Attachment 7.5

Economic Insights

Benchmarking operating and capital costs

SA Final Plan July 2021 – June 2026

July 2020

Australian Gas Networks

Benchmarking Operating and Capital Costs of Australian Gas Networks' South Australian Network Using Partial Productivity Indicators

Report prepared for

Australian Gas Networks

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CONTENTS

EXECUTIVE SUMMARY

This report discusses the efficiency performance of Australian Gas Networks (AGN) South Australian operations over the period 1999–2019 within a group of 11 Australian and two New Zealand gas distribution businesses (GDBs). The report has been prepared for AGN as an input to the forthcoming review by the Australian Energy Regulator (AER) of AGN SA's access arrangement for the period 1 July 2021 to 30 June 2026.

A set of partial performance indicators is presented to compare the opex and capital input efficiency of the 13 businesses against one another. These indicators have the advantage of being relatively easy to construct and understand. However, care needs to be exercised in interpreting the results, as individual partial performance indicator results may give a misleading impression of overall efficiency. To gain an indication of overall relative performance, the partial indicators need to be considered together and jointly with key operating environment indicators.

If a GDB is ranked poorly for most indicators then this may warrant further investigation as to whether that GDB was operating inefficiently. Conversely, if a GDB is ranked highly for most indicators then this may be taken to suggest that it is performing at levels consistent with industry best practice. If a GDB performs well on some indicators but poorly on others then the GDB's performance is harder to assess as it may be making trade–offs between different types of inputs (eg, opex and capital) and more detailed analysis may be required.

It is also desirable to have regard to more holistic measures of efficiency, such as total factor productivity (TFP) analysis, and methods of measuring efficiency, which can control for differences in scale and other operating environment differences.

Background

This report presents partial performance indicators analogous to those published by the AER for electricity distribution businesses (AER, 2014). The partial productivity performance indicators presented in this report complement the holistic productivity measures presented in the accompanying Economic Insights (2019b) report.

The Australian and New Zealand GDBs included in this study are:

1. AGN Albury (NSW)
2. AGN Queensland
3. AGN South Australia
4. AGN Victoria
5. AGN Wagga (NSW)
6. Allgas Energy (Queensland)
7. ATCO Gas Australia (Western Australia)
8. AusNet Services (Victoria)
9. Evoenergy (ACT)
10. Jemena Gas Networks (NSW)

11. Multinet (Victoria)
12. Powerco (New Zealand), and
13. Vector (New Zealand).

For each of these GDBs, the study presents operating environment factors and partial performance indicators. The operating environment indicators we present are:

- Energy delivered, number of customers and network kilometres
- Customer density—customers per kilometre (km) of mains
- Energy density—terajoules (TJ) per customer, and
- Network density—TJ per kilometre.

The partial performance indicators we present are:

- Opex per customer relative to customer density
- Opex per mains km relative to customer density
- Asset cost per customer relative to customer density
- Asset cost per mains km relative to customer density
- Total cost per customer relative to customer density
- Total cost per mains km relative to customer density.

This set of performance indicators establishes the relative performance of the GDBs across major facets of their businesses while identifying key operating environment differences. They provide an opportunity to examine the priorities and trade–offs of the various GDBs – for example, comparing operating expenditure (opex) and capital input indicators together allows trade–offs between opex and capital use to be recognised.

The data used in this study has been predominantly sourced from documents in the public domain. These data have been supplemented with information provided by several major Australian GDBs in response to common detailed data surveys. These include AGN SA, AGN Vic, ATCO, AusNet, Evoenergy, Jemena and Multinet. The survey-based data is also used in the productivity analysis presented in a separate report.

The public domain data is sourced mainly from Access Arrangement Information (AAI) filings, regulators' final review reports and GDB Annual Reports. We have used the latest available historic information wherever possible but in a limited number of cases the data represent forecasts as presented in the regulatory proceedings rather than historic information reported after the event. While every effort has been made to make the publicly available data used in this study as consistent as possible, the limitations of currently available public domain data need to be recognised.

Key findings

AGN SA's operating environment characteristics can be summarised as follows:

- AGN SA is the sixth largest GDB in the sample, on the basis of either customer numbers, network length or gas throughput. It is smaller than ATCO in Western Australia, and the Victorian GDBs, and Jemena in NSW. In terms of gas deliveries, it is most closely comparable to ATCO. AGN SA is significantly larger than the seven smaller GDBs included in the sample.

- AGN SA's customer density is similar to ATCO, Jemena and AGN Albury. It is somewhat lower than the three Victorian GDBs. The other GDBs in the sample, which tend to be smaller in size, also have lower customer densities.
- AGN SA's energy density per customer is the one of the lowest in the sample (only ATCO is lower). Other comparable GDBs in terms of energy density are Evoenergy, AGN Qld and Jemena.
- AGN SA has an intermediate level of energy deliveries per km, or 'network utilisation'. GDBs with comparable rates of network utilisation include Allgas and AGN Qld in Queensland, and Vector and Powerco in New Zealand.

AGN SA's comparative performance in terms of partial indicators is as follows:

- AGN SA's average opex per customer (in $2010) over the latest five-year period was $110, which was well below the average opex per customer for the six GDBs with lowest customer density ($151) but was the highest among the seven GDBs with higher customer density (which averaged $84 over the latest five-year period). AGN SA's opex per customer was similar to the average for the whole sample ($115).
- AGN SA's opex per km of mains was $5,920 over the latest five-year period, which is higher than the average of all GDBs in the sample ($4,614 for the latest five-years) and the highest among the GDBs with higher customer density.
- AGN SA's capital asset cost per customer averaged $311 in the latest five-year period. This is similar to the sample average of $280. It is lower than the average asset costs per customer of $369 for the group of GDBs with lower customer density, but is relatively high when compared to the average of $204 for the group of GDBs with higher customer density.
- AGN SA's average asset cost per km was $16,771 over the latest five years, which is comparatively high when compared to the average for all GDBs ($10,965).
- The average total cost per customer of AGN SA in the latest five-year period was $421. This is above the average total cost per customer for the seven GDBs with comparatively high customer density ($288), and below the average of $520 for the GDBs with comparatively low customer density. AGN SA's average total cost per customer is similar to the sample average of $395.
- AGN SA's average total cost per km of mains ($22,691 in the latest five-year period) was above the average total cost per km for all GDBs in the sample ($15,579 in the latest five-year period).

When real opex per customer for each GDB is normalised for differences in the main cost drivers, AGN SA's normalised real opex per customer is below the sample average and at a similar level to the average of the five largest Australian GDBs, which are also those of highest customer density. Prior to normalisation, AGN SA's average opex per customer was 35.6 per cent above the average opex per customer of the five largest Australian GDBs. After normalisation, AGN SA's average opex per customer was either 0.4 per cent below or 5.4 per cent above the average opex per customer of the five largest Australian GDBs, depending on which of the two methods of normalisation are used for comparison. This means that AGN SA's higher opex per customer, when compared to the five largest GDBs can be fully explained by its smaller scale, lower customer density and differences in the other identified cost drivers.

AGN SA's capital asset cost per customer averaged $311 in the latest five-year period. This is close to the sample average of $280. It is, again, relatively high when compared to the average of $204 for the group of GDBs with higher customer density. It is reasonable to conclude that, like opex per customer, this reflects its relatively low scale and customer density within this group.

The average total cost per customer of AGN SA in the latest five-year period was $421. This is close to the sample average of $395, and is again above the average total cost per customer for the seven GDBs with comparatively high customer density ($288). However, the normalisation exercise demonstrates that this difference when compared to the other larger GDBs mainly reflects its smaller scale and lower customer density.

The partial indicators analysis presented in this report do not enable influences such as scale economies or different mixes of inputs to be controlled for in a rigorous fashion. This means that care needs to be taken when drawing inferences from the raw data. Based on these indicators, AGN SA appears to have performed at about an average level overall. Although a direct comparison against the networks with relatively high customer density suggest that its cost per customer is above average, after normalisation of opex per customer is carried out, it is clear that this difference can be fully attributed to its smaller scale and lower customer density, and differences in the other identified cost drivers. After these differences are controlled for, AGN SA appears to have also performed at about an average level among the group of larger GDBs.

1 INTRODUCTION

1.1 Terms of reference

Australian Gas Networks (AGN) commissioned Economic Insights Pty Ltd ('Economic Insights') to provide advice on productivity measurement and benchmarking of its South Australian gas distribution network operations. The advice provided in this report presents partial indicator comparisons between a set of 11 Australian and two New Zealand GDBs using primarily public domain data. These partial performance indicators are analogous to those published by the Australian Energy Regulator for electricity distribution businesses (AER 2014). This report updates similar studies Economic Insights has carried out for AGN SA in 2015, the three Victorian GDBs (AGN Vic, AusNet and Multinet) in 2016, ATCO in 2017 and Jemena Gas Networks (JGN) in 2019 for their respective access arrangement reviews (Economic Insights, 2015, 2016, 2018, 2019).

1.2 Outline of the Report

Section 2 presents data on the business operating environment characteristics that influence the observed performance of GDBs. Section 3 provides a summary comparison of partial performance indicators relating to costs per customer.

1.3 Economic Insights' experience and consultants' qualifications

Economic Insights has been operating in Australia for over 20 years as an economic consulting firm specialising in infrastructure regulation. Economic Insights provides strategic policy advice and rigorous quantitative research to industry and government. Economic Insights' experience and expertise covers a wide range of economic and industry analysis topics including:

- infrastructure regulation;
- productivity measurement;
- benchmarking of firm and industry performance;
- infrastructure pricing issues; and
- analysis of competitive neutrality issues.

This report was prepared by Michael Cunningham, who is an Associate of Economic Insights. Michael Cunningham has read the Federal Court Guidelines for Expert Witnesses and this report has been prepared in accordance with the Guidelines.

2 OPERATING ENVIRONMENT INDICATORS

This section describes the key characteristics for the 13 GDBs included in this study, covering the years 1999 to 2019. The performance indicators discussed in this section are summarised in the Annexure at the end of this section, in Tables 2.1 to 2.4. Descriptive information on each GDB included in this study is presented in Appendix A.

The data covers the years 1999 (or 2000) to 2019 for four of the Australian GDBs, from 1999 to 2018 for a further three Australian GDBs and from 2004 to 2018 for Powerco. For the other GDBs the available data are not as up-to-date. Information on the dataset used in this analysis is included in Appendix B. Table B.1 in Appendix B shows the data sample periods for each included GDB. The data available from 1999 onwards is:

- 1999 to 2019 for AusNet, Evoenergy and AGN SA;
- 2000 to 2019 for ATCO;
- 1999 to 2018 for AGN Vic, Multinet and Jemena;
- 1999 to 2017 for AGN Albury;
- 1999 to 2016 for AGN Qld;
- 2000 to 2016 for Allgas;
- 1999 to 2015 for AGN Wagga;
- 2004 to 2018 for Powerco; and
- 2005 to 2019 for Vector.

Availability of earlier data for New Zealand GDBs has been affected by merger and restructuring activity. The comparability of data for Vector from 2016 onwards, against earlier years is affected by its divestiture of gas pipelines outside Auckland in November 2015. Growth rates and averages are calculated to avoid this structural break.

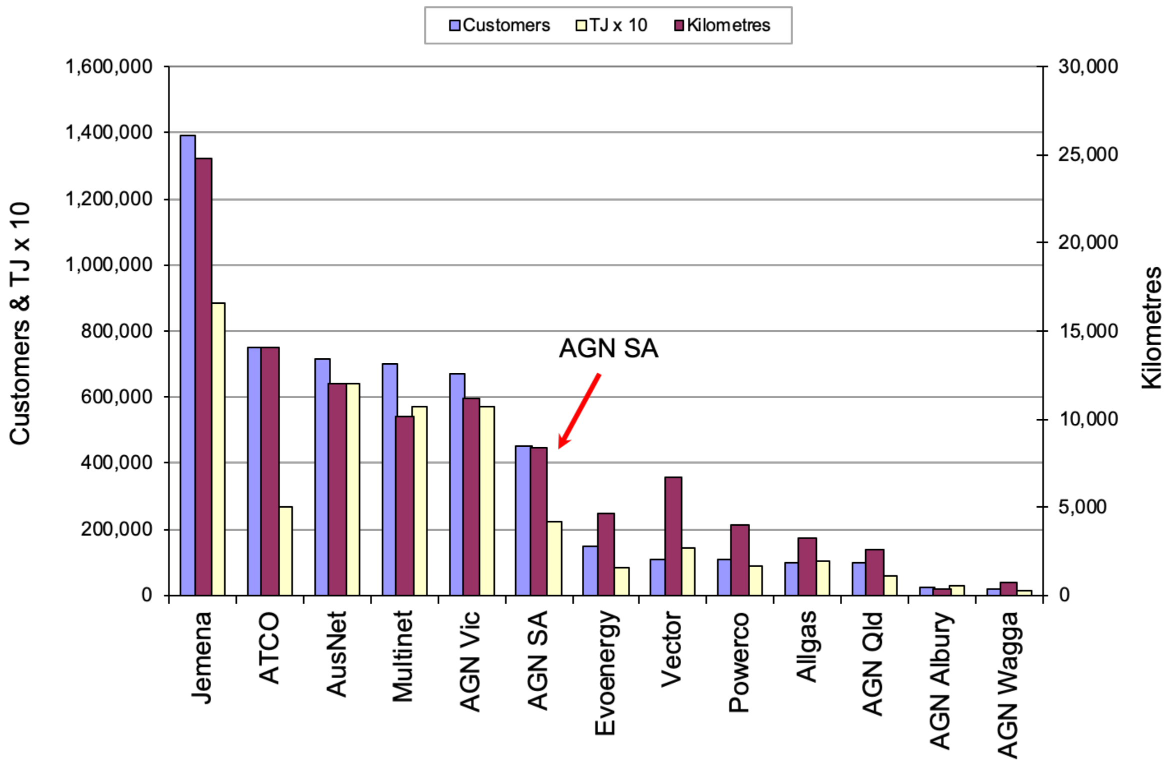
The 13 Australasian distribution businesses operate in varying environments often with substantial differences in network size, amount of throughput, demand growth, number and type of customers, and the mix of rural, urban and CBD customers. The operating environment indicators presented in this section are:

- Energy delivered (TJ), number of customers and network kilometres (Figure 2.1)
- Customer density—customers per kilometre (km) of mains (Figure 2.2)
- Energy density—terajoules (TJ) per customer (Figure 2.3)
- Network utilisation—TJ per kilometre (Figure 2.4).

