing observations.[3] Subsequent efficiency analysis was then conducted using cross-sectional methods.

For each quality group (or class), the latent class model showed a very high predicted probability (mean = 0.928, standard deviation = 0.120; 95% confidence interval, CI: 0.924, 0.933), indicating a low probability of misclassification of quality groups.

[2] For the consumer experience rating, the data were pooled (averaged) across the 3 years of available data (financial years 2016/17 to 2018/19), which resulted in 2,217 complete-case observations (facilities per year), covering about 80% of the sector.

[3] The latent class analysis is based on 2,847 unique residential aged care facilities across 5 years, which is higher than the number of active facilities in financial years 2014/15 to 2018/19 (i.e. 2,811, 2,813, 2,801, 2,782, and 2,762, respectively). Latent class analysis was able to analyse facilities with missing data, such as the facilities with missing data in the characteristics dataset, refer to the Technical Supplementary Report 1.

The number and proportion of facilities in each level of quality by service provider type are presented in Table 5. Facilities operated by government service providers had the highest proportion of facilities in the highest quality Q1 category (24%), followed by the facilities operated by not-for-profit providers (13%). Meanwhile, the for-profit facilities had a very low proportion (4%) of facilities in the Q1 category. The government service providers had the lowest proportion of facilities operating at the lowest quality Q3 category (8%), closely followed by the not-for-profit facilities (10%). The for-profit providers, again, were found to have the highest proportion of facilities in the lowest quality Q3 category. In the absence of data that can explain the representation differences across quality categories by provider type, we hypothesise that a different funding mechanism, thus profit motivation, might be in place. For instance, government-run facilities often received additional funding from the State government. This might allow them to provide more secure employment to staff, and/or to keep a slightly higher staff-resident ratio. Both of these could lead to higher work satisfaction and commitment, and as found in the literature, are strongly correlated with a higher quality of care in health and social services (Boakye-Dankwa et al., 2017; Castle and Engberg, 2007; Collier and Harrington, 2008; Spilsbury et al., 2011).

Table 5. Number and proportion of facilities in the quality levels by service provider type

	Quality levels			
Service provider type, n (%)	**Q1**	**Q2**	**Q3**	**Total**
Not-for-profit	207 (13%)	1,273 (78%)	162 (10%)	1,642 (100%)
For-profit	35 (4%)	793 (82%)	132 (14%)	960 (100%)
Government	60 (24%)	166 (68%)	19 (8%)	245 (100%)
Total	302 (11%)	2,232 (78%)	313 (11%)	2,847 (100%)

Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

The number and proportion of facilities in each level of quality by the size of the residential age care facility are shown in Table 6. Over 40% of the very small-sized facilities (15 places or fewer) were categorised as the highest quality level Q1. As the facilities became larger in size, the proportion of facilities in the higher quality Q1 category decreased. None of the very small-sized facilities (15 places or fewer) were in the lower quality Q3 category. None of the largest-sized facilities (over 200 places) were in the higher quality Q1 category. For lower quality Q3 facilities, the proportion of facilities increases as the size of the facility became larger, indicating a relationship between quality and size.

Table 6. Number and proportion of facilities in the quality levels by the residential aged care facility size

	Quality levels			
Facility size	**Q1**	**Q2**	**Q3**	**Total**
1–15 places	33 (41%)	47 (59%)	0 (0%)	80 (100%)
16–30 places	66 (26%)	177 (68%)	15 (6%)	258 (100%)
31–60 places	129 (17%)	569 (75%)	57 (8%)	755 (100%)
61–120 places	63 (5%)	1,018 (83%)	150 (12%)	1,231 (100%)
121–200 places	11 (2%)	394 (81%)	84 (17%)	489 (100%)
Over 200 places	0 (0%)	27 (79%)	7 (21%)	34 (100%)
Total	**302 (11%)**	**2,232 (78%)**	**313 (11%)**	**2,847 (100%)**

Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

Geographical classification was measured using the Modified Monash Model (MMM) which measures the remoteness and population size on a scale with categories from metropolitan (MM 1) to very remote communities (MM 7). Across the 5-year period, the majority of facilities (62%) operated in metropolitan areas (MM 1), while only 2% (45–50 facilities every year) operated in remote and very remote regions of Australia.

The number and proportion of facilities in each level of quality by geographical remoteness are provided in Table 7. Many challenges associated with the quality of residential aged care facilities may be associated with geographical isolation. These include reduced access to allied health and technology, high travel costs, and low staff retention rates. Interestingly, facilities located in remote and very remote areas had the highest proportion of facilities (around 27%) in the highest quality Q1 category and the lowest proportion of facilities (5%) in the lowest quality Q3 category. The quality appears to increase with the level of remoteness.

Table 7. Number and proportion of facilities in the quality levels by remoteness

Geographical remoteness (MMM classification)	Quality levels			
	Q1	Q2	Q3	Total
MM1: Metropolitan	142 (8%)	1,435 (81%)	199 (11%)	1,776 (100%)
MM2: Regional centres	17 (7%)	183 (80%)	28 (12%)	228 (100%)
MM3: Large rural towns	20 (9%)	186 (79%)	28 (12%)	234 (100%)
MM4: Medium rural towns	22 (12%)	148 (79%)	18 (10%)	188 (100%)
MM5: Small rural towns	86 (24%)	242 (66%)	37 (10%)	365 (100%)
MM6: Remote communities	10 (27%)	25 (68%)	2 (5%)	37 (100%)
MM7: Very remote communities	5 (27%)	13 (68%)	1 (5%)	19 (100%)
Total	**302 (11%)**	**2,232 (78%)**	**313 (11%)**	**2,847 (100%)**

MMM: Modified Monash Model classification system; Q1: quality level 1; Q2: quality level 2; Q3: quality level 3

3.3 Analysis of cost inefficiency

3.3.1 Stochastic frontier analysis and the cost function

A standard approach for efficiency and productivity analysis was applied in this project (Kumbhakar, 2015; Sickles and Zelenyuk, 2019). The step-wise approaches, for data and model exploration, are explained in detail in *Technical Supplementary Report 2*. Given the data availability and study aims, the main tool for the analysis was the cost frontier, which is a modified version of the standard (average) cost function. The modification includes splitting the stochastic error term in the cost function into two components, a “pure" error term (i.e. statistical noise) and an inefficiency term.

