Comparative Benchmarking of Gas Networks in Australia and New Zealand

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NEW ZEALAND

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EXECUTIVE SUMMARY

The Commerce Commission has engaged Meyrick and Associates to undertake a comparative benchmarking study of New Zealand and Australian gas transmission and distribution pipeline businesses using data sourced from New Zealand and Australian regulatory data. The Commission expects to use this advice to assist it in deciding on whether control is warranted for the businesses.

Comparative benchmarking studies can throw the most light on pricing efficiency by concentrating on comparisons of cost efficiency once operating environment differences have been allowed for. For instance, if the New Zealand businesses were found to be consistently less cost efficient than the normalised performance of overseas businesses then this would lend support to the case for imposing control.

While there are several alternative methods available to compare cost efficiency, the limited number of observations available for gas distributors in Australia and New Zealand restrict the techniques usable in practice to indexing methods. In this study we use the multilateral TFP index method applied to 2003 data to obtain a snapshot of comparative performance. Some additional time–series results are also presented for transmission pipeline comparisons.

We present cost efficiency comparisons for four New Zealand and 10 Australian gas distributors. We use the 2003 New Zealand Disclosure Data and responses to Section 70E information requests as the primary information sources for: NGC Distribution; Powerco; Wanganui Gas; and, Vector. Final approvals by Australian state regulators and associated access arrangement information filings are used as the primary data sources for: Envestra Albury (NSW); Envestra Queensland; Envestra South Australia; Allgas Queensland; Country Energy Wagga (NSW); Envestra Victoria; Multinet (Victoria); TXU Networks (Victoria); AGLGN (NSW); and, ACTEW–AGL (ACT).

For transmission we use the New Zealand Disclosure Data and responses to the Section 70E information request as the primary information sources for NGC Transmission and final approvals by the Australian Competition and Consumer Commission (ACCC) and associated access arrangement information filings for 7 Australian gas transmitters: EAPL Moomba to Sydney; Epic Moomba to Adelaide; APT Central West (NSW); Envestra Riverland (South Australia); GasNet and VENCorp (Victoria); NT Gas Amadeus Basin to Darwin (Northern Territory); and, Goldfields Transmission (Western Australia).

Ideally three outputs should be included in the distribution model and two in the transmission model. These are throughput, system capacity and customer numbers for distribution and throughput and system capacity for transmission. However, data on system capacity outputs have generally not been available from public sources and the time available for the study has precluded seeking detailed data directly from the utilities. As a result, and in line with previous studies, we have estimated a distribution model that contains two outputs (throughput and customer numbers). We have then used a proxy adjustment method to allow for differences in energy and customer density. For the transmission model we have used a proxy for system capacity. Both the distribution and transmission models have two inputs – operating and maintenance expenditure and capital. Capital quantities are generally represented by kilometres of main.

While the approaches adopted make the best use of the data available, the results of the study should be considered indicative rather than definitive until the data limitations can be addressed more systematically. As well as the need to obtain consistent measures of both distribution and transmission system capacity, input from the firms themselves is required to ensure the coverage of reported data, particularly that relating to operating and maintenance expenditure, is completely consistent across the sample. Some of the Australian data is forecast rather than actual data and there are differences between the data used in regulators' final approvals and the initial filings from the gas suppliers.

The major NSW, Victorian and South Australian distributors are several times larger than the other utilities using the output index based on throughput and customer numbers. With the exception of three distributors – NGC Distribution, Vector and Allgas Queensland – the average consumption per customer is relatively uniform. These three distributors have higher average consumption per customer reflecting the likely relative importance of a few large industrial customers relative to their smaller residential customer bases.

The New Zealand distributors generally have lower customer densities than their Australian counterparts. Wanganui Gas has the highest customer density of the New Zealand distributors at 30 customers per kilometre. This is around [ ] per cent higher than those for NGC Distribution and Powerco and around double that for Vector. The three Victorian distributors have the highest customer densities with Multinet having over twice Wanganui's density at around 70 customers per kilometre. All else equal, a higher customer density will allow the distributor to operate more efficiently as a smaller volume of inputs are required to deliver a given quantity of gas to a given number of customers.

Making no allowance for customer density differences leads to the Australian distributors having over twice the observed productivity of the New Zealand distributors on average. However, much of this difference will be due to operating environment differences beyond management control. Recognising that a kilometre of main in a more customer dense network will be more resource intensive than one in a less dense network reduces the observed gap between the New Zealand and Australian distributors to around 35 per cent on average. This will be, however, only a partial adjustment for customer density differences as some residual density economies will remain unaccounted for.