Figure 2.1 shows, for each GDB in the sample, customer numbers, gas throughput (TJ) and mains length (km) in 2019 (or the latest year available). GDBs are ranked in terms of number of customers and the position of AGN SA is highlighted. AGN SA is the sixth largest GDB in the sample in terms of customer numbers, gas throughput and network length. It is only slightly smaller than ATCO in terms of gas throughput, but is significantly smaller than ATCO in terms of network length and customer numbers.

Among the other GDBs, Jemena in NSW is by far the largest. Other larger GDBs include the three Victorian networks and ATCO. Among the GDBs that are smaller than AGN SA are the two New Zealand GDBs. Vector is larger than Powerco on the basis of all three measures. Evoenergy, Allgas and AGN Queensland are comparable in size to the New Zealand GDBs, at least on some measures. The two remaining Australian GDBs in the sample (i.e. AGN Albury and AGN Wagga Wagga) are much smaller than the other included GDBs.

Figure 2.1: **Key features of the operating environment, 2019***



** Or latest year.*

Source: Economic Insights gas utility database.

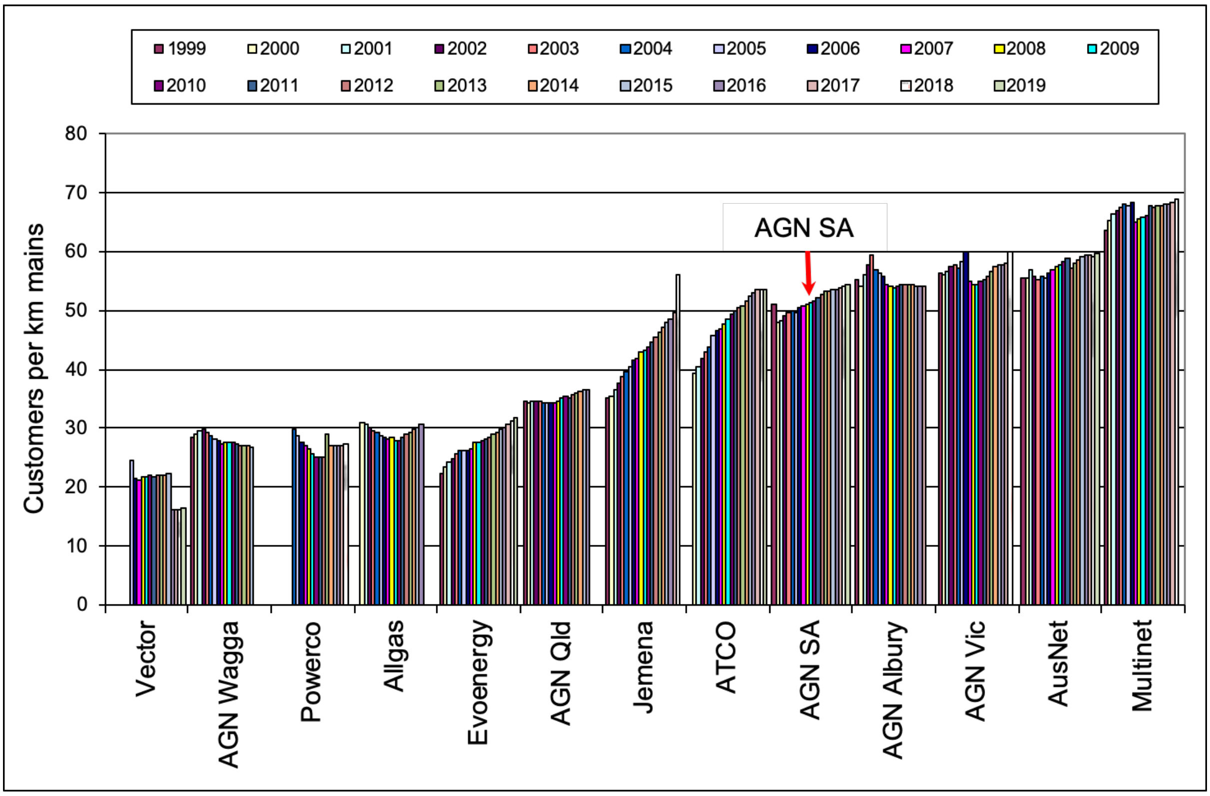
Two of the key operating environment characteristics influencing energy distribution business productivity levels and costs are customer density, measured by the number of customers per kilometre (km) of mains, and energy density measured by the energy throughput (ie, TJ) per customer. A GDB with lower customer density will require more pipeline length to reach its customers than will a GDB with higher customer density but the same consumption per customer. This would make the lower density distributor appear less efficient unless the differing densities are allowed for. Being able to deliver more energy to each customer means that a GDB will usually require less inputs to deliver a given volume of gas as it will require less pipelines than a less energy-dense GDB would need to deliver the same total volume.

These two density measures for all companies in the sample for all available years are presented in Figures 2.2 and 2.3. When the foregoing two measures are multiplied together, the result is the ratio of energy throughput per km, or 'network utilisation'. This measure is presented in Figure 2.4.

The three Victorian GDBs have the highest customer densities. In terms of the five-year average to 2019 (or latest year available) AGN Vic, AusNet and Multinet had 58.2, 59.3 and

68.2 customers per km, respectively. AGN SA has the fifth highest customer density in the sample (averaging 53.9 customers per km over the latest five years). This is comparable to those of AGN Albury, ATCO and Jemena (54.2, 53.2 and 49.9 customers per km, respectively). The remaining smaller Australian GDBs and the two New Zealand businesses all have comparatively low customer densities.

Figure 2.2: **Customer density, 1999–2019**



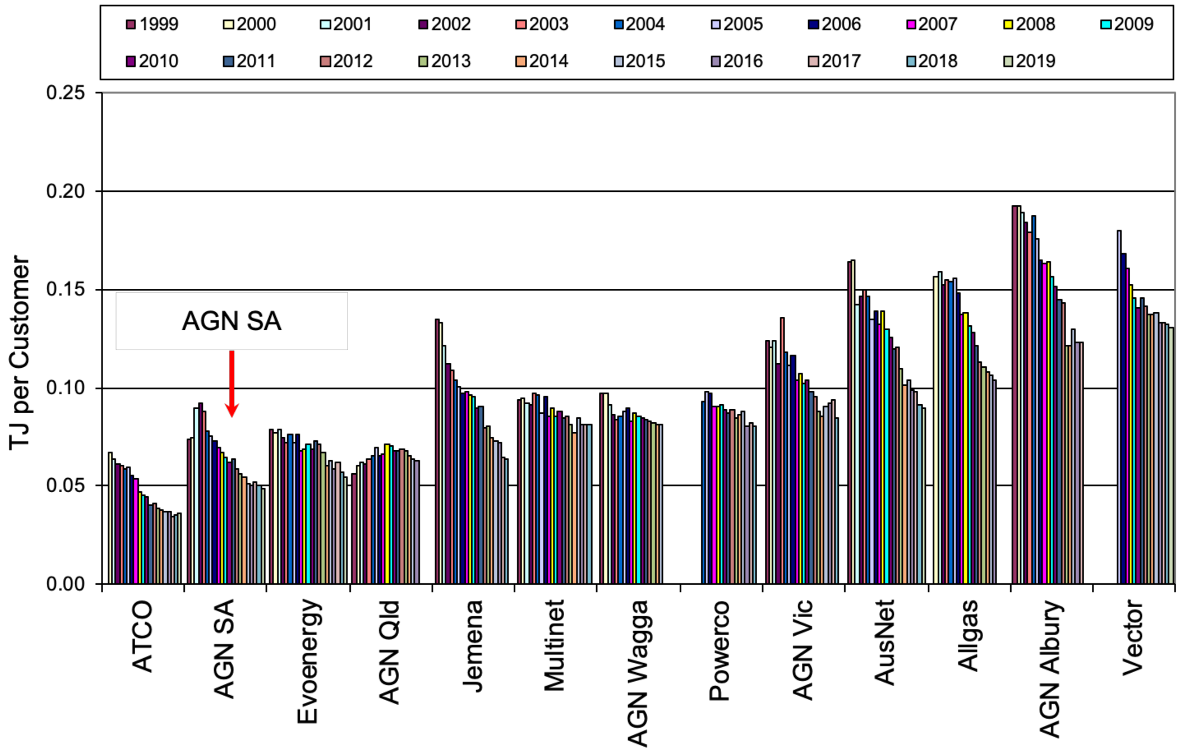
Source: Economic Insights gas utility database

Like Evoenergy, ATCO and Jemena, AGN SA's customer density has increased quite strongly over the sample period. AGN Vic, AusNet and Multinet have had more moderate increases in customer density. The remaining smaller Australian GDBs and the two New Zealand businesses have either had relatively static, or even declining, network densities over the sample period.

AGN SA had the second lowest energy density of all the GDBs in the sample, an average of 51 gigajoules (GJ) per customer over the five years to 2019. This includes all customer types.[1] By comparison, AGN Vic, AusNet and Multinet had energy densities of 89, 96 and 81 GJ per customer respectively, and Jemena had an energy density of 70 GJ per customer (all in the latest five-year period). ATCO's energy density of 36 GJ per customer is the only one lower than AGN SA. There is considerable diversity in the energy densities of the smaller Australian and New Zealand GDBs, reflecting wide variation in climates and the competitiveness of alternative fuels.

[1] A GJ is one thousandth of a TJ.

Figure 2.3: **Energy density, 1999–2019**



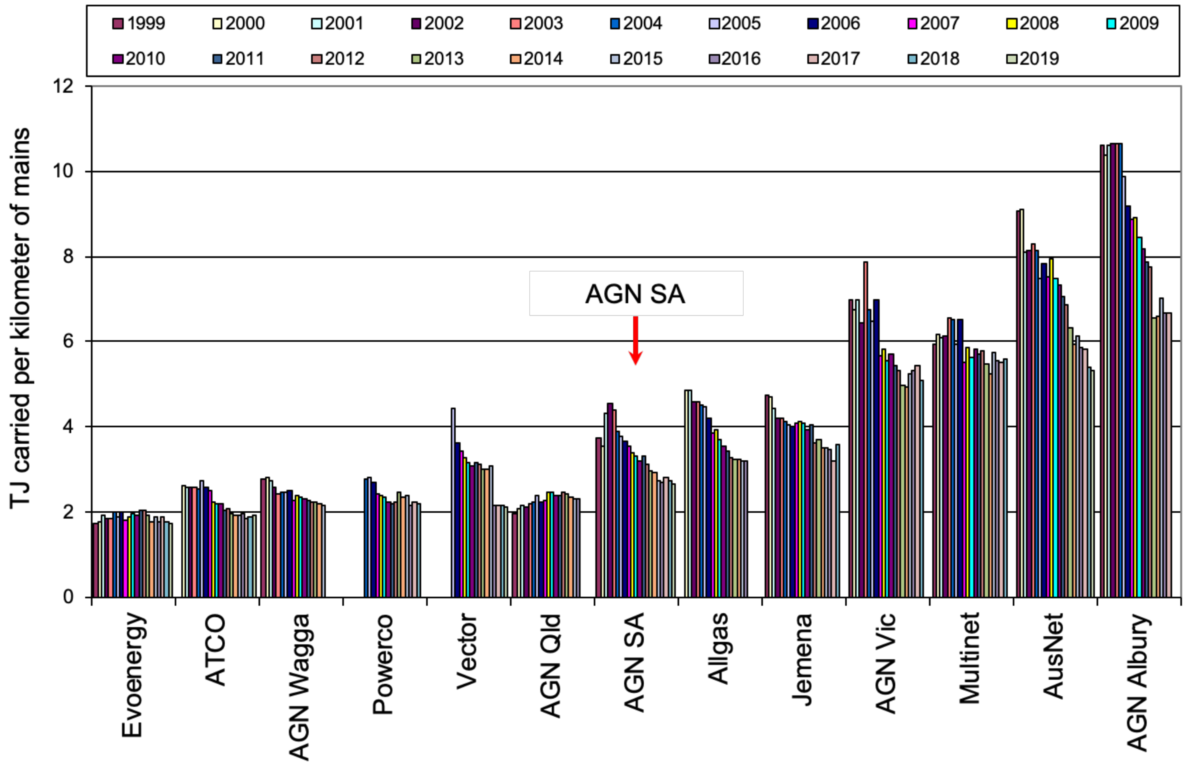
Source: Economic Insights gas utility database.