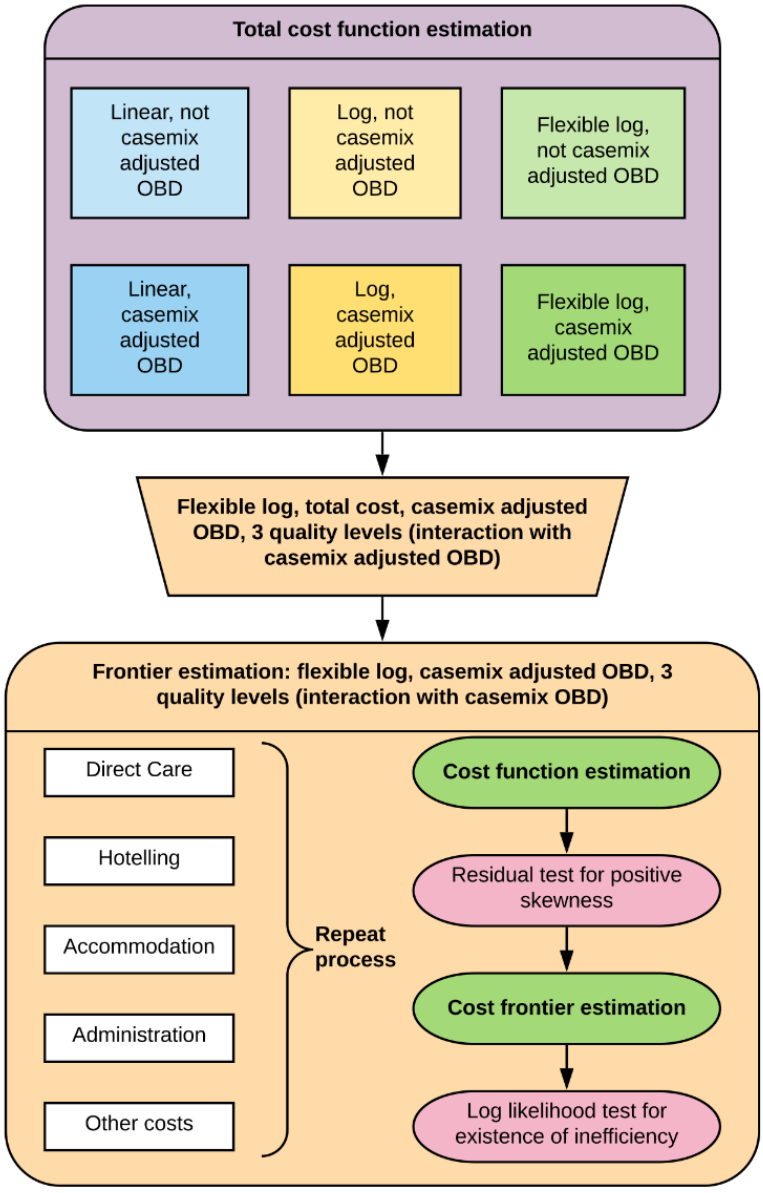
The stochastic frontier analysis (SFA) was chosen, over the alternative and popular method of data envelopment analysis (DEA) for two main reasons. First, the aim of the study was to benchmark facilities of a similar quality level to their respective quality (cost) frontiers. In DEA, the sample would need to be split into three quality groups to estimate the three separate quality frontiers. SFA has the ability to accommodate a flexible functional form with interactions between the composite quality index and the output variable, which allows the three frontiers to be estimated in one equation. Second, unlike the traditional DEA method, the SFA can handle statistical noise which captures measurement errors in the data with the error term specification (Kumbhakar, 2015; Sickles and Zelenyuk, 2019).

The cost frontier was selected over the production frontier to achieve the study aim of estimating the cost efficiency of facilities in the RAC sector. Facilities operate within a constrained budget, given by the pre-defined payment per resident, from both the Commonwealth and resident co-contributions. It is reasonable to assume that the objective of facilities is to minimise costs to meet the budget. This context naturally lends the analysis towards an input-oriented and cost efficiency approach.

The cost function is a fundamental concept in economics, which is relevant for all types of input- or cost-minimisation behaviours. The cost function is also a dual and complete characterisation of technology (or a production function), in the sense that it contains all information about the corresponding technology (Kumbhakar, 2015; Sickles and Zelenyuk, 2019). It is also very convenient because it is a natural aggregator

of the many (disaggregated) inputs used in the production process, for which the data is typically unobserved implying that the estimation of the production function is infeasible. Methods for estimating the cost function are well developed in econometric analysis and in frontier analysis in particular.[4] Details of the efficient models in the literature are summarised in *Technical Supplementary Report 2*.

For this project, a three-stage process was followed to explore the data and models to understand the cost structure of the RAC sector and the association between the three quality levels (Q1, Q2, and Q3), total cost, disaggregated costs (direct care, accommodation, hotelling, administration and other costs) and facility / provider characteristics. The process is summarised in Figure 2 below.



Abbreviations: OBD: occupied bed days

[4] Detailed discussions about cost function estimation in frontier analysis context can be found in Kumbhakar and Lovell (2000), Greene (2008), Parmeter and Kumbhakar (2014), Kumbhakar, Wang, and Horncastle (2015), Kumbhakar, Parmeter and Zelenyuk (2018) and perhaps most comprehensively and in textbook style discussion in Sickles and Zelenyuk (2019).

Figure 2. Process chart of the analytics steps of the analysis

In **Stage 1**, given the amount of variation (and potential noise) in the data, the average tendency for this important economic relationship was estimated as accurately as possible. The average tendency was examined between the total cost and the output (non-adjusted and adjusted), conditional on many factors (with and without quality adjustments). Statistical tests were also performed to examine whether or not cost inefficiency existed. A flexible log function that is grounded strongly in economic theories and practices was identified and fitted the data well. The results served as a foundation for the second stage.

In **Stage 2**, the frontier analysis was conducted to estimate the efficiency relative to the best practice. A standard approach in efficiency and productivity analysis was followed for the frontier analysis to estimate the total cost associated with delivering residential aged care for a range of quality levels observed historically. Additional statistical tests were performed to confirm the existence of cost inefficiencies. The final total cost frontier that accounts for the three quality levels (Q1, Q2 & Q3) was identified. Results of the total cost frontiers are discussed in the Results section below.

In **Stage 3**, separate frontiers for each cost category (i.e. direct care, hotelling, accommodation, administration, and other costs) were estimated, with the three quality levels included in the frontier functions. The estimation process was similar to that of the total cost, starting with the (average) cost function and statistical tests to examine whether or not inefficiency associated with each cost category existed, followed by the frontier estimation and statistical tests to confirm the existence of inefficiencies. Finally, the efficiency scores and predicted efficient costs (in Australian dollars) were calculated from the final models. In this final step, the predicted efficient cost was extracted per resident bed days and for the whole sector for three quality levels, for small-sized facilities (<30 beds) and the rest. Then the whole-sector efficient cost was predicted for a hypothetical scenario where all facilities provided care at the highest quality Q1 category with the care model of a small-sized home.

Details of the estimation process and the results are explained in the *Technical Supplementary Report 2.*

3.3.2 Cost frontiers for three quality levels

An objective of this project was to understand the association between cost and different quality levels in residential aged care facilities. Facilities in the sample were stratified into three groups: Q1, Q2 & Q3, with Q1 representing a higher level of quality and Q3 representing the lowest level of quality.