Undertaking a more comprehensive proxy adjustment for both customer and energy density differences leads to the productivity gap between the New Zealand and Australian distributors being further reduced to around 21 per cent. We do this by adjusting output levels for each distributor to give them the same implied energy and customer densities as AGLGN – a utility with around average energy and customer densities for the sample – and making a corresponding weighted average change to operating and maintenance expenditure levels. This produces the most 'like–with–like' comparison of the cost efficiency performance of the New Zealand and Australian distributors given currently available data.

The Australian transmission pipelines' throughput weighted average TFP is found to be around 57 per cent higher than NGC Transmission's. This model uses asset value as a proxy for system capacity but contains very limited adjustment for operating environment differences. It is not possible to adequately adjust for operating environment differences for transmission pipelines given the small number of observations and the limited data currently available. Future work may develop measures to capture system configuration that have an impact on measured TFP (eg straight line systems as found in Australia are likely to have inherent efficiency advantages over radial systems like NGC's of a similar total length).

Extension of the database to include US utilities would greatly increase the number of observations available and provide more confidence that best practice was being captured in the sample although operating environment differences would then be more important. It would also increase the scope to use multiple techniques, including econometric methods. Provided the data supported the necessary estimation, it may then be possible to incorporate more operating environment differences.

1 INTRODUCTION

The Commerce Commission is undertaking an inquiry to report on whether goods and services supplied by persons in markets directly related to either a natural gas transmission system or a natural gas distribution system or both should be controlled. The Commerce Commission (2003) indicated in its Draft Framework Paper that it intends to consider two approaches to determine whether prices for gas pipeline services are efficient. One of the approaches – the comparative benchmarking approach – involves comparing the prices with those of comparable services in other markets either that have workable competition or in which the prices are known or assumed to be efficient.

The prices charged by pipeline providers will be influenced by a range of factors including:

- the cost efficiency of the provider;
- the rate of return earned by the provider;
- service quality provided; and,
- operating environment conditions faced.

A pipeline provider that is less cost efficient will have to charge higher prices than a more cost efficient provider to earn the same rate of return. Cost efficiency is a combination of technical efficiency (whether the maximum quantity of output is being produced from the quantity of inputs used) and allocative efficiency (whether inputs are being used in the cost minimising combination). As a less cost efficient provider will face higher costs, all else equal it will have to charge higher prices. Conversely, for two otherwise identical providers with equal cost efficiency, one earning higher rates of return will be charging higher prices.

It normally costs more to provide better levels of service quality and hence a provider with superior service quality will normally be charging more, all else equal, to cover its higher costs. Finally, the geographic, climatic and demand conditions faced by a pipeline provider will influence the level of costs and, hence, prices charged. For instance, pipeline providers supplying densely settled networks will face lower costs than those supplying spread out customer bases.

Comparative benchmarking studies can throw the most light on pricing efficiency by concentrating on comparisons of cost efficiency once operating environment differences have been allowed for. For instance, suppose the New Zealand businesses were found to be operating at similar or superior levels of cost efficiency, once operating environment conditions and service quality levels are taken into account, compared to overseas businesses thought to be achieving high efficiency levels. There would then appear to be less of a case for imposing control (provided profitability levels are not excessive). Conversely, if the New Zealand businesses were found to be consistently less cost efficient than the normalised performance of overseas businesses then this would lend support to the case for imposing control.

The Commission has engaged Meyrick and Associates to undertake a comparative benchmarking study of New Zealand and Australian gas pipeline businesses using data sourced from the disclosure data, section 70E notices and Australian access arrangement information filings, supplemented with additional data from other public sources. The Commission expects to use this advice to assist it in deciding on whether control is warranted for the businesses.

The terms of reference for the study are as follows:

- use one or more methods or processes for assessing the efficiency of pipeline costs, using comparative benchmarking, taking into account the data currently available for the New Zealand and Australian businesses, or data that could be acquired, and taking into account the Commission's time frame for the Inquiry;
- distinguish between the capital and operating cost efficiency of the businesses;
- identify what operating environment conditions can be adjusted for, the reasons why and the robustness of the adjustment; and,
- comment on the constraints imposed by the data, and the additional information that would be required to improve the results in the future.