Energy use per customer has generally declined over the period from 1999 to 2019. For example, for AGN SA it decreased from 74 GJ per customer in 2000 to 49 GJ/customer in 2019 (a 34 per cent cumulative decrease). Jemena's energy density decreased from 135 GJ per customer in 1999, to 64 GJ/customer in 2018 (a 53 per cent cumulative decrease). ATCO's energy density decreased from 67 GJ/customer in 2000, to 36 GJ/customer in 2019 (a 47 per cent cumulative decrease), and AusNet has seen a decline from 164 GJ/customer in 1999 to 89 GJ/customer in 2019 (a 55 per cent decrease). AGN Vic's energy density decreased from 124 GJ/customer in 1999, to 85 GJ/customer in 2018 (a 31 per cent cumulative decrease); Evoenergy's energy density declined from 79 GJ/customer in 1999 to 55 GJ/customer in 2019 (a 30 per cent decrease). Multinet's energy density decreased less strongly from 94 GJ/customer in 1999 to 81 GJ/customer in 2018 (a 13 per cent decrease).

These trends reflect a combination of decreased gas demand by energy-intensive industries, residential energy efficiency improvements, and greater competition in the domestic heating market from electric split systems (air-conditioning and heating).

The combined effect of customer density and energy density is the energy delivered per km of mains or 'network utilisation', which is shown in Figure 2.4. AGN SA has the seventh highest (and seventh lowest) level of network utilisation in the latest five-year period, at 2.7 TJ per km. This average level of network utilisation results from relatively low energy density and above-average customer density. For comparison, the Victorian GDBs have much higher levels of network utilisation, all above 5 TJ/km. Jemena is slightly higher than AGN SA, with a network utilisation of 3.5 TJ/km. ATCO has a much lower level of network utilisation: 1.9 TJ/km. Among the smaller Australian GDBs, AGN Albury has an especially high network utilisation, and Evoenergy has an especially low network utilisation. The other smaller Australian GDBs and the New Zealand GDBs generally have either average or low levels of network utilisation.

Figure 2.4: **Network Utilisation (Energy per kilometre), 1999–2019**



Source: Economic Insights gas utility database

For most GDBs, network utilisation has declined over the sample period, reflecting the fact that declines in energy density per customer have typically outpaced increases in customer density per km. AGN SA's network utilisation decreased from 3.8 TJ/km in 1999 to 2.7 TJ /km in 2019 (a cumulative decrease of 29 per cent). This is comparable to ATCO and Jemena (with cumulative decreases of 27 and 25 per cent, respectively). AusNet had a larger decline in network utilisation over the sample period (41 per cent) and AGN Vic and Multinet had smaller declines (15 and 10 per cent, respectively).

Table 2.1 shows averages for each of the operating environment indicators presented in Figures 2.1 to 2.4, for each GDB over the five-year period to 2019 (or the latest year). It also shows a number of additional partial performance indicators including:

- Opex per customer, per TJ and per mains km
- Capex per customer, per TJ and per mains km, and
- Assets per customer, per TJ and per mains km
- Asset cost per customer, and
- Total cost per customer.

Table 2.2 shows the average growth rates of each of these partial performance indicators for each GDB over the whole sample period available for that GDB. Table 2.3 shows the average growth rates of each partial performance indicator for each GDB over the last five years of the data sample.

Table 2.1: **Operating and performance indicators, Australian and New Zealand GDBs, average***

Company	Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	2013-2017	2,646	21,371	394	54	6.7	0.124	764	94	5,125
AGN Vic	2014-2018	56,374	630,330	10,829	58	5.2	0.089	952	85	4,946
Multinet	2014-2018	56,219	693,278	10,159	68	5.5	0.081	981	80	5,423
AusNet	2015-2019	65,691	682,921	11,513	59	5.7	0.096	705	68	4,020
AGN SA	2015-2019	22,334	442,298	8,210	54	2.7	0.051	2,174	110	5,920
AGN Qld	2012-2016	6,055	92,100	2,548	36	2.4	0.066	3,686	242	8,757
Allgas Qld	2012-2016	10,110	93,397	3,133	30	3.2	0.108	1,751	190	5,649
AGN Wagga	2011-2015	1,609	19,554	723	27	2.2	0.082	1,443	119	3,214
JGN	2014-2018	89,797	1,294,269	25,985	50	3.5	0.070	1,293	90	4,466
Evoenergy	2015-2019	8,295	140,516	4,576	31	1.8	0.059	2,032	120	3,685
ATCO WA	2015-2019	26,287	734,519	13,818	53	1.9	0.036	1,782	64	3,389
Pwrco NZ	2014-2018	8,786	105,071	3,878	27	2.3	0.084	1,622	136	3,673
Vector NZ	2016-2019	15,776	117,881	6,725	17	2.3	0.133	740	99	1,717
Average		28,460	389,808	7,884	43	3.5	0.083	1,533	115	4,614

Company	Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	2013-2017	465	58	3,122	12,420	1,536	83,326	157	251
AGN Vic	2014-2018	1,537	137	7,970	22,111	1,976	115,016	217	302
Multinet	2014-2018	1,059	86	5,871	18,781	1,522	103,846	157	237
AusNet	2015-2019	1,234	119	7,033	20,456	1,966	116,600	180	248
AGN SA	2015-2019	3,700	187	10,055	61,001	3,078	165,856	311	421
AGN Qld	2012-2016	4,751	314	11,320	61,296	4,025	145,532	399	641
Allgas Qld	2012-2016	2,563	278	8,269	45,677	4,947	147,381	499	689
AGN Wagga	2011-2015	2,609	215	5,817	41,221	3,391	91,773	389	507
JGN	2014-2018	1,887	131	6,526	29,745	2,062	102,771	282	371
Evoenergy	2015-2019	1,824	109	3,325	36,537	2,157	66,181	281	401
ATCO WA	2015-2019	2,837	101	5,395	42,175	1,508	80,185	125	188
Pwrco NZ	2014-2018	1,365	114	3,090	37,223	3,110	84,260	312	447
Vector NZ	2016-2019	1,287	171	2,965	24,659	3,283	56,721	333	432
Average		2,086	155	6,212	34,869	2,659	104,573	280	395

*Note: * Average for period indicated. TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 Australian dollars.*

Table 2.2: **Operating and performance indicators, average annual growth rate since earliest year**

Company	Year/ Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	1999-2017	-0.4	2.1	2.2	-0.1	-2.5	-2.4	1.9	-0.6	-0.7
AGN Vic	1999-2018	0.6	2.6	2.3	0.3	-1.6	-2.0	-0.8	-2.8	-2.5
Multinet	1999-2018	0.2	0.9	0.5	0.4	-0.3	-0.7	-2.0	-2.7	-2.3
AusNet	1999-2019	-0.6	2.5	2.1	0.4	-2.6	-3.0	-0.7	-3.6	-3.3
AGN SA	1999-2019	-0.3	1.7	1.4	0.3	-1.7	-2.0	-1.2	-3.2	-2.9
AGN Qld	1999-2016	2.6	1.9	1.6	0.3	1.0	0.7	-0.9	-0.2	0.1
Allgas Qld	2000-2016	0.7	3.3	3.4	-0.1	-2.6	-2.5	2.8	0.2	0.2
AGN Wagga	1999-2015	0.8	2.0	2.4	-0.4	-1.5	-1.1	-0.6	-1.8	-2.1
JGN	1999-2018	-0.7	3.3	0.8	2.5	-1.5	-3.9	-1.8	-5.6	-3.2
Evoenergy	1999-2019	1.6	3.4	1.6	1.8	0.0	-1.8	-1.0	-2.8	-1.0
ATCO WA	2000-2019	-0.2	3.2	1.5	1.6	-1.7	-3.2	0.0	-3.3	-1.7
Pwrco NZ	2004-2018	-0.9	0.1	0.8	-0.6	-1.7	-1.0	-1.6	-2.6	-3.2
Vector NZ	2005-2019*	-0.1	2.1	2.8	-0.6	-2.8	-2.1	-3.5	-5.5	-6.1
Average		0.3	2.2	1.8	0.5	-1.5	-1.9	-0.7	-2.6	-2.2

Company	Year/ Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	1999-2017	2.7	0.2	0.1	0.6	-1.8	-1.9	-2.7	-2.0
AGN Vic	1999-2018	2.5	0.5	0.9	1.7	-0.3	0.1	0.2	-0.8
Multinet	1999-2018	4.4	3.6	4.0	0.0	-0.7	-0.3	-0.3	-1.0
AusNet	1999-2019	4.4	1.3	1.7	2.7	-0.3	0.1	-1.2	-2.1
AGN SA	1999-2019	5.3	3.1	3.5	2.8	0.7	1.0	1.3	-0.1
AGN Qld	1999-2016	1.3	2.0	2.3	0.9	1.6	1.9	6.1	3.0
Allgas Qld	2000-2016	4.5	1.5	1.6	3.2	0.6	0.5	1.1	0.9
AGN Wagga	1999-2015	2.1	0.9	0.5	2.6	1.4	1.0	0.6	0.0
JGN	1999-2018	3.3	-0.8	1.7	2.2	-1.8	0.7	-2.1	-3.3
Evoenergy	1999-2019	-1.6	-3.3	-1.7	-0.5	-2.3	-0.5	-3.5	-3.3
ATCO WA	2000-2019	4.3	0.9	2.6	2.6	-0.8	0.9	-3.8	-3.6
Pwrco NZ	2004-2018	4.3	3.1	4.2	-1.3	-2.3	-2.9	-2.5	-2.5
Vector NZ	2005-2019*	6.6	5.3	5.8	1.5	-0.7	-1.3	-4.1	-4.7
Average		3.4	1.4	2.1	1.5	-0.5	-0.1	-0.8	-1.5

Note: TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 Australian dollars.

Table 2.3: **Average annual indicator growth rate, latest 5 years**

Company	Year/ Period	TJ	Cust.	Km	Cust/ km	TJ/ km	TJ/ cust	Opex/ TJ	Opex/ cust	Opex/ km
AGN Albury	2012-2017	-1.3	1.7	1.7	-0.1	-3.0	-2.9	5.3	2.2	2.2
AGN Vic	2013-2018	2.1	2.8	1.6	1.1	0.5	-0.6	-1.5	-2.1	-1.0
Multinet	2013-2018	0.7	0.6	0.3	0.3	0.4	0.0	-7.5	-7.4	-7.1
AusNet	2014-2019	-0.1	2.4	2.0	0.4	-2.1	-2.5	1.2	-1.3	-0.9
AGN SA	2014-2019	-0.9	1.4	1.0	0.4	-1.9	-2.3	-5.7	-7.8	-7.4
AGN Qld	2011-2016	1.1	2.5	1.7	0.8	-0.6	-1.4	3.4	1.9	2.7
Allgas Qld	2011-2016	0.2	3.4	1.7	1.7	-1.5	-3.1	3.4	0.3	1.9
AGN Wagga	2010-2015	0.7	1.5	2.0	-0.5	-1.3	-0.8	0.8	0.0	-0.5
JGN	2013-2018	-1.3	3.4	-0.5	3.9	-0.8	-4.5	0.4	-4.2	-0.4
Evoenergy	2014-2019	1.1	2.9	1.3	1.6	-0.2	-1.8	0.7	-1.1	0.5
ATCO WA	2014-2019	0.7	1.8	1.0	0.7	-0.3	-1.1	-0.7	-1.7	-1.0
Pwrco NZ	2013-2018	-0.1	0.9	2.3	-1.4	-2.3	-1.0	-0.2	-1.1	-2.5
Vector NZ	2016-2019	1.7	2.4	1.7	0.6	0.0	-0.7	4.0	3.3	4.0
Average		0.4	2.1	1.4	0.7	-1.0	-1.7	0.3	-1.5	-0.7

Company	Year/ Period	Capex/ TJ	Capex/ cust	Capex/ km	Assets/ TJ	Assets/ cust	Assets/ km	Asset cost/ cust	Total cost/ cust
AGN Albury	2012-2017	17.1	13.7	13.6	1.2	-1.8	-1.8	-6.3	-3.3
AGN Vic	2013-2018	-7.8	-8.4	-7.3	2.4	1.8	2.9	2.4	1.0
Multinet	2013-2018	11.7	11.8	12.1	0.1	0.1	0.4	3.2	-0.2
AusNet	2014-2019	0.3	-2.2	-1.8	2.3	-0.3	0.1	0.0	-0.4
AGN SA	2014-2019	-0.8	-3.1	-2.7	4.9	2.5	2.9	-3.8	-4.8
AGN Qld	2011-2016	9.0	7.5	8.4	4.2	2.8	3.6	7.0	5.1
Allgas Qld	2011-2016	0.8	-2.3	-0.7	3.0	-0.2	1.5	7.2	5.2
AGN Wagga	2010-2015	3.8	2.9	2.5	2.3	1.5	1.0	5.0	3.7
JGN	2013-2018	6.5	1.7	5.7	3.9	-0.8	3.1	-5.2	-4.9
Evoenergy	2014-2019	-12.5	-14.1	-12.7	1.0	-0.8	0.8	-8.3	-6.2
ATCO WA	2014-2019	0.5	-0.5	0.2	2.9	1.8	2.5	-11.8	-8.0
Pwrco NZ	2013-2018	12.9	11.8	10.2	0.7	-0.3	-1.7	1.1	0.4
Vector NZ	2016-2019	6.2	5.5	6.2	0.8	0.2	0.8	-10.0	-7.0
Average		3.7	1.9	2.6	2.3	0.5	1.2	-1.5	-1.5

Note: TJ is terajoules, km is kilometres, cust is customers, opex/unit is opex per unit of a comprehensive output index, assets is the regulatory value of fixed assets. All costs in 2010 Australian dollars.