From Stage 1, a step-wise approach was undertaken for the analysis, starting with the simplest specification and moving sequentially towards the final model. The following specifications were considered:

a) *Dummy variables for different quality levels included in the cost function:* This specification infers that facilities/providers of different quality levels *belong* to (and would be benchmarked against) their respective frontiers, and that quality affects the relative position (high – low) of the frontier. For instance, if it is assumed that it requires more resources and thus spending to achieve quality, then the higher-quality groups will be associated with higher cost frontiers. As shown in Figure 3, holding all other variables constant, the (two) higher quality frontiers (Q1 and Q2) would be parallel to the base frontier (Q3).

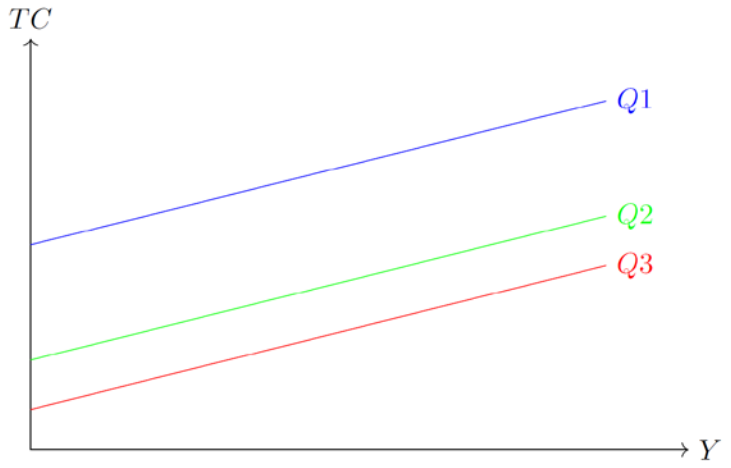


Figure 3. Quality frontiers, dummies for different quality levels included in the cost function (a linear function in both cost and output, no interaction between quality levels and output)

b) *Quality dummies and their interaction with output included in the cost function:* This specification infers that quality affects both the position and the shape of the cost function (along the output axis). As output increases, the cost of providing RAC services at Q1 and Q2 quality level changes at different rates compared to that of Q3. This means facilities of different levels of quality might have different *marginal costs* with respect to the same output level. As shown in Figure 4, the (three) quality frontiers for the three levels of quality might not be parallel with each other along the output axis, instead possibly having different slopes and/or intercepts.

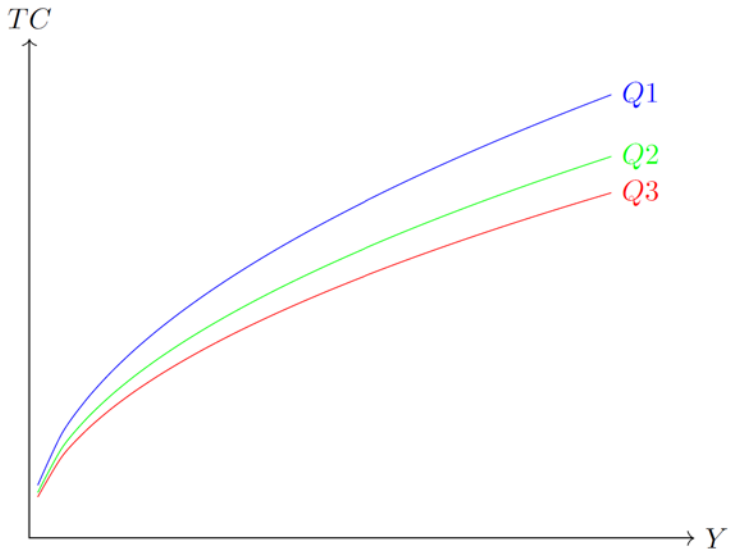


Figure 4. Quality frontier, quality dummies and their interaction with output included in the cost function (log-log function in both cost and output)

c) *Quality dummies and their interaction with output, with the higher order term of output (e.g. squared terms) included in the cost function:* If the interaction terms are expended between quality and output to a higher order, a more flexible function is achieved. The implication is that the marginal cost of different quality levels can change disproportionately with respect to the level of output (i.e. facility size). For instance, small-sized facilities might have high operating costs to deliver a higher quality of care,

compared to delivering lower quality. However, medium-sized facilities might achieve economies of scale when delivering care at the Q1 quality level, compared to those delivery care at the Q3 quality level. Visually, as shown in Figure 5, it implies that the cost frontiers of different quality levels can intersect at various output levels.

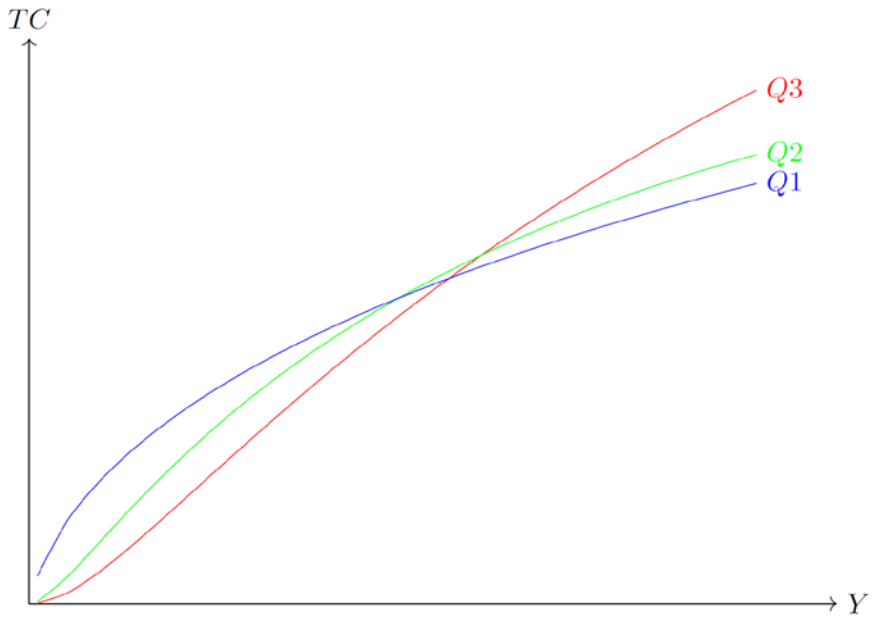


Figure 5. Quality frontiers, quality dummies and their interaction with output, with higher order term of output included in the cost function (flexible log-log function of cost and output)

3.3.3 Variables included in the cost frontier

As shown in Figure 2 (three-stage process) above, the analysis started with a total cost function, starting from the simple linear function with raw output (non-casemix-adjusted occupied bed days) and then casemix-adjusted output and three quality levels. We then achieved the flexible log function with Q1, Q2 and Q3, which is the final model presented in this project. Details of the other estimated models can be found in the *Technical Supplementary Report 2* and its *Appendices*.