We present cost efficiency comparisons for four New Zealand and 10 Australian gas distributors. We use the 2003 New Zealand Disclosure Data and data supplied in response to Section 70E notices as the primary information sources for:

- NGC Distribution;
- Powerco;
- Wanganui Gas; and,
- Vector.

Final approvals by Australian state regulators and associated access arrangement information filings are used as the primary data sources for:

- Envestra Albury (NSW);
- Envestra Queensland;
- Envestra South Australia;

- Allgas Queensland;
- Country Energy Wagga (NSW);
- Envestra Victoria;
- Multinet (Victoria);
- TXU Networks (Victoria);
- AGLGN (NSW); and,
- ACTEW–AGL (ACT).

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- NT Gas Amadeus Basin to Darwin (Northern Territory); and,
- Goldfields Transmission (Western Australia).

In the following section of the report we briefly review earlier studies of gas pipeline efficiency in Australia and New Zealand. In the third section we set out some of the major measurement issues that have to be addressed in undertaking a cost efficiency benchmarking study before describing the data used in more detail in section 4. Gas distribution results are presented in section 5 for a range of partial measures as well as total factor productivity (TFP). We discuss the role of operating environment conditions and undertake a limited analysis of their impact given data constraints. We present similar results for the transmission comparisons in section 6 before commenting on possible future extensions and data requirements in section 7.

2 PREVIOUS BENCHMARKING STUDIES

There have been fewer international benchmarking studies undertaken of gas pipeline efficiency than there have been for other infrastructure industries such as electricity lines businesses. There are fewer firms and generally a less wide range of data available on gas pipelines worldwide than is the case for electricity utilities. This has correspondingly limited the sophistication that can be built into the modelling of gas pipeline efficiency.

There have been three major studies undertaken previously of gas pipeline efficiency performance in Australasia. These are Bureau of Industry Economics (1994), IPART (1999) and Pacific Economics Group (2001a,b,c).

Bureau of Industry Economics (1994)

While now somewhat dated, the Bureau of Industry Economics (BIE 1994) international benchmarking study was the first major comparative study of gas supply performance in Australia. It compared prices and technical efficiency of 42 utilities including five Australian utilities, 23 US utilities, nine Canadian utilities, four Japanese utilities and one UK utility. No New Zealand pipelines were included in the study. Technical efficiency was calculated using the quantity only version of data envelopment analysis (DEA) using energy deliveries and customer numbers as the outputs, employee numbers, distribution kilometres of mains and transmission kilometres of mains as the inputs and the number of degree days and customer density (customers per kilometre of main) as operating environment variables.

Data on transmission and distribution pipelines were pooled as there were insufficient observations to undertake separate analyses. The output and input specifications were chosen so that the linear programming based DEA would not choose distributors as peers for transmitters and vice–versa. The data for the overseas gas utilities were mainly assembled from information provided by the gas industry associations in the respective countries.

The BIE noted that input coverage was likely to be somewhat inconsistent due to varying amounts of contracting out between utilities and the unavailability of data on operating and maintenance expenses. No account was able to be taken of differences in pipeline age and construction methods (eg cast iron versus polyethylene).

Under the assumptions of constant returns to scale and no differences in operating environments, the Australian utilities were found to be around 20 per cent behind industry best practice. Canadian and Japanese utilities were found to be the most efficient on average. Including the operating environment condition variables of climate and density in the DEA analysis lead to the Australian utilities increasing their average efficiency score to 10 per cent behind best practice.

IPART (1999)

In 1999, the New South Wales Independent Pricing and Regulatory Tribunal (IPART) published a research paper titled *Benchmarking the Efficiency of Australian Gas Distributors*. Eight Australian distributors were benchmarked against a sample of 51 US local distribution companies (LDCs) using the quantity only version of data envelopment analysis. Sensitivity testing of the DEA efficiency scores against efficiency scores derived from stochastic frontier analysis (SFA) and corrected ordinary least squares (COLS) was also undertaken.

Data used by IPART for the Australian distributors were sourced from:

- access arrangement information (AAI) filings;
- annual reports of local distributors; and,
- confidential information obtained from local distributors.

The outputs included in the study were energy deliveries (in terajoules), residential customer numbers, the number of non–residential customers and the reciprocal of unaccounted for gas. The inputs included were the length of mains in kilometres and operating and maintenance expenditure. The number of heating degree–days and the age of the network were included as operating environment variables in a second stage Tobit regression.