Table 2.4: Market decomposition, Australian and New Zealand GDBs, average*

Company	Period	TJ Tariff V	TJ Tariff D	TJ Tariff V %	Cust. Tariff V	Cust. Tariff D
AGN Albury	2013-2017	1,145	1,501	43.3	21,363	7
AGN Vic	2014-2018	37,261	19,113	66.1	630,071	259
Multinet	2014-2018	44,262	11,957	78.7	692,996	282
AusNet	2015-2019	38,268	27,423	58.3	682,637	284
AGN SA	2015-2019	10,631	11,703	47.6	442,180	119
AGN Qld	2012-2016	2,082	3,973	34.4	92,027	73
Allgas Qld	2012-2016	3,110	7,000	30.8	93,293	104
AGN Wagga	2011-2015	928	681	57.7	19,539	15
JGN	2014-2018	37,459	52,338	41.7	1,293,864	405
Evoenergy	2015-2019	7,084	1,210	85.4	140,477	40
ATCO WA	2015-2019	15,217	11,070	57.9	734,444	75
Pwrco NZ	2014-2018	4,629	4,157	52.7	104,843	228
Vector NZ	2016-2019	10,074	5,702	63.9	117,838	42
Average		16,319	12,141	55.3	389,659	149

Company	Period	TJ/km Tariff V	TJ/km Tariff D	TJ/cust Tariff V	TJ/cust Tariff D
AGN Albury	2013-2017	2.91	3.81	0.054	208.444
AGN Vic	2014-2018	3.44	1.77	0.059	73.879
Multinet	2014-2018	4.36	1.18	0.064	42.416
AusNet	2015-2019	3.32	2.38	0.056	96.559
AGN SA	2015-2019	1.29	1.43	0.024	98.512
AGN Qld	2012-2016	0.82	1.56	0.023	54.428
Allgas Qld	2012-2016	0.99	2.23	0.033	67.308
AGN Wagga	2011-2015	1.28	0.94	0.048	45.376
JGN	2014-2018	1.44	2.01	0.029	129.102
Evoenergy	2015-2019	1.55	0.26	0.050	30.561
ATCO WA	2015-2019	1.10	0.80	0.021	147.211
Pwrco NZ	2014-2018	1.19	1.07	0.044	18.248
Vector NZ	2016-2019	1.50	0.85	0.085	134.481
Average		1.9	1.6	0.045	88.194

Note: 'Tariff V÷refers to volumetric customers (i.e. residential and small/medium commercial and industrial users); 'Tariff D refers to demand customers (i.e. large industrial users).

3 PARTIAL PERFORMANCE INDICATORS

The AER has said the following in relation to electricity distribution, which applies equally to gas distribution:

> *We consider that the most significant output of distributors is customer numbers. The number of customers on a distributor's network will drive the demand on that network. Also, the comparison of inputs per customer is an intuitive measure that reflects the relative efficiency of distributors* (Australian Energy Regulator (AER), 2014: 23).

This section presents information on the inputs per customer of GDBs compared to their network customer densities. Information on GDB inputs per mains km are also compared to their customer densities. By expressing inputs in per customer or per km values and plotting them against customer density, we seek to control for differences in the size and customer densities of GDBs.

The inputs we present information on include real opex, real asset costs, and total costs (the sum of real opex and real asset costs). All of the input, output and customer density measures presented in this section are averages over the five-year period ending 2019 (or latest year). The partial performance indicators we present are:

- Opex per customer relative to customer density (Figure 3.1)
- Opex per mains km relative to customer density (Figure 3.2)
- Opex per customer relative to total customer numbers (Figure 3.3)
- Asset cost per customer relative to customer density (Figure 3.4)
- Asset cost per mains km relative to customer density (Figure 3.5)
- Total cost per customer relative to customer density (Figure 3.6), and
- Total cost per mains km relative to customer density (Figure 3.7).

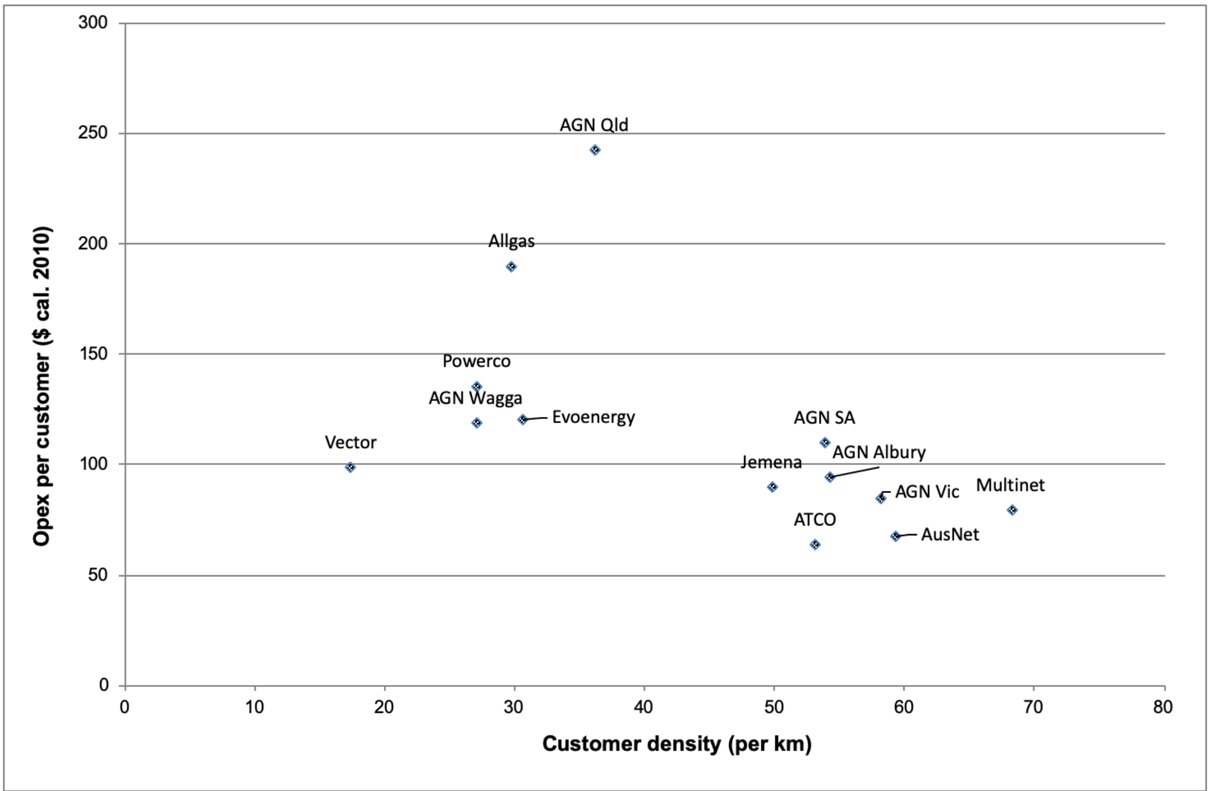
In light of the clear relationships between opex per customer and customer density, on the one hand, and total customer numbers, on the other, we show the opex per customer for the effects of the main cost drivers, using two different approaches. Normalised comparisons of opex per customer, using each approach, are shown in Figures 3.8 and 3.9.

3.1 Opex per customer

Figure 3.1 plots real opex per customer (in $2010) against customer density. GDBs with lower customer density, such as Vector, Powerco, AGN Wagga, Allgas, Evoenergy and AGN Qld, usually have higher opex per customer, although with considerable variation. For example, opex per customer for AGN Qld and Allgas averaged $242 and $190 respectively for the latest five-year period (see Table 2.1). Opex per customer for Powerco, AGN Wagga, Evoenergy and Vector were not as high, but overall, for the six GDBs with lowest customer density, the average opex per customer was $151 for the latest five-year period.

GDBs with higher customer density— such as AGN SA, Jemena, ATCO, AGN Vic, AusNet, Multinet and AGN Albury—tend to have lower opex per customer. For example, the average opex per customer of AGN Vic, Multinet and AusNet over the latest five-year period was $85, $80 and $68, respectively. Average opex per customer of Jemena and AGN SA over the latest five-year period was $90 and $110, respectively. ATCO's average opex per customer ($64) was comparatively low among the GDBs with higher customer density. The average opex per customer of the seven GDBs with higher customer density was $84 over the latest five years. AGN SA's opex per customer was the highest among that group, noting that AGN SA has the third lowest customer density of this group. AGN SA's opex per customer was somewhat below the average for the whole sample ($115).

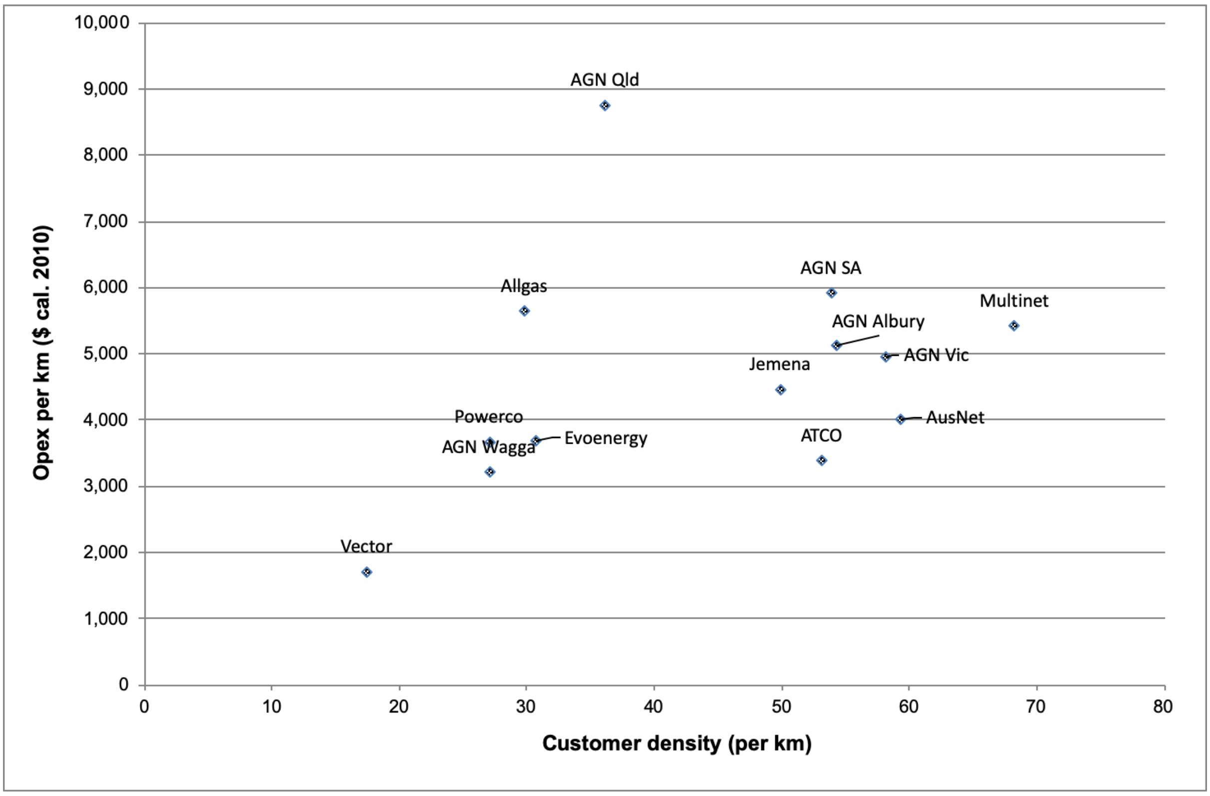
Figure 3.1: **Opex per customer relative to customer density (avg. 2015–2019*)**



** Or latest 5-year period. Source: Economic Insights gas utility database.*

Figure 3.2 plots real opex per mains km against customer density. Among the seven GDBs with higher customer density, the average opex per km was $4,755 over the latest five years. AGN SA's opex per km was $5,920 over the same period, which is the highest among the GDBs with higher customer density, again noting that AGN SA has the third lowest customer density within this group. There is a very wide variation in opex per km among the GDBs with relatively low customer density. The average opex per km for the six GDBs with relatively low customer density was $4,449 over the latest five years, which is slightly lower than for the GDBs with higher customer density. Although opex per km appears to increase with customer density, there is too much variation between the GDBs to be able to draw that conclusion firmly. The sample average was $4,614 for the latest five years.