Cost: The estimation started with the total cost function, followed by five functions disaggregated by the five cost categories: direct care, hotelling, accommodation, administration, and other costs.

Output: Residential aged care facilities provide accommodation and (day-to-day) care services for residents. The main output of the residential service in each facility is, therefore, the number of days that residents live and receive care in the facility, or number of occupied bed days (OBD).

Residents are different in their health and level of frailty (severity), leading to a variety of care needs and thus resources used (and cost). Casemix is often used to capture the similarity in resource consumption (and cost) while allowing for meaningful variations. Casemix is a general term describing a system that aggregates information about residents and associated services or procedures into groups based on the type and mix of the residents receiving care services. Casemix classifications are useful because they help to explain the relationship between services and costs. For the efficiency analysis, occupied bed days were adjusted by casemix to measure the output of RAC facilities.

Quality levels: A quality composite index was generated for each facility, using a latent class analysis. Details can be found in the *Technical Supplementary Report 1* and its *Appendices*. Facilities were then grouped into three quality levels. Q3 was used as the base in the frontier model, and included two binary

variables to capture the Q1 and Q2 quality levels. The two binary variables are also interacted with output to allow for the flexible functional form.

Index for real cost inflation: It was anticipated that a rise in the real cost of providing RAC services would be observed, driven by both higher labour costs and supplies. The most recent financial year (2018/19) was used as the base and included four binary variables representing financial years (2014/15 to 2017/18) to capture the change in cost over time.

The flexible log function was the final model chosen to accommodate the non-linear relationship between cost and output with respect to different quality levels. To achieve this, natural logarithmic values for costs (total cost, and each disaggregated cost categories for their respective frontiers) and output were generated. A squared term for log of output was also generated. It should be noted that casemix adjustment accounts for some of the differences in resource use to provide care to residents of different level of frailty (severity); the log-log transformation helps to reduce the impact of potential heteroskedasticity in the data associated with casemix and the sparsity at the tails of the cost and output distributions as the log-log transformation reduces the data scale.

For the total cost frontier, the right-hand side includes the log of output (casemix-adjusted OBD in log form), the quadratic term of log of output, financial year dummies, quality dummies and their interaction terms with log of output and quadratic term of log of output. The left-hand side includes the log of the total cost.

For each cost category, the right-hand side of the cost frontier(s) includes log of output (casemix-adjusted OBD in log form), the four remaining cost categories (all in log form), and together with quality dummies (i.e., Q1 and Q2 quality levels) and their interaction terms with output. The flexible log-log form also includes in the frontier function the quadratic term of log output and its interaction terms with quality dummies.

4. Results

The final cost frontier model is a flexible log function with three quality levels and their interactions with output, and indices for real cost increases over the period of five years (2014/15 to 2018/19). The model was estimated, using the approach proposed by Aigner, Lovell and Schmidt (1977), referred to here as the ALS77 approach, for cross-sectional. Both the cost and output were transformed into natural logarithm form. Output was casemix-adjusted occupied bed days. In the results and discussion sections below, the output is referred to as (resident) bed days.

The results presented below should be interpreted with caution due to the data limitations (discussed in Section 2). The **main limitations** are briefly summarised here:

a) First, the RAC facility sample in which the final analysis was conducted accounts for 31% of the whole RAC sector. The for-profit sector, as well as remote facilities, have less representation than their relative importance in the sector. (See details in *Appendices A and B* of this *Main Report*, where we presented the data exploration prior to both the quality and efficiency analyses).

b) Second, only one set of composite quality indices for the whole five-year period was able to be created, instead of one set of indices per year. Not all quality variables were able to be used. Amongst the ROSA indicators, only the four indicators for use of high-risk medicines were used as hospital indicators were not available except for South Australia. The consumer experience rating variables were unavailable for all facilities. The latent class model used to create the composite quality index was able to accommodate the data incompleteness and the resulting index showed robust features that passed the (sector) reality checks. Despite this, it would be more precise and sensitive to have all of the data required be available. (See details in *Technical Supplementary Report 1* for both data exploration and analysis, and a substantial discussion of the limitations associated with the composite quality index).

c) Third, cost data were combined from two sources (Stewart Brown and Department of Health financial reports). Extensive statistical tests and comparisons were conducted, and supplementing the Stewart Brown data with the Department of Health financial data was considered appropriate where the Stewart Brown data was unavailable (note that the Stewart Brown financial data only covered 34% of the sector). Despite this, small deviations might remain a source of miscalculation. (See details in the *Appendices A and B* of this *Main Report*).

4.1 Main Findings – Total Cost Frontiers

After adapting various existing models and testing, we conclude that there is statistical evidence for the existence of cost inefficiency (even after we controlled for statistical noise and other factors). Therefore, the a *priori* decision to choose a frontier analysis approach by the Royal Commission was appropriate to understand the behaviour of the RAC sector. There was some variation in estimates across models, the model presented here was considered the most appropriate fit for the data. Details of all other models considered are given in the *Technical Supplementary Report 2*.

The average (total cost) efficiency was around 0.88 (min 0.54, max 0.98) during the study period (2014/15 to 2018/19).[5] A small proportion of facilities had the efficiency ratio falling below 0.60. The distribution of total cost efficiency in 2018/19 is presented in Figure 6. Facilities with an efficiency score close to or equal to 1 are operating at or near full efficiency (i.e. highest productivity level feasible given their resources, expressed in dollars cost). The figure shows that most facilities are clustered towards the right side (close to 1), demonstrating that the cost inefficiency of the Australian RAC sector is quite low.

[5] This represents an equally-weighted average. We also estimated a weighted average that accounted for the economic weight (size) of each facility and the results are very similar

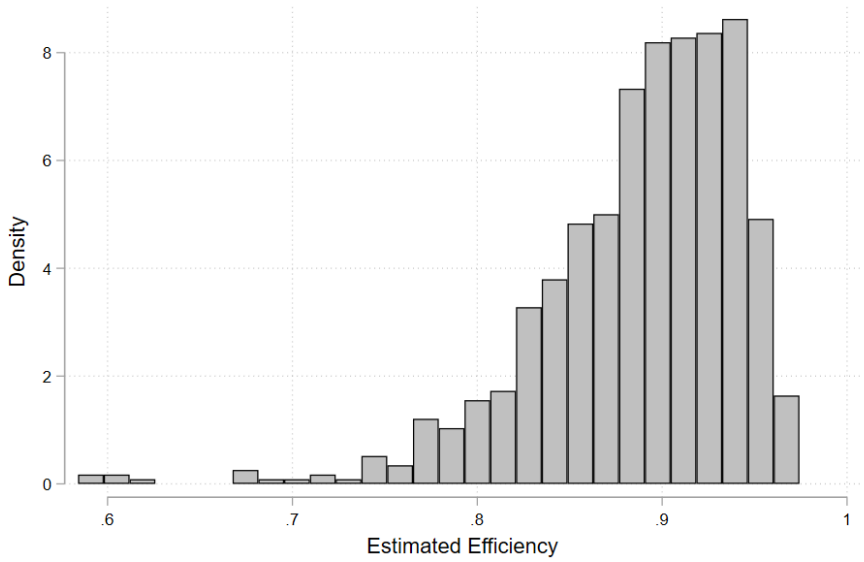


Figure 6. Distributions of total cost efficiency for the financial year 2018/19

There was evidence that the real cost to provide RAC services had increased steadily since 2014/15. This increase in real costs was not associated with a nominal rise in prices (i.e. inflation) because all costs were deflated using appropriate health and aged care sector price deflator before the analysis.