IPART undertook extensive work with the included Australian distributors to align their operating and maintenance costs with the US Federal Energy Regulatory Commission (FERC) data classifications to ensure as like activities as possible were being compared.

The Australian distributors were found to be around 27 per cent behind best practice on average. The Victorian distributor Multinet was found to achieve best practice while the least efficient of the Australian distributors was AGLGN (ACT) (the forerunner of ACTEW–AGL) at 58 per cent behind best practice. IPART found that neither of its included operating environment variables of climate and density were statistically significant. It rationalised the climate result by stating that the higher demand for gas in the northern hemisphere is likely to be offset by higher input requirements to deal with the adverse conditions.

Pacific Economics Group (2001)

In 2001 Pacific Economics Group (PEG) benchmarked the Australian gas distribution operations of three Victorian utilities – Multinet (United Energy), TXU, and Envestra Victoria (PEG 2001a,b,c) – against its database of US gas utilities. The variables included in the analyses were:

- Number of gas delivery customers (outputs);
- Total gas throughput (outputs);

- Operation and maintenance (O&M) expenses (inputs);
- Value of plant (inputs);
- Labour costs (inputs);
- Percentage of distribution miles in total distribution and transmission miles (operating environment);
- Percentage of distribution mains that are cast iron (operating environment);
- Percentage of electricity distribution capital in the gross value of distribution plant (operating environment); and
- Percentage of sales volume to non–industrial users (operating environment).

PEG benchmarked the O&M cost performance of the Australian gas distributors against those of 43 distributors in the United States using a translog econometric cost function. PEG uses standard regression techniques to compare the O&M actual cost for the utility in question with that predicted by the model. The model predicted O&M cost is that for an average utility after adjusting for the included operating environment conditions. The estimation results for the US database are applied 'out of sample' to data for each of the three Australian utilities.

PEG find that Multinet's actual O&M cost is nearly 50 per cent below the model's point prediction making Multinet a superior performer compared to the sample of US utilities. Similarly, Envestra Victoria's and TXU Networks' actual O&M costs are 34 per cent and 28 per cent, respectively, below the model's predictions.

Based on their sample of US gas utilities, PEG find that reported distribution costs increase as the firm's involvement in transmission increases. Costs also increase as the proportion of cast iron pipes in total kilometres of mains increases and as the proportion of non–industrial customers increases. On the other hand, gas distribution costs tend to decrease if utilities provide both gas and electricity distribution services to the same service area and are, hence, able to reap economies of scope.

3 MEASUREMENT ISSUES

To measure cost efficiency or productivity performance we require data on the price and quantity of each output and input and data on key operating environment conditions. We require quantity data because productivity is essentially a weighted average of the change in output quantities divided by a weighted average of the change in input quantities. Although the weights are complex and vary depending on the technique used, they are derived from the share of each output in total revenue and the share of each input in total costs. To derive the revenue and cost shares we require information on the value of each output and input, ie its price times its quantity. Hence, we require either the price and quantity of each output and input or, alternatively, their values and quantities, or their values and prices.

In a sense the quantity data are the primary drivers of productivity results while the value or price data are secondary drivers in that they are used to determine the weights for aggregation. Quantity information can be obtained either directly or indirectly. Direct quantity data are physical measures of a particular output or input, eg terajoules of throughput or full–time equivalent employees. Indirect quantity data are obtained by deflating the revenue or cost of a particular output or input by an average price or a price index. There are arguments in favour of both methods. Some argue that the indirect method allows greater differences in the quality of outputs or inputs to be captured and for a greater range of items to be captured within the one measure (eg a greater extent of automation reflected in a higher capital value). However, the indirect method places more onus on having both the value and the price data completely accurate. Since price data are generally harder to match to the specific circumstances of a particular firm, there is more scope for error with the indirect method. Hence, it is a good policy to rely on direct quantity data wherever possible and to only use indirect quantity data in those cases where the category is too diverse to be accurately represented by a single quantity (eg materials and services inputs).

In common with other network infrastructure industries, measuring the performance of gas pipelines presents a number of challenges, not the least of which is defining exactly what a pipeline business's output is. In this section we examine a number of difficult measurement issues including how to define pipeline outputs and inputs and the likely impact of operating environment conditions.