Figure 3.2: **Opex per mains km relative to customer density (avg. 2015–2019*)**

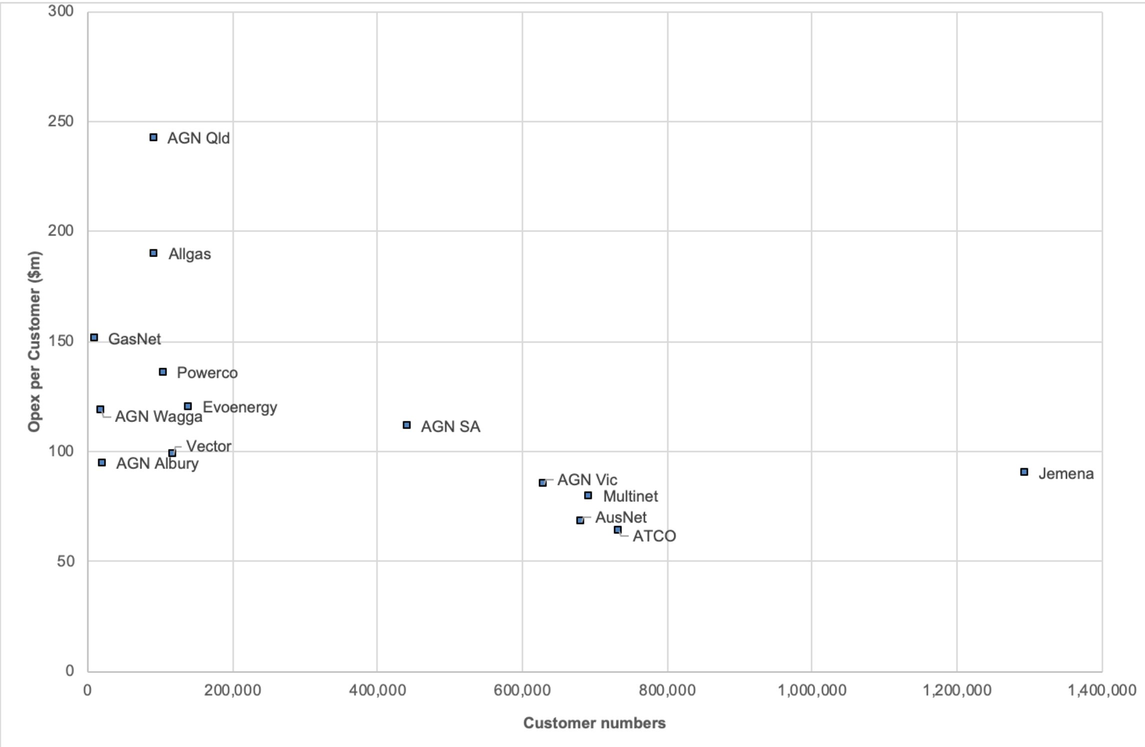


** Or latest 5-year period. Source: Economic Insights gas utility database.*

AGN SA's average opex per customer is above the average for GDBs with relatively high customer density, and similarly its average opex per km is above the average for the same group of GDBs. But this needs to be interpreted in the context of AGN SA having the third lowest customer density within this group. It should be noted a comparison of this kind does not control for other drivers of opex costs that may be relevant, and only qualified conclusions can be drawn from it.

Just as Figure 3.1 shows a clear relationship between opex per customer and customer density, Figure 3.3 shows that there is also a relationship between opex per customer and scale as measured by customer numbers. AGN-SA is significantly smaller in terms of customer numbers than the six largest GDBs, and this could be another contributing factor to its slightly higher opex cost per customer compared to the larger GDBs.

Figure 3.3: **Opex per Customer relative to Scale (2015-2019*)**

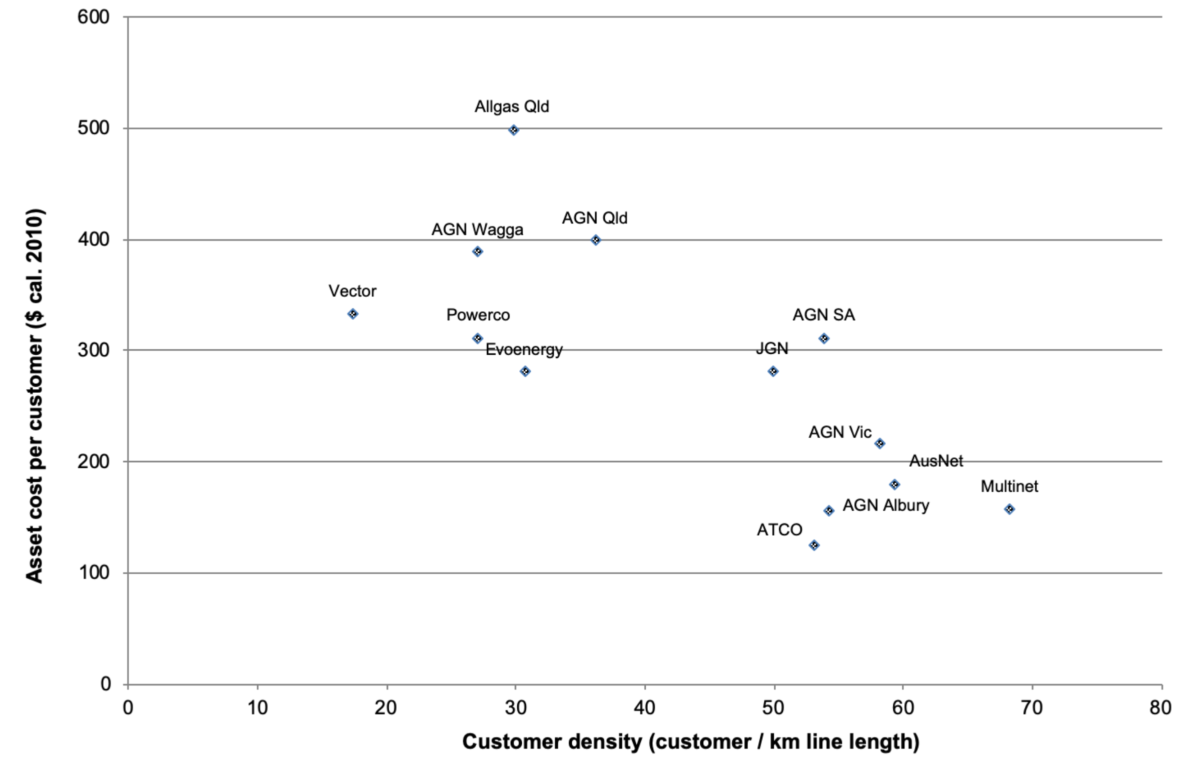


3.2 Capital assets cost per customer

The efficiency of the use of capital inputs is indicated by asset cost per customer, which is based on actual returns to capital rather than a measure based on the opportunity cost of capital and depreciation cost, as used by the AER, because insufficient information is available from public sources to derive a measure based on the latter approach (AER, 2013). Figure 3.4 plots the average asset cost per customer (in $2010) against average customer density in the period 2015 to 2019 (or latest five-year period available), where asset cost is measured by the actual return to and return of capital (or gross return including depreciation). The chart shows that GDBs with lower customer density tend to have higher asset cost per customer than the GDBs with higher customer density (averaging $369). AGN SA's asset cost per customer was $311 in this period. This can be compared to the asset costs per customer of the three Victorian GDBs, which were $157 for Multinet, $180 for AusNet and $217 for AGN Vic; and to AGN Albury, which was $157. AGN SA's average asset costs per customer is more comparable to Jemena, which was $282. ATCO's asset cost per customer of $125 is particularly low compared to the other GDBs. The average asset cost per customer for the six GDBs with comparatively low customer density was $204 over the latest five-year period. The average for the sample was $280.

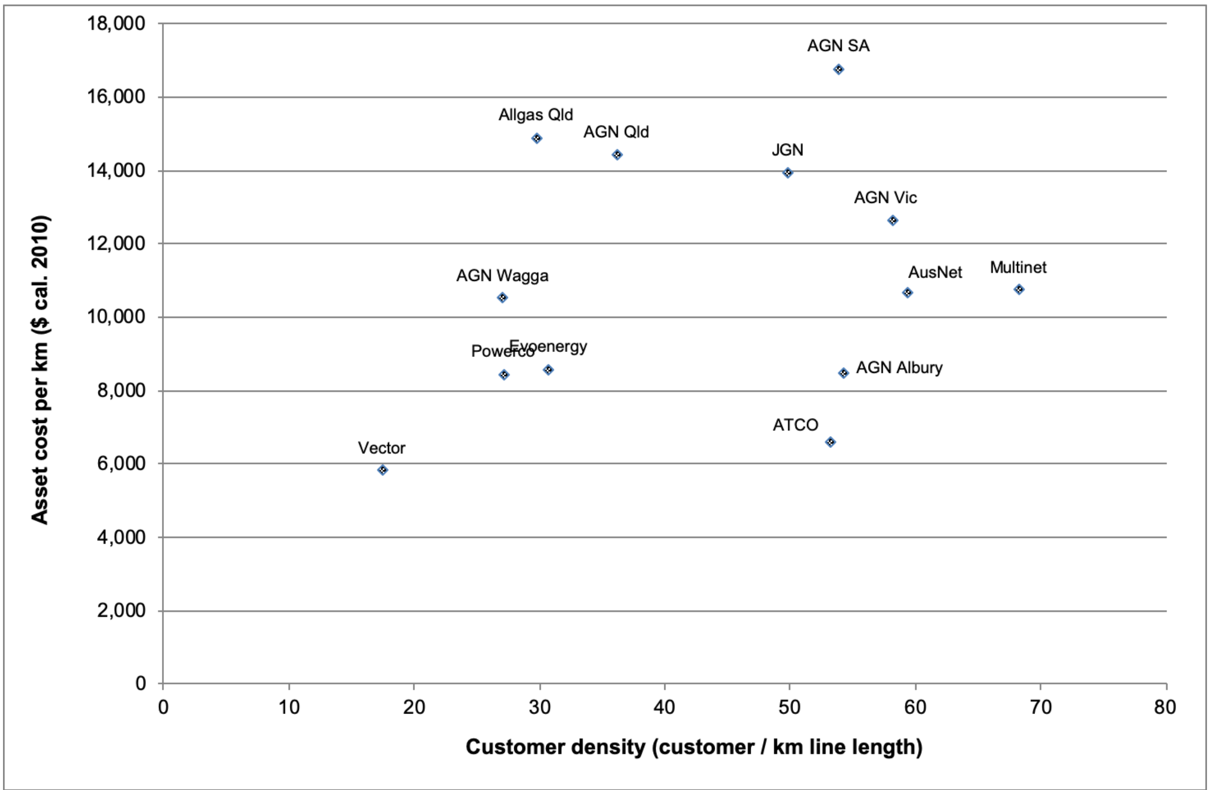
Figure 3.5 shows average asset cost per km of mains for the latest five-year period for each GDB, plotted against customer density. There is no apparent relationship between assets cost per km and customer density. AGN SA's average asset cost per km was $16,771 over the latest five years, which is comparatively high when compared to the average for all GDBs shown (i.e. $10,965). The average for the GDBs with higher customer density ($11,408) is broadly similar to that for the GDBs with lower customer density ($10,448).

Figure 3.4: **Asset cost per customer relative to customer density (avg. 2015–2019*)**



** Or latest 5-year period. Asset cost is defined as real revenue minus real opex. Source: Economic Insights gas utility database.*

Figure 3.5: **Asset cost per mains km relative to customer density (avg. 2015–2019*)**



** Or latest 5-year period. Asset cost is defined as real revenue minus real opex. Source: Economic Insights gas utility database.*

The comparisons in Figure 3.4 and 3.5 are influenced, among other things, by asset age, original network asset valuations, and various factors not controlled-for which influence the quantity of assets per customer, and hence asset cost per customer. Thus, only qualified conclusions can be drawn from this chart. It suggests that AGN SA has a relatively high asset cost when compared to most other GDBs in the sample.