There was strong statistical evidence supporting the hypothesis that an association between the quality of RAC services and the total cost existed, and that the magnitude of such association changes at different levels of output. On average and holding everything else constant, the efficient cost of Q1 and Q2 facilities was found to be higher than that of Q3 facilities at very small and very large-sized facilities. Frontier estimates of total cost in 2018/19 are shown in Figure 7. The dots represent observed costs and outputs for individual facilities, and the coloured curves represent the cost frontiers for the three different quality levels. The marginal efficient cost was different at different levels of output:

- Very low output (small-sized facilities): The marginal efficient cost of Q1 facilities was larger than that of Q2 and Q3 facilities.
- Increased output (or larger-sized facilities): Initially the marginal cost of Q3 facilities rose faster than that of Q2 and Q1 facilities.
- Further increased output: The marginal efficient cost of Q1 and Q2 facilities was larger than that of Q3 facilities.

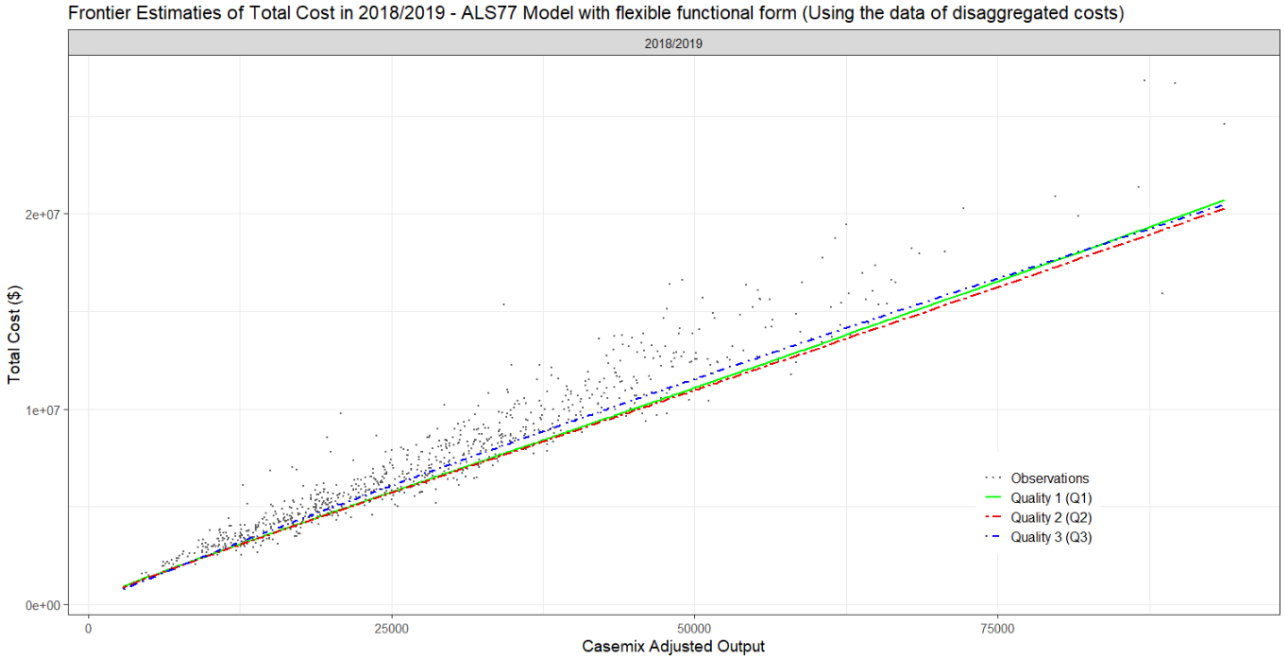


Figure 7. Frontier estimates of total costs across financial years (ALS77 Model with flexible log-log function for total cost and output, allowing for interactions of three quality levels with output)

Higher quality in RAC facilities was found to be highly correlated with size (Table 6, Section 3.2 above), such that a high proportion of small-sized facilities (fewer than 30 beds) were classified as Q1.[6] For small-sized facilities, the average efficient (total) cost of a resident bed day in the financial year of 2018/19 was estimated at $274 [95% CI: $268 - $279] for Q1 facilities, $267 [95% CI: $263 - $271] for Q2 facilities and $261 [95% CI: $255 - $266] for Q3 facilities, respectively. For facilities with more than 30 beds, the average efficient (total) cost per resident bed day for the three quality levels in the financial year of 2018/19 was estimated at $235 [95% CI: $233 - $237] for Q1 facilities, $224 [95% CI: $223 - $225] for Q2 facilities and $234 [95% CI: $233 - 235] for Q3 facilities, respectively. These estimates show statistical evidence of economies of scale (i.e. larger facilities have lower average cost, *ceteris paribus*). However, as high quality is strongly associated with small-sized facilities, we hypothesise that the small-sized model of care drove the higher quality performance yet was inevitably associated with higher cost. The larger facilities that had good care management, clinical governance and high-quality workforce might achieve economies of scale much faster than facilities that did not have these. Since we did not have data that captured those factors, we could not verify the hypotheses.

These predicted efficient spending were of a similar magnitude to the per bed day revenue (approximately $264 for the financial year 2018/19, from both the Commonwealth and resident contributions).[7] This reflected our assumption that facilities operated within a budget constraint, and aimed to minimise cost given the budget and their resident bed days. Additionally, this supports the findings that the RAC sector in Australia operated quite efficiently, with the cost inefficiency estimated to be around 12%. Compared to the estimates in the international literature, where the average efficiency score was 0.75 (Tran et al., 2019) (i.e. inefficiency of 0.25) the Australian RAC sector has been doing very well comparatively. In the healthcare sector where a large number of efficiency studies have been conducted for hospitals, the average inefficiency was about 18% (Nguyen and Coelli, 2009). It is unrealistic to expect a sector with all production units operating at the

[6] Small facilities only provided about 2% of (casemix-adjusted) occupied bed days of the sector, and about 10% of the sector was classified as high quality. Approximately 29% of small facilities were of high quality.
[7] Amount calculated from the Stewart Brown Annual Report of the Sector

highest productivity level. Natural variations in business environment and operation/management style always generates disparities in productivity levels, thus inefficiency arises.