3.1 Measuring pipeline outputs

Early energy supply productivity studies simply measured output by system throughput. However, this simple measure ignores important aspects of what pipelines really do. Like all network infrastructure industries, a major part of pipelines' output is providing the capacity to supply the product. In this sense, there is an analogy between a gas distribution system and a road network. The distributor has the responsibility of providing the 'road' and keeping it in good condition but has little, if any, control over the amount of 'traffic' that goes down the road. Consequently, the distributor's output should also be mainly measured by the availability of the infrastructure it has provided and the condition in which it has maintained it. Other outputs the distributor provides are directly related to its number of connections ('local access roads') as well as call centre operations responding to queries, connection requests, etc.

In Meyrick and Associates (2003), our recent study of electricity lines business productivity, to capture these multiple dimensions of lines business output we measured distribution output using three outputs: throughput, system line capacity and connection numbers. This also had the advantage of incorporating the major density effects (consumption per customer and customers per MVA–kilometre of line) directly into the output measure. Transmission output was measured by throughput and system capacity. A similar output specification would be appropriate for gas distribution and transmission as gas network output has similar dimensions and density considerations to that for electricity networks.

Ideally, service quality would be included as a fourth output. However, attempts to include reliability measures as a fourth output in energy distribution efficiency studies have proven unsuccessful due to the way output is measured. As both the frequency and duration of interruptions are measured by indexes where a decrease in the value of the index represents an improvement in service quality, it would be necessary to either include the indexes as 'negative' outputs (ie a decrease in the measure represents an increase in output) or else to convert them to measures where an increase in the converted measure represents an increase in output. Most indexing methods cannot readily incorporate negative outputs and inverting the measures to produce an increase in the measure equating to an increase in output leads to non–linear results. They have not been included in previous gas supply efficiency studies and are again excluded in this study. Service quality issues are generally less of a problem in gas supply than they in electricity supply where outages are more frequent given the more exposed nature of overhead wires compared to buried pipelines.

Previous gas network efficiency studies have typically only included two of the three principal output dimensions – throughput and customer numbers. Both BIE (1994) and PEG (2001) include throughput and total customer numbers as the outputs while IPART (1999) included throughput, residential customer numbers and other customer numbers. IPART (1999) also included the reciprocal of unaccounted for gas as an output in an alternate specification as an attempt to include service quality although this measure abstracts from the main reliability dimensions.

In this instance we do not have access to consistent data on distribution system capacity, particularly for the New Zealand distributors, so we follow the practice of the earlier studies in specifying two distribution outputs: throughput and total customer numbers. This will include some direct allowance for differences in energy density (consumption per customer) across distributors but not for customer density, particularly if kilometres of mains is used as the capital input measure. We examine two options for allowing for different customer densities in section 5 – using a measure of capital value as the capital input and a proxy adjustment of output levels and operating expenditure usage to put all the sample on a common customer density footing.

For transmission it is essential to incorporate a measure of system capacity, including length of the pipeline, to compare different pipelines. The Australian regulators prefer a measure of maximum sustainable capacity calculated as maximum feasible terajoules per day throughput multiplied by length of the pipeline in kilometres. However, there appears to be some debate over what constitutes maximum feasible daily throughput and consistent data are not available for all transmitters. In this study we have supplemented the available data on the capacity measure with proxies for the transmitters where this is not available, including NGC Transmission, based on recorded peak throughput. We also investigate representing the capacity of the pipeline by its capital value.

A priority area for further work in this area is developing consistent measures of distribution and transmission pipeline capacity. Due account would need to be taken of practical difficulties that can arise from having related concepts or measures as appearing as both outputs and inputs (eg system capacity as an output and mains length or asset value as an input).

To aggregate the two outputs into a total output index using indexing procedures, we have to allocate a weight to each output. For most industries which produce multiple outputs these output weights are taken to be the revenue shares. However, in this case we cannot observe separate amounts being paid for the different output components. In this case we can either make some arbitrary judgements about the relative importance of the output components or we can draw on econometric evidence. One way of doing this using econometrics is to use the relative shares of cost elasticities derived from an econometric cost function. The latter approach is often used in industries not subject to high levels of competition because the cost elasticity shares reflect the marginal cost of providing an output.

In Meyrick and Associates (2003) we had sufficient observations for New Zealand's electricity distribution lines businesses to estimate a basic cost function model and derive output cost shares. In this case, however, there are insufficient observations available to carry out robust econometrics. Instead, we use Pacific Economics Group's (2001) cost elasticity shares derived from their large sample of US gas distributors over several years which imply cost shares for throughput of 14 per cent and for customers of 86 per cent. These shares are consistent with expectations as the marginal cost of extra throughput from an engineering perspective is relatively low. The results are likely to be relatively insensitive to varying the throughput share through a range of 5 to 25 per cent.