3.3 Overall cost efficiency

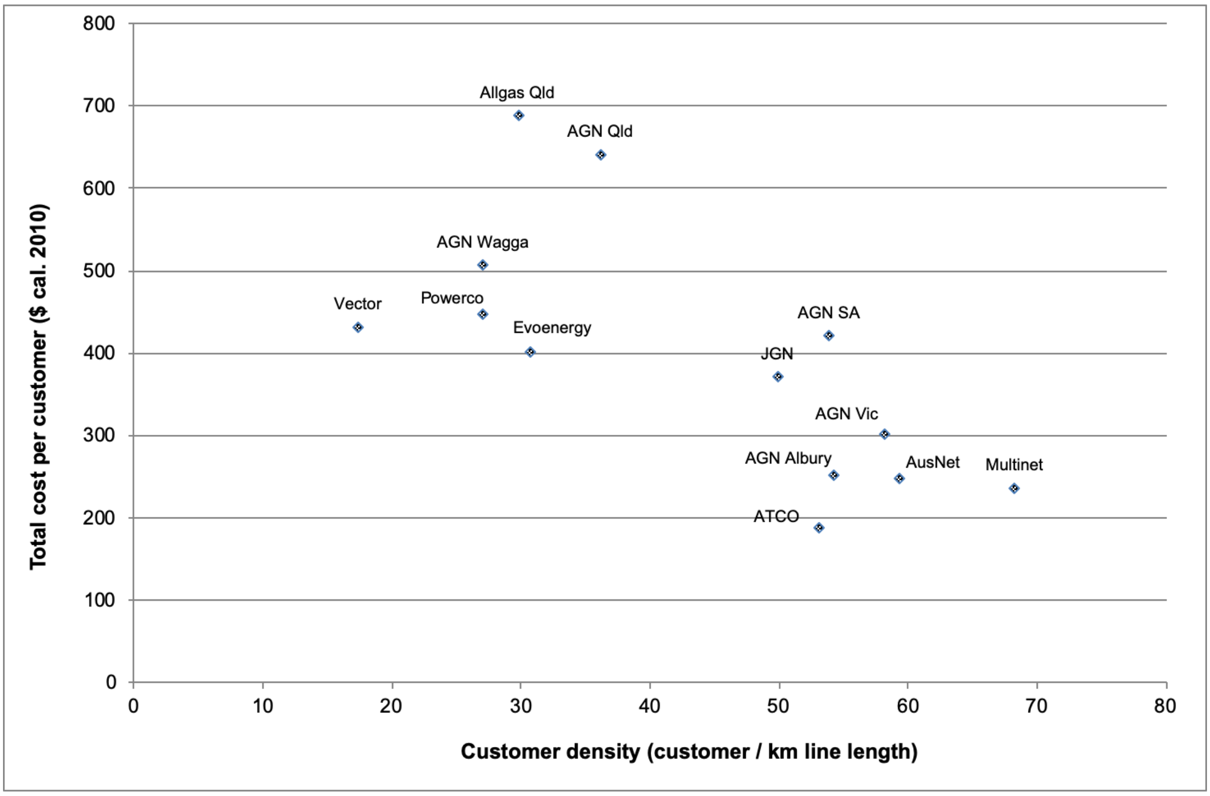
Figure 3.6 plots total cost per customer against customer density, where total cost is the sum of opex and asset cost shown in Figures 3.1 and 3.3 respectively. This chart shows the very clear relationship between cost per customer and customer density. The average total cost per customer of AGN SA in the period 2015 to 2019 was $421, which is comparable to that for JGN ($371 over the latest five-year period). The other GDBs with relatively high customer density had lower levels of total cost per customer. For example, Multinet ($237), AGN Albury ($251), AusNet ($248) and AGN Vic ($302), and ATCO ($188). For the seven GDBs with higher customer density, the average total cost per customer was $288, which is lower than AGN SA's average total cost per customer. However, AGN SA does have the third lowest customer density within this group.

For the six GDBs with lower customer density, the average total cost per customer was $520, which is significantly higher than AGN SA's average total cost per customer. The total costs per customer for GDBs with lower customer density include: Vector ($432), Powerco ($447), Evoenergy ($401), AGN Wagga ($507), AGN Queensland ($641) and Allgas ($689).

Figure 3.7 shows total cost per km of mains plotted against customer density. Although total cost per km appears to increase slightly with customer density, there is considerable variation among the GDBs. Several low density GDBs have relatively low total cost per km including Vector ($7,530), Powerco ($12,114), Evoenergy ($12,266) and AGN Wagga ($13,734). Some GDBs with relatively high customer density have low total cost per km, including ATCO ($10.001) and AGN Albury ($13,620). The Victorian GDBs have intermediate levels of total cost per km (AusNet, $14,691; Multinet, $16,163; and AGN Vic, $17,577). Some of the low density GDBs such as Allgas and AGN Queensland, and some of the higher density GDBs such as Jemena and AGN SA, have comparatively higher total cost per km (Allgas, $20,547; AGN Qld, $23,193; Jemena, $18,398; and AGN SA, $22,691.

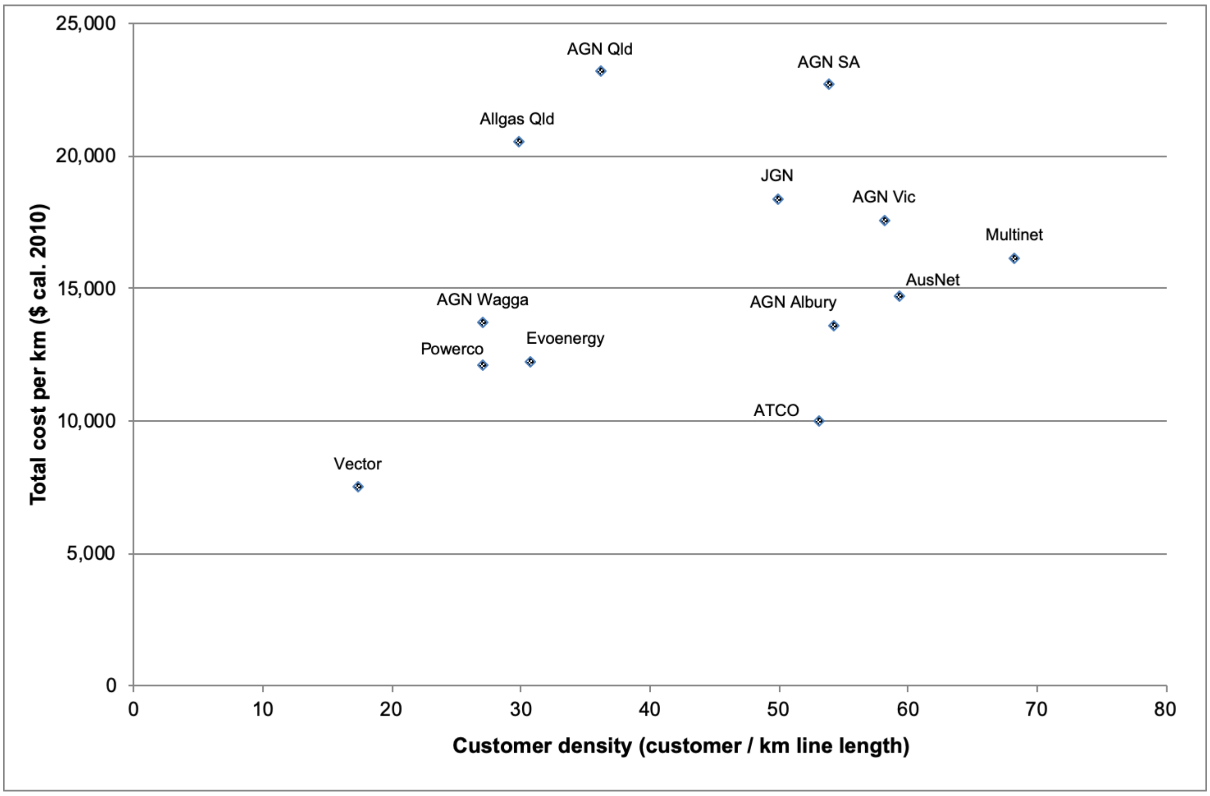
Once again, caution is needed in drawing strong conclusions for these comparisons alone. That said, the results tend to indicate that AGN SA has somewhat below average total cost per customer which is in line with its somewhat higher than average customer density.

Figure 3.6: **Total cost per customer relative to customer density (avg. 2015–2019*)**



** Or latest 5-year period. Source: Economic Insights gas utility database*

Figure 3.7: **Total cost per mains km relative to customer density (avg. 2015–2019*)**



** Or latest 5-year period. Source: Economic Insights gas utility database*

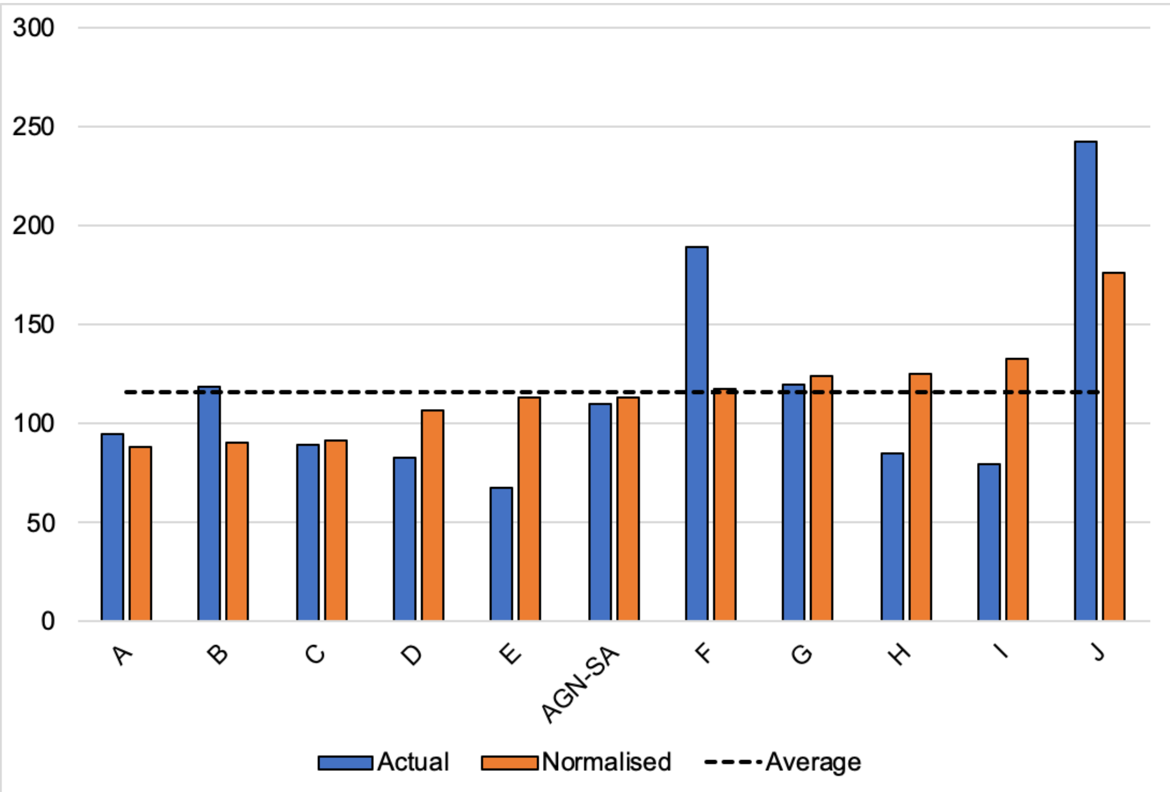
3.4 Normalising opex per customer

One way of adjusting for the effects of customer density and scale is to use econometric modelling. Two different approaches to econometric analysis are presented in Appendix C.

The first approach presented in Appendix C involves regressing real opex per customer against a number of key determinants, including customer density, scale (measured as the number of customers up to a maximum of 0.75 million, which is taken to be the minimum efficient scale) and average minimum temperature, which is a proxy for climate differences more generally. This analysis uses a sub-sample of the data, including only the Australian GDBs and the period from 2005 onwards. Appendix C presents the estimation results and discusses the method of normalisation. Figure 3.8 shows the result of normalising real opex per customer using this method. It presents the average real opex and the normalised opex for each GDB over the last five years of the sample period.

Figure 3.8 shows that AGN SA's normalised real opex per customer is below the sample average. The sample average is $116.4, and AGN SA's normalised opex per customer is $113.5; or 2.5 per cent lower.

Figure 3.8: **Normalised Opex per Customer (2015-2019*) – 1st Method**

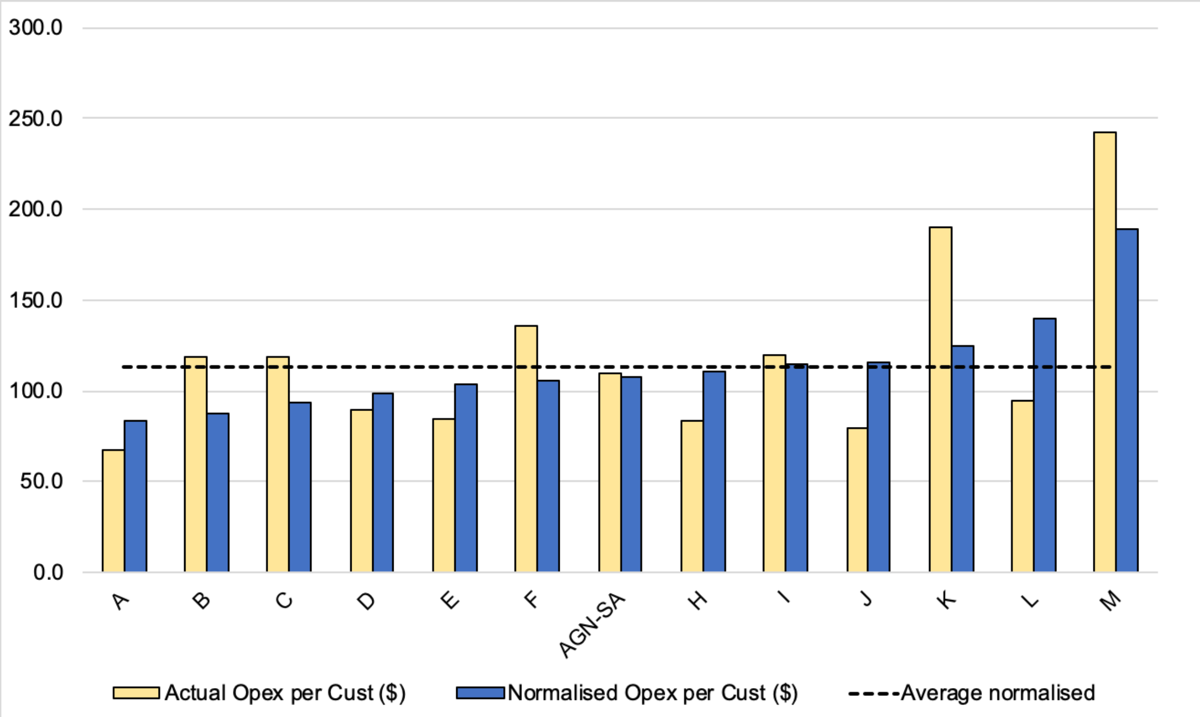


The second approach presented in Appendix C uses a real opex cost model similar to those Economic Insights has estimated in the past. Log real opex is a function of several explanatory variables including log values of customer numbers, mains length, capital stock and a time variable. The sample includes Australian and New Zealand GDBs and extends from 1998 to 2019 (but not all of these years are available for all GDBs). There are two regression models, one using stochastic frontier (SF) analysis and the other using feasible generalised least squares

(FGLS), with differing standard errors for each GDB. Both generate very similar results for normalisation, and Figure 3.9 shows the average results for the two models after normalising real opex per customer for the last five years of data for each GDB.