From the estimates of efficient cost per resident bed days above, we calculated the efficient total cost for the whole sector (Table 8 below). Note that there are different ways to estimate sector-wide efficient cost, and different assumptions may lead to different estimates. Here, we applied a simple calculation, using the resident bed days provided for each facility in the sector (N = 2,692 facilities that provided approximately $69.2 million bed days in 2018/19). Our main assumption was that the Q1 quality level observed in the 10% of facilities was also feasible for all facilities in the sector, and it was possible to change the model of care from the large-scaled institution-style RAC facility to a small-sized model.

If all the facilities were operating without any cost inefficiency, the whole sector would have spent **$15.70 billion** [95% CI: $15.66 billion – $15.74 billion] in 2018/19. If we allowed for 12% cost inefficiency, the estimated cost would be approximately $17.6 billion. This estimated cost was of smaller magnitude to the reported expenditure ($19.3 billion) and revenue ($19.0 billion) of the RAC sector (by the Department of Health) for the financial year 2018/19 (Aged Care Financing Authority, 2020). *Note that our estimate was based on a sample of 31% of all facilities in Australia, with a slight under-representation of the for-profit sector.*

Table 8. Predicted efficient (total cost) per resident bed day, and calculated efficient (total) cost for the whole Australian RAC sector (2018/19)

		Quality 1	Quality 2	Quality 3	Total
Total resident bed days	<30 beds	10,823	785,573	44,534	
	30+ beds	3,665,152	55,181,363	9,116,929	
Efficient (total) cost per resident bed day *(estimated from the frontier)*	<30 beds	$273.57	$267.07	$260.71	
	30+ beds	$235.26	$224.04	$234.54	
Efficient (total) cost for all bed days = *total resident bed days * efficient total cost per resident bed day*	<30 beds	$112,388,108	$209,799,680	$11,610,392	
	30+ beds	$862,262,934	$12,362,876,677	$2,138,255,320	
Estimated efficient (total) cost		**$974,651,043**	**$12,572,676,357**	**$2,149,865,713**	**$15,697,193,112**

We then estimated the total spending of the sector if all facilities were to operate at Q1 quality level at the current operating size (scenario 1, Table 9 below), and if all facilities were to operate at Q1 quality level with a small-sized (<30 beds) model of home (scenario 2, Table 10 below). In 2018/19, the RAC sector would have spent **additional $621 million** [95% CI: $576 million – $687 million] under scenario 1, OR **additional $3.23 billion** [95% CI: $2.89 billion – $3.58 billion] under scenario 2.

*Table 9. Calculated **additional** (total) cost per resident bed day, and **additional** (total) cost for the whole Australian RAC sector to provide service at Q1 level at current operating size (2018/19)*

		Quality 1	Quality 2	Quality 3	Total
Total resident bed days (*same as Table 8 above*)	<30 beds	410,823	785,573	44,534	
	30+ beds	3,665,152	55,181,363	9,116,929	
Additional (total) cost per resident bed day to provide Q1 quality at the current operating size = *difference between the efficient (total) cost of Q1, (Table 8 above) and efficient (total) costs of Q2 and Q3 in the respective cells*	<30 beds	$0	$6.50	$12.86	
	30+ beds	$0	$11.22	$0.72	
Additional (total) cost for all bed days = *additional cost per resident bed day * total resident bed days*	<30 beds	$0	$5,108,110	$572,694	
	30+ beds	$0	$619,079,710	$6,591,540	
Estimated additional total cost to provide Q1		**$0**	**$624,187,820**	**$7,164,233**	**$631,352,053**

*Table 10. Calculated **additional** (total) cost per resident bed day, and **additional** (total) cost for the whole Australian RAC sector to provide service at Q1 level and with small-sized model (2018/19)*

		Quality 1	Quality 2	Quality 3	Total
Total resident bed days (*same as Table 8 above*)	<30 beds	410,823	785,573	44,534	
	30+ beds	3,665,152	55,181,363	9,116,929	
Additional (total) cost per resident bed day to provide Q1 quality and small-sized (<30 beds) = *difference between the efficient (total) cost of Q1, <30 beds ($273.57, Table 8 above) and efficient (total) costs of other cells*	<30 beds	$0	$6.50	$12.86	
	30+ beds	$38.31	$49.53	$39.03	
Additional (total) cost for all bed days = *additional cost per resident bed day * total resident bed days*	<30 beds	$0	$5,108,110	$572,694	
	30+ beds	$140,406,110	$2,732,989,430	$355,846,497	
Estimated additional total cost to provide Q1		**$140,406,110**	**$2,738,097,540**	**$356,419,191**	**$3,234,922,841**

It is worth noting that changing assumptions would lead to different conclusions. For example, if we take a more conservative approach and instead of the mean estimated efficient (total cost), assume the lower 95% CI values, while keeping the other assumptions the same, the estimation for the additional total cost that the whole sector would have spent to deliver RAC services at small-scale and Q1 quality level would be $2.89 billion. Meanwhile, if we take a less conservative approach and instead of the mean estimated efficient (total cost), assume the upper 95% CI values while keeping the other assumptions the same, the estimation for the additional total cost that the whole sector would have spent to deliver RAC services at small-scale and Q1 quality level would be $3.58 billion.

Again, it is very important that these estimates be interpreted correctly by the reader. These estimates are for the quality levels found among facilities within the current residential aged care system under current funding levels. Funding levels might need to be much higher than the estimates if the Australian community and Royal Commission aspire to achieve a higher quality in the future than facilities have achieved historically.

The figures should also be interpreted as indicative, within the context of data limitations (as outline above), understanding the underlying assumptions and simplifications of modelling as well as natural uncertainty around the estimates.

Focusing on quality improvement may have wider benefit than could be captured in this analysis. Shifting the focus from cost-minimisation to resident-centred to achieve best possible outcomes to RAC residents may lead to process improvements in the facility and a better workplace culture. The cost to move facilities to a better quality may be offset in other government spending in healthcare and other aged care services. For example, better care for residents may reduce the need for hospitalisations, especially for preventable issues (e.g. pressure injury or falls). Since the data on hospitalisations was not available for this analysis, we could not test this hypothesis. Stronger focus on resident outcomes, both health and quality of life, may also reduce spending on high-risk medicines, as well as reducing workplace injuries and accidents.

4.2 Main findings - disaggregated cost frontiers

There was strong statistical evidence that cost inefficiency existed in direct care. The average cost efficiency associated with direct care was estimated to be 91% (min 0.73, max 0.97), indicating there were variations in practice of providing direct care to residents in RAC facilities. There was insufficient statistical evidence that cost inefficiencies existed in the remaining four cost categories of hotelling, accommodation, administration and other costs.