3.2 Measuring pipeline inputs

Previous studies of pipeline productivity have typically used two or three input categories. For instance, BIE (1994) used labour numbers, kilometres of distribution main and kilometres of transmission main. No allowance was made for materials and services inputs due to lack of data at that time. IPART (1999) used operating expenditure and kilometres of main as its two inputs. Differences in the levels of contracting out between utilities made obtaining labour data problematic either due to its unavailability or lack of comparability. PEG (2001) uses a three input specification with labour, other operating expenditure and capital inputs. As labour data is not publicly available for most Australasian pipeline businesses we adopt a similar approach to IPART (1999) by using a two input specification with operating expenditure and capital. In this specification labour inputs are subsumed within operating expenditure which is a more appropriate treatment where levels of contracting out differ substantially across the sample.

There are a number of different approaches to measuring both the quantity and cost of capital inputs. The quantity of capital inputs can be measured either directly in quantity terms (eg using a pipeline length measure) or indirectly using a constant dollar measure of the value of assets. Similarly, the annual cost of using capital inputs can be measured either directly by applying the sum of an estimated depreciation rate and a rate reflecting the opportunity cost of capital to the optimised deprival value (ODV) or depreciated optimised replacement cost (DORC) of assets or indirectly as the residual of revenue less operating costs.

Some analysts have argued that measuring the quantity of capital by the deflated asset value method provides a better estimate of total input as it better reflects the quality of capital and can include all capital items, not just pipelines. There are three potential problems with this approach. Firstly, it is better suited to more mature systems where the asset valuations are very consistent over time and across organisations. If the asset valuation process is still being bedded down, then the estimated quantity of capital inputs is likely to be artificially variable using this approach as was found to be the case in our recent study of electricity lines businesses. Secondly, ODV and DORC measures already contain some degree of optimisation or removal of redundant capital that may lead to actual performance being overstated. However, ODV and DORC measures are usually the most consistent form of asset values available. Thirdly, approaches using the capital stock to reflect the quantity of inputs usually incorporate some variant of either the declining balance or straight line approaches to measuring depreciation. Gas pipeline assets tend to be long lived and produce a relatively constant flow of services over their lifetime. Consequently, their true depreciation profile is more likely to reflect the 'one hoss shay' or 'light bulb' assumption than that of a declining balance. That is, they produce the same service each year of their life and until the end of their specified life rather than producing a given percentage less service every year. In these circumstances it may be better to measure the quantity of capital input by the physical quantity of the principal assets. This approach is also invariant to different depreciation profiles that may have been used by different pipeline businesses. In this study we investigate the use of both direct physical and indirect financial asset measures to proxy the quantity of capital inputs.

The direct approach to measuring capital costs involves applying a constant percentage reflecting depreciation and the opportunity cost of capital to the value of assets. Given that gas pipelines and electricity lines generally have similar lifespans, we follow Meyrick and Associates (2003) and NZIER (2001) in assuming a common depreciation rate of 4.5 per cent of ODV and an opportunity cost rate of 8 per cent of ODV in calculating the cost of capital inputs. Given that the cost of capital is only used to weight the input quantities together and is hence a secondary driver, variations in assumed depreciation and opportunity cost rates over a reasonable range are likely to have only a minor impact on the results.

The indirect approach of allocating a residual or ex post cost to capital of the difference between revenue and operating costs has been favoured by some regulatory agencies such as the US Federal Communications Commission (1997). However, estimating productivity using a direct estimate of the cost of capital is more consistent with the underlying producer theory where an ex ante measure is required.

3.3 International comparisons

A particular problem encountered in international benchmarking studies is the need to convert value and constant price quantity series to a common currency. This can be done using purchasing power parities or exchange rates. Purchasing power parities were developed to reflect underlying differences in purchasing power between countries. As such, they should abstract from much of the financial market volatility and 'overshooting' which affects exchange rate movements. However, the main focus of development of purchasing power parities has been on the consumption rather than the production sector. Consequently, there is limited detail on producer items such as capital inputs and materials and services inputs – the main areas where constant price quantity series have to be used. Many studies simply use the economy–wide or GDP purchasing power parity for all conversions but there can be differences between these overall purchasing power parities and those for broadly relevant capital items such as civil construction and engineering projects. Which of these conversion factors is chosen can have a bearing on conclusions regarding relative efficiency levels.