Figure 3.9 shows that AGN SA's normalised real opex per customer is again below the sample average.[2] The sample average is $115.9, and AGN SA's normalised opex per customer is $107.9; or 6.9 per cent lower. Although the two methods used for normalisation are significantly different, they produce a consistent result in terms of the finding that AGN SA's normalised real opex per customer is below the sample average.

Figure 3.9: **Normalised Opex per Customer (2015-2019*) – 2nd Method**



A further finding of these normalisations is seen by comparing AGN SA to the five other GDBs that are among the largest six. AGN SA's average *actual* opex per customer for the latest five years is $110.0, is 35.6 per cent higher than the average *actual* opex per customer for the other five larger GDBs; which is $81.1.

- Using the first method, AGN SA's normalised opex per customer is $113.5, when compared to a normalised average for the other five large GDBs of $114.0, or 0.4 per cent lower.
- Using the second method, AGN SA's normalised opex per customer is $107.9, when compared to a normalised average for the other five large GDBs of $102.4, or only 5.4 per cent higher.

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[2] The formula used for normalising the dependent variable is: $NRO = \exp(y^n)\ /\ \overline{cust}$, where: y^n is the normalised dependent variable, obtained using: $y^n = y + \sum_k(\bar{x}_k - x_k)$, where the x variables are as discussed.

These results indicate that when some of the known determinants of real opex beyond management control are controlled-for, AGN SA's real opex per customer is closely comparable to those of the other large Australian GDBs.

4 CONCLUSIONS

AGN SA's average opex per customer (in $2010) over the latest five-year period was $110, which was close to the average for the whole sample ($115) but was the highest among the seven GDBs with higher customer density (which averaged $84 over the latest five-year period). AGN SA's opex per km of mains was $5,920 was also the highest among the GDBs with higher customer density.

When real opex per customer for each GDB is normalised for differences in the main cost drivers, AGN SA's normalised real opex per customer is below the sample average and at a similar level to the average of the five largest Australian GDBs, which are also those of highest customer density. Prior to normalisation, AGN SA's average opex per customer was 35.6 per cent above the average opex per customer of the five largest Australian GDBs. After normalisation, AGN SA's average opex per customer was either 0.4 per cent below or 5.4 per cent above the average opex per customer of the five largest Australian GDBs, depending on which of the two methods of normalisation are used for comparison. This means that AGN SA's higher opex per customer, when compared to the five largest GDBs can be fully explained by its smaller scale, lower customer density and differences in the other identified cost drivers.

AGN SA's capital asset cost per customer averaged $311 in the latest five-year period. This is similar to the sample average of $280. It is, again, relatively high when compared to the average of $204 for the group of GDBs with higher customer density. It is reasonable to conclude that, like opex per customer, this reflects its relatively low scale and customer density within this group.

The average total cost per customer of AGN SA in the latest five-year period was $421. This is similar to the sample average of $395, and is again above the average total cost per customer for the seven GDBs with comparatively high customer density ($288). However, the normalisation exercise demonstrates that this difference when compared to the other larger GDBs mainly reflects its smaller scale and lower customer density.

The partial indicators analysis presented in this report do not enable influences such as scale economies or different mixes of inputs to be controlled for in a rigorous fashion. This means that care needs to be taken when drawing inferences from the raw data. Based on these indicators, AGN SA appears to have performed at about an average level overall. Although a direct comparison against the networks with relatively high customer density suggest that its cost per customer is above average, after normalisation of opex per customer is carried out, it is clear that this difference can be fully attributed to its smaller scale and lower customer density, and differences in the other identified cost drivers. After these differences are controlled for, AGN SA appears to have also performed at about an average level among the group larger GDBs.

APPENDIX A: GAS DISTRIBUTION BUSINESSES INCLUDED IN THE STUDY

The database formed for the study includes 11 Australian GDBs and two New Zealand GDBs A brief summary of the operations of the included GDBs follows.

Australian GDBs

Evoenergy, Australian Capital Territory

Evoenergy (the energy networks part of Evoenergy[3]) is the distribution business supplying gas and electricity in the Australian Capital Territory (ACT). The total population of the ACT in 2017 was 413,000. Gas is distributed to a predominantly residential customer base with Canberra the largest market. Outside the ACT, Evoenergy supplies gas to Queanbeyan, Bungendore and Nowra in NSW. There are relatively few major industrial users in its supply area. Canberra covers a large geographical area and the majority of urban development is low density. Moreover, gas distribution in residential areas utilises a dual mains configuration with mains on both sides of a street, rather than a single sided system with longer across-road service connection. For these reasons, it is a low-density distribution network when measured in terms of customers per kilometre of main. In 2017 Evoenergy supplied 140,200 customers with 7,600 TJ of gas from a distribution network of around 4,700 kilometres of mains.

Allgas Energy Pty Ltd (Allgas), Queensland

Allgas is owned by Marubeni Corporation, SAS Trustee Corporation and the APA Group. It supplies gas to consumers in several areas in and around Brisbane and to several Queensland regional areas. The Allgas distribution system is separated into three operating regions. About 59 per cent of the network is located in Brisbane (south of the Brisbane river to the Albert River), 19 per cent in the Western region (including Toowoomba and Oakey) and the remaining 22 per cent on the South Coast (including the Gold Coast, and Tweed Heads in NSW).

Queensland's mild to hot climate means that residential and commercial heating demand is low. Residential demand for gas is mainly for hot water systems and cooking. In 2016 southeast Queensland's population was around 3.3 million. Approximately 70 per cent of Allgas' gas demand is from around 100 large demand class customers. In 2016 Allgas supplied approximately 99,600 customers with 10,300 TJ of gas from a distribution network of 3,200 kilometres of mains. From 2015-16, Allgas is no longer required to have an approved access arrangement, and instead the AER arbitrates any access disputes.

AGN Albury, NSW

Australian Gas Networks Limited (AGN) is, since 2017, part of the Australian Gas Infrastructure Group, owned by a consortium led by CK Infrastructure Holdings.

AGN Albury operates in the large regional centre on the border of NSW and Victoria often referred to as Albury–Wodonga. It operates on the North side of the Murray River in Albury and Ettamogah which in 2016 had a population of approximately 51,000. There is a small

[3] Evoenergy includes an energy retailing partnership and an energy distribution partnership. The latter is called Evoenergy, and is owned jointly by Icon Water and Jemena Networks (ACT) Pty Ltd.

number of large industrial customers which represent over half of its gas deliveries. In 2017 AGN Albury supplied its 22,100 customers with around 2,200 TJ of gas from a distribution network of 400 kilometres of mains. Prior to 2017, AGN had separate approved access arrangements for AGN Albury and AGN Victoria, but these are now consolidated into a single approved access arrangement.

AGN Queensland, Queensland

AGN Queensland is an operating division of AGN, with a distribution network that supplies a Brisbane region (including Ipswich and suburbs north of the Brisbane river); and a Northern region (serving Rockhampton, Gladstone and Bundaberg). The network comprises approximately 2,600 kilometres of low, medium, high and transmission pressure mains. Assets used to service the Brisbane region comprise 88 per cent of the network with the balance of 12 per cent attributable to the Northern region.

AGN Queensland is subject to similar climatic influences on residential gas demand as Allgas. Customer numbers are similar to those for Allgas but gas volumes for customers included in this study are smaller. However, AGN has a number of industrial customers with very large volumes that are not reflected in the data used in this study. In 2016 there were approximately 96,600 customers consuming 6,100 TJ of gas. From 2015, AGN Queensland is no longer required to have an approved access arrangement, and instead the AER arbitrates any access disputes.

AGN SA, South Australia

AGN SA's distribution network services: greater Adelaide; to the north-east of Adelaide, the Barossa Valley, Riverland and Mildura in Victoria; to the north, Peterborough, Port Pirie and Whyalla; and in the east and south-east regions, Murray Bridge and Mt Gambier. Adelaide's population in 2016 was approximately 1.3 million. As with Melbourne, Adelaide's winter climate is conducive to relatively high residential gas demand for heating.

In 2017, AGN SA supplied 442,300 customers with 23,000 TJ of gas from a distribution network of 8,200 kilometres of mains. The Adelaide network makes up 93 per cent of the total network length.

AGN Victoria, Victoria

AGN Victoria serves parts of the greater Melbourne metropolitan area (population of 4.85 million in 2016) including the northern suburbs, the Mornington Peninsula and Pakenham/Cranbourne. AGN Victoria also supplies the north central Victorian area (including Seymour, Wodonga, Wangaratta, Shepparton-Mooropna and Echuca among others). It also supplies rural townships and cities in the Gippsland region (including Bunyip, Drouin, Warragul, Traralgon, Morwell and Sale among others), and a number of outlying towns in East Gippsland such as Bairnsdale and Paynesville (which are in the new Eastern Zone). The Distribution System is divided into four Zones – North, Central, Murray Valley and Eastern.

Melbourne's gas market is well established and cool to mild climatic conditions result in high residential gas consumption for heating, cooking and hot water systems. A relatively high concentration of industry also supports industrial gas demand provided that prices are competitive with other sources of energy supply. In 2017 there were 640,900 customers using 54,100 TJ of gas, supplied from a distribution network of 10,800 kilometres of mains.

AGN Wagga Wagga, NSW

AGN (formerly Envestra) took over gas supply from the NSW Government's Country Energy from October 2010. It supplies gas to the city of Wagga Wagga (estimated population of 48,300 in 2016) in southern regional NSW. In 2015 there were approximately 20,100 customers. AGN supplied these customers with 1,600 TJ of gas from a distribution network of 750 kilometres of mains. In April 2014 the NSW Energy Minister, the Honourable Anthony Roberts, determined that coverage of the Wagga Wagga gas distribution network be revoked, and economic regulation of the network by the AER ceased at that time.

ATCO Gas Australia, Western Australia

ATCO acquired the network previously operated by WA Gas Networks (WAGN) in July 2011. ATCO Gas Australia is the principal GDB for Western Australian businesses and households. It operates the gas distribution system in the mid-west and south-west of Western Australia, including the greater Perth Metropolitan region (with a population of approximately 1.9 million in 2016), Busselton and Bunbury (together a population of 96,000), Geraldton, Kalgoorlie and the Albany region (each with a population of approximately 30,000). Each of these urban areas has a separate gas distribution network (Albany is supplied with reticulated LPG). In 2017, ATCO supplied approximately 738,100 customers with 25,300 TJ of gas from a distribution network of 13,800 kilometres of mains.

AusNet Services, Victoria

AusNet's Victorian gas distribution business was formerly TXU networks, which was formerly Westar (Assets) Pty Ltd, and is now part of AusNet Services, an ASX-listed business. The AusNet gas distribution business delivers gas to a number of urban centres across a geographically diverse region spanning the western half of Victoria, including the Western part of Melbourne, from the Hume highway in metropolitan Melbourne west to the South Australian border and from the southern coast to Horsham and just north of Bendigo. Its supply area includes the major Victorian regional centres of Geelong, Ballarat and Bendigo, and many other cities and towns in western Victoria. In 2017, AusNet supplied its 677,800 customers with 71,800 TJ of gas from a distribution network of 11,300 kilometres of mains.

Jemena Gas Network, NSW

JGN was formed from the sale of Alinta Ltd in 2007, Alinta itself having acquired the gas assets of AGL Gas Networks (AGLGN) in 2006. It is now co-owned by State Grid Corporation of China and Singapore Power. The JGN network provides gas to customers in Sydney, Newcastle, Wollongong and the Central Coast, and over 20 country centres including those within the Central Tablelands, Central West, Southern Tablelands and Riverina regions of NSW. JGN has the largest distribution network and customer base of the Australian GDBs. In 2017 it supplied 1,330,800 customers with 86,200 TJ of gas from a distribution network of 26,800 kilometres of mains.