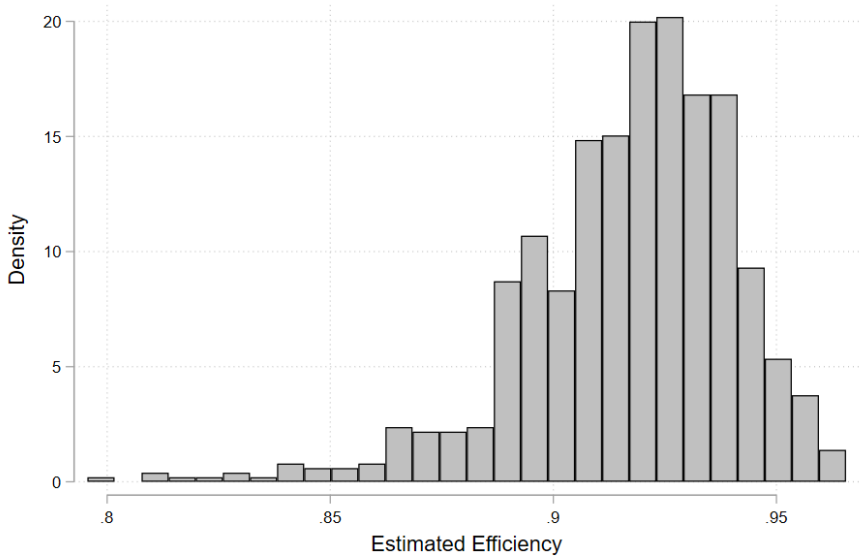


Figure 8. Distributions of average cost efficiency associated with direct care (2018/19)

Unlike direct care costs, there were no strong statistical associations between the *quality* of RAC services and the other cost categories (*hotelling, accommodation, administration* and *other costs*).

There was evidence that the real cost to provide *direct care* and to operate *administrative* functions in RAC facilities increased steadily since 2014/15. However, there was little evidence of increases in real costs for the other cost categories (*hotelling, accommodation* and *other costs*) (Table 10). The increase in direct care and administration costs are likely to be largely driven by labour.

There was a strong positive correlation between most of the cost categories, with the exception of a negative correlation between *direct care* and *administration* costs. It was anticipated that costs would be higher as the size of the facilities got larger (i.e. output increased). However, for a similar size-sized facility (i.e. same level of output), when the *direct care* costs increased, the *administration* costs did not also increase (Table 11).

Table 11. Estimated results for cost frontiers

	Ln of TC Direct Care	Ln of TC Hotelling	Ln of TC Accommodation	Ln of TC Administration	Ln of TC Others
Frontier: *Estimates of coefficients for different specifications presented with corresponding standard errors in parentheses. These coefficients determine the position and shape of the respective frontier*.					
Ln of casemix-adjusted OBD	1.18***	0.19	1.87***	0.83	-1.99
	(0.33)	(0.42)	(0.71)	(0.65)	(1.21)
Squared of ln of casemix-adjusted OBD	-0.02	0.01	-0.07**	-0.01	0.11*
	(0.02)	(0.02)	(0.04)	(0.03)	(0.06)
QI High	5.27**	0.17	4.75	-2.24	5.07
	(2.27)	(2.88)	(4.88)	(4.51)	(8.36)
QI Medium	3.80**	-0.31	6.24*	4.42	-6.41
	(1.75)	(2.22)	(3.76)	(3.48)	(6.45)
QI High * Ln of casemix-adjusted OBD	-1.09**	-0.03	-0.85	0.70	-1.29
	(0.46)	(0.59)	(1.00)	(0.92)	(1.71)
QI Medium * Ln of casemix-adjusted OBD	-0.77**	0.07	-1.23*	-0.80	1.32
	(0.35)	(0.44)	(0.75)	(0.69)	(1.29)
QI High x Squared of Ln of casemix-adjusted OBD	0.06**	0.00	0.04	-0.05	0.08
	(0.02)	(0.03)	(0.05)	(0.05)	(0.09)
QI Medium x Squared of Ln of casemix-adjusted OBD	0.04**	-0.00	0.06	0.04	-0.07
	(0.02)	(0.02)	(0.04)	(0.03)	(0.06)
Financial Year 14-15	-0.07***	0.01	0.00	-0.04***	-0.09***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Financial Year 15-16	-0.04***	0.01	-0.01	-0.04**	-0.11***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Financial Year 16-17	-0.02***	0.01	-0.04**	-0.05***	0.04
	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)
Financial Year 17-18	-0.01	0.01	-0.06***	-0.03*	0.06**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)
Ln of TC Direct care		0.32***	0.12***	-0.04	0.23***
		(0.02)	(0.03)	(0.03)	(0.06)
Ln of TC Hotelling	0.19***		0.22***	0.11***	0.44***
	(0.01)		(0.03)	(0.02)	(0.04)
Ln of TC Accommodation	0.03***	0.08***		0.17***	-0.02
	(0.01)	(0.01)		(0.01)	(0.03)
Ln of TC Administration	-0.01*	0.05***	0.20***		0.10***
	(0.01)	(0.01)	(0.02)		(0.03)
Ln of TC Others	0.02***	0.05***	-0.01	0.03***	
	(0.00)	(0.01)	(0.01)	(0.01)	
Constant term (intercept)	2.36	3.46*	-5.66	2.34	10.50*
	(1.65)	(2.10)	(3.57)	(3.28)	(6.08)
$U\sigma$ inefficiency component					
Constant term	-4.36***	-14.18	-14.54	-13.03	-13.66
	(0.31)	(484.31)	(1562.80)	(289.92)	(873.32)
$V\sigma$ statistical noise (residuals)					
Constant term	-3.92***	-3.23***	-2.17***	-2.33***	-1.10***
	(0.07)	(0.02)	(0.02)	(0.02)	(0.02)
Number of observation	4228	4228	4228	4228	4228
Akaike Information Criteria (AIC)	-3657.93	-1605.49	2841.22	2184.43	7402.27
Bayesian Information Criteria (BIC)	-3537.29	-1484.85	2961.86	2305.07	7522.91

ln: natural logarithm; OBD: occupied bed days; QI: quality index; TC: total cost
Statistically significant at 1% (***), 5% (**) and 10% (*)

Similar to the pattern of association between *total cost* and *quality levels*, there was an association between *direct care* costs and *quality levels*. That is, the association between the efficient *care* cost and *quality* was different at different levels of output. Frontier estimates of direct care costs for financial year 2018/19 are shown in Figure 9. On average and holding everything else constant, the facilities that deliver care services at Q1 and Q3 quality levels had higher efficient *care* costs than those at Q2 quality level. This finding was consistent across the size, except for very small facilities (<15 beds), where the efficient cost associated with direct care for Q1 was larger than that of Q2 and Q3.