In its report on telecommunications interconnection charges, the Commerce Commission (2002) used a 10 year average of past and forecast future exchange rates to convert interconnection charges to a common currency. It chose not to use purchasing power parities for this specific situation because earlier work by the Reserve Bank of New Zealand claimed that purchasing power parities do not fully allow for the effects of ‘persistently high current account deficits’ on the exchange rate. However, the Commission also noted that the majority of benchmarking studies used purchasing power parities as the preferred conversion factor although most of these had not been addressing the specific issue of setting interconnection prices.

All conversion methods have a number of advantages and disadvantages. While readily obtainable, current exchange rates exhibit considerable volatility and are generally unsuitable for use in efficiency studies. Averages of exchange rates over a longer period are more stable but require inclusion of subjective forecasts of ‘equilibrium’ exchange rates. Purchasing power parities compare specific baskets of commodities but tend to have more detail on the consumption than the production side and may not take full account of persistent current account deficits. Weighing up these advantages and disadvantages, most benchmarking studies focused on efficiency comparisons (as opposed to price comparisons) have used purchasing power parities as the preferred measure of converting implicit input quantities to a common implicit quantity measure.

In this study we use the average of the OECD (2004) purchasing power parities for 2002 and 2003 to convert implicit quantities. This works out to be a conversion rate of 1.066 New Zealand dollars per Australian dollar. This compares with a corresponding average exchange rate of 1.146 over the same period. In those models where kilometres are used as the measure of pipeline capital this conversion factor is only applied to the quantity of operating expenditure and variations in the rate used will have a relatively minor impact on the results. Assuming that operating expenditure accounts for 30 per cent of total costs, the impact of using the exchange rate instead of the purchasing power parity would be a reduction in productivity of the Australian firms relative to their New Zealand counterparts of just over 2 per cent, all else equal.

For those specifications where an asset value measure of capital inputs is used, the effect could be more significant. For instance, using the average exchange rate in that case instead of the average purchasing power parity would lead to the Australian firms being seen to use an extra 7.5 per cent of total input quantity with an associated reduction in productivity relative to their New Zealand counterparts of around 7 per cent, all else equal. However, the purchasing power parity is likely to provide the better relative measure of resources used and is adopted in this study in line with most earlier benchmarking studies. For instance, PEG (2001c, p.27) observe that the purchasing power parity is 'considered a better measure of the "real" underlying differences between value in the two countries than the current exchange rate that may apply at any point in time'.

Given that international comparisons are likely to be able to shed most light on cost comparisons once operating environment differences are taken into account, it is desirable to undertake the analysis with respect to total costs, wherever possible, rather than simply looking at just operating or capital costs alone. This is because comparisons based on the partial productivity of one input in isolation can be misleading. Depending on local operating conditions and relative prices, two utilities could have very different combinations of operating costs and capital and yet both be technically and allocatively efficient. For instance, if one utility faces low labour costs but high capital costs compared to another then it will be efficient for that utility to use relatively more labour and relatively less capital. If it is then compared with the second utility in terms of just operating costs it will appear inefficient as it will be penalised for using more labour but not given credit for using less capital. To capture these effects it is necessary to use a more holistic measure of inputs and, hence, a total factor productivity based measure although these sorts of influences are less likely to be relevant for comparisons between Australia and New Zealand which face similar economic conditions. Consequently, we present partial operating expenditure and capital productivity comparisons as well as total productivity comparisons.

3.4 Techniques for assessing cost efficiency

The main methods used to assess cost efficiency are total factor productivity (TFP), data envelopment analysis (DEA), stochastic frontier analysis (SFA) and econometric cost functions. Meyrick and Associates (2003) recently used the multilateral TFP method to estimate the efficiency of New Zealand electricity distributors. This method allows the estimation of TFP levels as well as growth rates and can incorporate some operating environment differences by appropriate specification of outputs. It can be applied in situations where there are a limited number of observations available and has the advantage of being readily reproducible. Being a non–parametric approach, it does not, however, produce statistical tests.