Multinet Gas, Victoria

Multinet Gas is, since 2017, part of the Australian Gas Infrastructure Group, owned by a consortium led by CK Infrastructure Holdings, following that consortium's acquisition of the DUET Group. The Multinet gas distribution system covers the eastern and south–eastern suburbs of Melbourne extending over an area of approximately 1,600 square kilometres as well as comparatively recent extensions of supply to townships in the Yarra Valley and South Gippsland. In 2017, Multinet supplied 697,300 customers with 54,800 TJ of gas from a distribution network of 10,100 kilometres of mains.

New Zealand GDBs

The New Zealand gas distribution industry is generally less mature than Victoria's with penetration rates still increasing relatively quickly, but comparatively low customer density at present.

Powerco Limited

Powerco is based in New Plymouth (population 56,000 in 2015) and distributes gas in the central and lower North Island regions. It is a dual gas and electricity network business. Powerco's gas networks in the central North Island region include the Taranaki (including New Plymouth), Manawatu and Horowhenua (including Palmerston North, population 83,500 in 2015), and Hawkes Bay networks (including Napier-Hastings, population 130,000 in 2015). In the lower North Island it supplies Wellington City (population of 203,000 in 2015), Hutt Valley (estimated population 141,000 in 2015) and Porirua (district population of 54,000 in 2015). Powerco acquired part of UnitedNetworks' gas operations in 2002 comprising the Hawkes Bay, Wellington, Horowhenua and Manawatu networks. In 2017, Powerco supplied 106,000 customers with 8,700 TJ of gas from a distribution network of 3,900 kilometres of mains.

Vector Ltd

Vector Ltd operates the gas distribution network in Auckland (estimated population of 1,418,000 including North Shore City, and the urban parts of Waitakere and Manukau cities). It is listed on the NZ Stock Exchange and is about 75 per cent owned by the Auckland Energy Consumer Trust. Vector acquired the remaining part of UnitedNetworks' gas operations in 2002 comprising its Auckland gas network and the National Gas Corporation's gas distribution business in 2004 and 2005. The Vector data from 2006 represent the combined operations of Vector and the former NGC Distribution. In November 2015 it sold its regional gas pipelines business via which it supplied a number of regional towns and cities in the North Island. In 2015, Vector supplied 105,900 gas distribution customers with 14,100 TJ of gas from a distribution network of 6,500 kilometres of mains.

APPENDIX B: DATABASES USED IN THE STUDY

The analysis in of this report uses a dataset that includes 13 GDBs, including 11 Australian and two New Zealand GDBs. The analysis uses data for seven major Australian GDBs (AusNet, AGN SA, AGN Vic, Evoenergy, ATCO, JGN and Multinet) which is sourced from survey data obtained for this study. For the other GDBs included in this study, data has been sourced from documents in the public domain and relates to the period 1999 to 2019, or a shorter period.

Table B.1: Summary of data sample

GDB	*Data period*	*Years ending*	*# obs*
AGN Albury	1999–2017	Dec	19
AGN Qld#	1999–2016(1)	Jun	18
AGN SA	1999–2019	Jun	21
AGN Vic	1998–2018	Dec	21
AGN Wagga	1999–2015(2)	Jun	17
Allgas	2000–2016(1)	Jun	17
ATCO	2000–2019	Dec	20
AusNet	1998–2019	Dec	22
Evoenergy	1999–2019	Jun	21
Jemena	1999–2018	Jun	20
Multinet	1998–2018	Dec	21
Powerco (NZ)	2004–2018(3)	Sep	15
Vector (NZ)	2005–2019(4)	Jun	15

Notes: # For AGN Qld, public domain data is used in Parts A and C; and survey data is used in Part B which is available for the period 1999-2014.
* GasNet is not included in the analysis in this report due to its small size.
(1) Regulatory forecasts used for the period 2012 to 2016
(2) Regulatory forecasts used for the period 2011 to 2015.
(3) Capex available only from 2011.
(4) Capex available only for 2007–2017. Vector divested some major networks in November 2015. For some analysis the periods after 2015 are excluded.

The detailed data surveys carried out for the major Australian GDBs followed a common format, covering key output and input value, price and quantity information over the period from 1998 or 1999 to the latest year available (either 2017 or 2018). The GDBs for which data from public sources data is used in Parts A and C include: (i) in Australia, Evoenergy, AGN Albury, AGN Qld, AGN Wagga, and Allgas; and (ii) in New Zealand, Powerco, Vector and GasNet (the last in part C only).

The public domain data sources used for Australian GDBs include:

- Access Arrangement Information (AAI) filings as proposed and as amended by a regulator's decision
- Regulators' final decisions, sometimes with amendment following appeal, and
- Annual Reports from the GDB or its parent firm.

The public domain data source used for the NZ GDBs is the Information Disclosure Data filings required by the Gas (Information Disclosure) Regulations 1997. There are fewer consistent observations publicly available for the New Zealand GDBs, reflecting the impact of mergers, asset sales and industry restructuring.

Data used includes throughput, customer numbers, distribution pipeline length, opex, capex and regulatory asset value. While every effort has been made to make the publicly available data used in this study as consistent as possible, the limitations of currently available public domain data need to be recognised. In a few cases missing observations were estimated based on growth rates for the variable or a related variable before and after the missing year. In a number of cases adjustments were made to ensure the data related to comparable activities and measures (eg unaccounted for gas allowances for non-Victorian GDBs have been excluded to put those GDBs on a comparable basis with Victorian reporting). The data used for the Australian GDBs cover only the regulated (or previously regulated) activities. Data relating to large industrial users whose supply is not regulated are not included. Inclusion of this data would require access to information not generally in the public domain and has been beyond the scope and timeframe of this study.

The data derived from public sources relate to the time periods normally reported by each GDB, and some GDBs use calendar year reporting while others use financial year reporting, and sources varied in reporting data in nominal and real terms. All cost data were first converted to nominal terms (where necessary) using the All Groups Consumer Price Index in Australia and the equivalent in New Zealand. The nominal series were then converted to real series in 2010 dollars using the same price indexes. The New Zealand data were then converted to Australian dollars using the OECD (2014) purchasing power parity for 2010. Purchasing power parities are the rates of currency conversion that eliminate differences in international price levels and are commonly used to make comparisons of real variables between countries.

The measure of opex covers regulated distribution activities only and excludes all capital costs. It includes all non–capital costs allowed by the regulatory authorities, including directly employed labour costs, contracted services, materials and consumables, administration costs and overheads associated with operating and maintaining the distribution service. It excludes unaccounted for gas for all the GDBs as this is treated differently in Victoria compared to the other Australian States and excluding this item provides the best basis for like–with–like comparisons. In line with earlier studies, full retail contestability (FRC) costs are included as reported. All of the cost data are expressed in $A 2010 prices. The estimates of capital assets are based on depreciated asset values for regulatory purposes or those calculated using the same approach as used in regulatory accounts in $A 2010.

APPENDIX C: ECONOMETRIC COST FUNCTION ANALYSIS

The purpose of this appendix is to develop methods for normalising opex, or opex per customer, for the effects of major cost drivers which differ between GDBs, and to thereby derive comparisons of opex that control for differences in the cost drivers. This normalisation leaves an unexplained residual of differences between GDBs that may more closely approximate differences in opex cost efficiency. Two alternative approaches are examined, both using econometric analysis.

The econometric studies both use a database that includes 11 Australian and 3 New Zealand gas distribution businesses (GDBs). The data has two main sources. For 5 Australian GDBs the data was provided by the businesses in response to surveys prepared by Economic Insights. These GDBs include Australian Gas Networks (AGN) South Australia (SA), AGN Victoria, Multinet, ATCO, AusNet Services, Evoenergy and JGN. Data for the other GDBs in the sample was sourced from documents in the public domain. The data includes revenue, throughput, customer numbers, distribution pipeline length, opex, capex and regulatory asset value. In some cases, missing observations were estimated based on growth rates for the variable or a related variable before and after the missing year. All cost data were first converted to nominal terms (where necessary) using the All Groups Consumer Price Index in Australia and the equivalent in New Zealand. The nominal series were then converted to real series in (calendar year) 2010 dollars using the same price indexes. The New Zealand data were then converted to Australian dollars using the OECD (2014) purchasing power parity for 2010. Purchasing power parities are the rates of currency conversion that eliminate differences in international price levels and are commonly used to make comparisons of real variables between countries.

C.1 A simple approach

One way of normalising is to regress opex per customer against the variables used in Figures 3.1 and 3.3; customer density (i.e. customers per km of main) and scale (number of customers). Table C.1 shows such an analysis. The model includes a third explanatory variable, average minimum temperature, to indicate differences in climate. Scale is here measured as the number of customers up to a maximum of 0.75 million, which is assumed to be the minimum efficient scale. To estimate this model, the data sample is restricted to post-2004, to reduce the effects of the least current data. The sample includes only the Australian GDBs because we have not collected temperature data for the New Zealand GDBs.

Table C. 1: **Model for Normalising Opex per Customer for Selected Influences***

	Coeff.	t-stat
Constant	95.7442	(6.65)*
Density	-0.8924	(3.81)*
Scale	-73.3634	(-6.08)*
Avg. Minimum Temperature (Celsius)	7.7862	(8.34)*
R^2	0.72	
N	150	

(a) Uses data from 2005 only; + p<0.1; * p<0.05.

Density = customers per km.; Scale = Mil. Customers (up to 0.75).

Using this regression model, it is possible to normalise the results for each utility over the last five-year period. The method of normalisation is as follows. The averages over the last five years of the sample, for the explanatory variables customer density (*Dens*), scale (*Scale*) and average minimum temperature (*Temp*) and denoted with a bar above. Then

$$OpexCust^{normalised} = OpexCust^{actual} + \hat{\beta}_{Dens}(\overline{Dens} - Dens)$$
$$+\hat{\beta}_{Scale}\left(\overline{Scale} - Scale\right) + \hat{\beta}_{Temp}(\overline{Temp} - Temp)$$

C.2 Previously used model specifications

The second approach more closely follows previous econometric work by Economic Insights on estimating a short-run opex cost function. In 2012, Economic Insights used econometric analyses of the total and opex cost functions for gas distribution businesses to assess the comparative efficiency of SP AusNet (Economic Insights 2012). Economic Insights (2015) estimated an econometric variable cost function for Australian and New Zealand gas networks on behalf of Jemena Gas Networks. The econometric analysis utilised both stochastic frontier and feasible generalized least squares methods, and the models were used for both efficiency benchmarking and forecasting opex partial productivity. In a subsequent econometric study for Multinet Gas, Economic Insights (2016) estimated the relationship between gas network real operating costs ('opex') and outputs, fixed capital inputs and operating environment factors. The aim of that study was to ascertain the most significant output measures as determinants of opex and to quantify the elasticities of real opex with respect to each of the outputs. A similar modelling exercise was undertaken for Jemena Gas Networks (JGN) in 2019 for the purpose of ascertaining JGN's relative technical efficiency compared to an estimated efficiency frontier and for forecasting productivity trends. The 2019 study used two different estimation methods, stochastic frontier (SF) analysis (using a half-normal distribution for inefficiencies) and feasible generalised least squares (FGLS).

The same methods are used in this analysis. The sample includes Australian and New Zealand GDBs and extends in most cases from 1998 or 1999 to 2018 or 2019.

The estimated models are presented in Table C.2. Unlike the model in Table C.1, in these models all variables are expressed in logs. In the 2019 study, the dependent variable used throughout the analysis was constant price opex (in 2010$). In the preferred model there were two outputs; customer numbers and the network length in km. A measure of capital inputs was included — the constant price asset value. The annual rate of technological change was measured by the coefficient on a variable that measures time in years. Operating environment variables (OEVs) previously used included: (i) the proportion of the network not made of cast iron or unprotected steel (a proxy for network age); (ii) the number of city gates (a proxy for service area dispersion); and (iii) tariff class customer share of total gas throughput (all in log form. In this study, the performance of the OEVs in the initial model estimates was not entirely satisfactory because none of the estimated coefficients on those variables were statistically significant in the SF model (although all were statistically significant in the FGLS model), and because the FGLS model has an unexpected sign on the tariff class customer share of total gas throughput. Given the inadequacy of the OEVs in the SF model, all of the OEVS were omitted in the preferred models.

The models in Table C.2 generally satisfy the following requirements:

- the elasticities of variable cost with respect to each of the outputs (*Cust* and *Mains*) are positive, and in most cases they are significant;
- the elasticity of variable cost with respect to the capital stock (*RAV*) is positive and significant;

These models used are used here to calculate normalised opex per customer based on standardised values of the main explanatory variables (except time), being the sample averages over the latest five-year period. The average of the results for the two models is then used.

Table C.2: **Log real opex (removing operating environment variables)**

	*SF model**		*FGLS model***	
	coeff	*t-stat*	*coeff*	*t-stat*
Const	-4.8969	(-15.91)	-5.4509	(-35.56)
ln*Cust*	0.1289	(1.55)	0.2590	(10.21)
ln*Mains*	0.3861	(3.63)	0.3842	(11.01)
ln*RAV*	0.5226	(7.46)	0.3805	(11.37)
t	-0.0126	(-7.54)	-0.0144	(-10.42)
D-H test (p-value)(1)	0.4174		0.0079	
BIC(2)	-189.96		-211.62	
RMSE(3)	0.1443		0.1936	
N (sample size)	264		264	

See notes to Table 8.1.

C.3 Results

The results of normalising opex per customer using these two modelling approaches are presented in section 3.4 of the report.

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