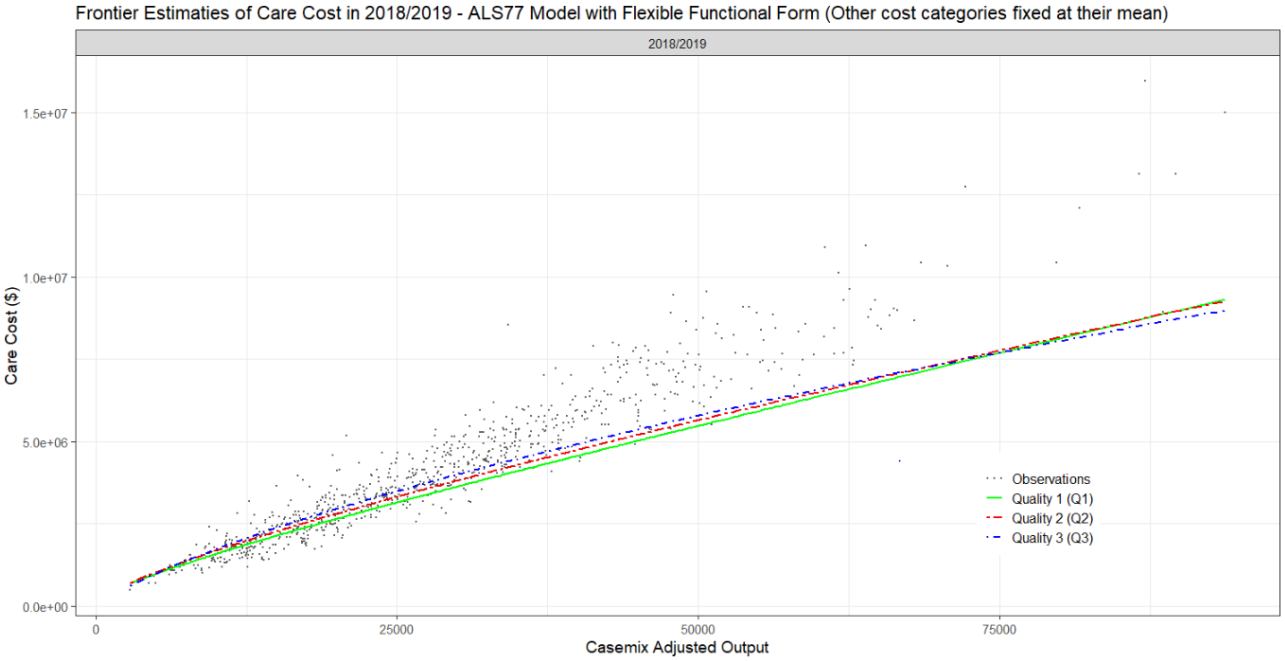


Figure 9. Frontier estimates of care costs across financial years (ALS77 Model with flexible functional form with other cost categories fixed at their mean)

The finding that efficient cost for facilities that delivered RAC service at Q3 quality level was approximately the same as those at Q1, and higher than that of Q2 was unexpected. While this requires a separate study to better understand whether or not this finding is true, there are several possible explanations:

- First, as highlighted by the Donabedian model, quality is produced by a range of factors other than expenditure. This can include the skills of staff, efficient work processes, strong clinical governance, and good organisational culture. While labour inputs were considered during the analysis, a *post-hoc* exploration of the workforce data did not find a strong association between higher quality and higher staffing hour per resident per day. Considering staffing hours only, without accounting for staffing quality (previous and continuous professional training, turnover and absenteeism), might not be the strongest predictor of care quality. As an example, in the literature on hospital efficiency, the 2009 WHO has estimated about 15 to 25% of hospital inefficiency is related to workforce.
- Second, there might be additional cost associated with providing low-quality services. For instance, a facility that failed accreditation standards or received a sanction in any particular year would have spent additional resources to rectify the standing issues to meet standards and remove sanctions for the following years. Since the composite quality index was constructed for a 5-year period as a whole, rather than annually, we could not account for this lagging association between quality and cost. Again, this is a limitation acknowledged in this report, and discussed further in the *Technical Supplementary Report 1*. In the future when more complete data for all the quality indicators becomes available, for all financial years, the quality and frontier analyses can be repeated. The findings from such analysis would provide more insights into the true nature of the quality-cost association.

5. Limitations

To the best of our knowledge, **this is the first time a large-scale and national study on residential aged care (RAC) facilities has been conducted in the world, with an extensive linked dataset. It is also the first efficiency analysis that has been conducted that includes measurements of both quality and efficiency in the sector.** The study used a comprehensive set of quality indicators, ranging from clinical outcomes of residents, process quality standards and service experience indicators.

The findings presented here have been checked thoroughly and individually by the project team members, and were subject to critical review throughout the project by the Steering Committee. However, **the numbers presented should be interpreted with caution**, **due to the three main limitations described in the Results section above.** Any model represents an abstraction of reality is necessarily simplified.

More reliable estimations of efficiency in the RAC sector in Australia will require better routine data collections of inputs, costs, outcomes and quality within facilities, where well-validated quality measures including quality of life become an essential part of the minimum data requirement.

The quality index derived for this study was limited by the availability of data. Data on hospitalisations were not available. Commonly used indicators internationally such as pressure ulcers and falls were not available. Quality of care indicators such as those reported in North America and New Zealand (e.g. relating to pressure injury, weight loss or decline in function) are not yet available in Australia, although the Department of Health commenced mandatory reporting of a small group of indicators in 2019, and is currently working to expand the indicator set (Department of Health, 2019; PricewaterhouseCoopers Australia, 2019). Data items were also not available for all facilities for every financial year of the study period. This led to a cross-sectional index creation whereas the rest of the data were available in a yearly (panel data) form. However, within these limitations, the quality index was able to identify a clear proportion of higher quality performers (Q1) and an equivalently sized group of lower quality (Q3). The remainder of the facilities were not easily distinguishable between levels of quality. This was largely due to the indicators that were used to develop the index. A more comprehensive collection of quality indicators would improve the sensitivity of the measure to different levels of quality. Routinely collected data and reporting system are required for the longitudinal analysis of the trade-off between costs and quality, which was not feasible within the scope of this project.

The cost and workforce data were not available for the whole sector at the facility level. It was not possible to completely supplement one financial data source (Stewart Brown) with another (Department of Health) due to different financial reporting standards and requirements. While required reporting standards might need revisions over time, it is essential to have strong consistency and reporting standards for this sector. Similar arguments apply to the workforce data. It was not possible to estimate technical efficiency and allocative efficiency separately in this analysis. While hours of care per resident per day were available for about 30% of the sector, the unit price of labour for direct care by individual facility as well as the staffing quality was unavailable. A more complete cost and workforce dataset, and representative sample of RAC facilities, if available in the future, would allow questions about the technical and allocative efficiencies to be examined. It would also provide further insights into the correlation between staff hours, quality of care and efficient use of resources in providing care for RAC residents.

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The project team sincerely thanks the input and commitment from the steering committee on this project. Their time, expertise and valuable feedback during the project was essential to the production of this report.

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