The same basic data set (the prices and quantities of the key outputs and inputs and information on the main operating environment conditions) is required to implement TFP, DEA and econometric methods such as SFA in a rigorous fashion. Each method tends to have a comparative advantage in providing information on different aspects of efficiency. Given the relatively small number of gas utilities operating in New Zealand and Australia, however, the feasible methods are limited to TFP indexes as there are insufficient observations available to support either DEA or robust econometric approaches. Consequently, in this study we use the multilateral TFP index method to examine comparative cost efficiency.

3.5 Normalisation for operating environment conditions

Operating environment conditions can have a significant impact on transmission and distribution costs and productivity and in many cases are beyond the control of managers. Consequently, to ensure reasonably like–with–like comparisons it is desirable to 'normalise' for at least the most important operating environment differences. Likely candidates for normalisation include energy density (energy delivered per customer), customer density (customers per kilometre of main), customer mix, the proportion of cast iron pipes and climatic and geographic conditions.

Utilities operating in colder climates are likely to have a less even demand for gas from residential customers with higher winter peaks than utilities operating in warmer climates. However, this may be offset to a large extent if the utility has a high proportion of industrial usage, as is the case with NGC Distribution and Vector. Also, utilities in colder climates generally have more success in achieving higher rates of domestic sales penetration which improves their customer density.

Energy density and customer density are generally found to be the two most important operating environment variables in energy distribution normalisation studies (see Meyrick and Associates 2003). Being able to deliver more energy to each customer means that a distributor will usually require less inputs to deliver a given volume of gas as it will require less pipelines than a less energy dense distributor would require to reach more customers to deliver the same total volume. A distributor with lower customer density will require more pipeline length to reach its customers than will a distributor with higher customer density but the same consumption per customer making the lower density distributor appear less efficient unless the differing densities are allowed for.

Most electricity distribution studies incorporate density variables by ensuring that the three main output components – throughput, system capacity and customers – are all explicitly included. This means that distributors who have low customer density, for instance, receive credit for their longer line lengths whereas this would not be the case if output was measured by only one output such as throughput. As noted above, we have insufficient information to include a system capacity output for gas distributors and only very imperfect information on which to base a capacity variable for gas transmitters.

To overcome this problem we investigate two alternatives. We first investigate using an asset value based measure of the quantity of capital input. As gas utilities with higher customer density will require more off–takes and associated equipment per kilometre of main, they will have a high asset value per kilometre of main, all else equal. Using this measure of capital input will hence partly take account of customer density differences although there will be some residual economies of density not accounted for. The second avenue we explore is using a proxy adjustment for density differences by scaling both throughput and customers for all utilities to give them the same densities per kilometre of main as AGLGN in NSW, a utility with around average energy and customer density for the sample. We then rescale operating expenditure by a weighted average of the scale factors for the two outputs (where the weights are those derived from the PEG (2001) cost function) while leaving kilometres of main unchanged. Recalculating multilateral TFP with this adjusted data gives us an approximation to density adjusted results.

Operating environment differences other than energy and customer densities are likely to be minimised by limiting the comparison to New Zealand and Australian gas pipeline businesses because the two countries have similar climates and industrial structures. Notwithstanding this, however, there are likely to be significant differences in scale between the two countries. The relatively small number of observations available limits the efficiency measurement techniques usable to multilateral TFP indexes which, in turn, limits the scope to adjust for operating environment conditions other than density. However, density differences are likely to be the main operating environment differences between the two countries and these can be largely accommodated in the TFP methodology. Adjusting for other operating environment conditions such as climate and geography would require the use of regression based techniques which are not feasible due to the limited number of observations. However, these factors are more likely to be similar between these two countries making adjustment for these factors less critical.

4 DATA

The data used in this study primarily relate to the 2003 financial year. The primary data sources used for the NZ gas pipeline businesses are the Disclosure Data and data supplied in response to Section 70E notices. Where there is a difference between the Disclosure Data and information supplied in response to Section 70E notices, the Section 70E responses are used. Minor changes have been made to some of the Section 70E data to make it consistent with that used by the Commerce Commission in its Draft Report. This mainly relates to excluding costs associated with the inquiry from operating expenditure. For NGC Transmission the replacement cost of easements has been removed from the ODV and replaced with a notional historic cost figure. The primary data sources for the Australian gas pipeline businesses are the final approvals for access arrangements by jurisdictional regulators and, to a lesser extent, the Access Arrangement Information (AAI) filings.

For distribution the analysis is limited to one year, 2003, because of difficulties in obtaining consistent data. The restructuring of the New Zealand industry in 2002 with the break-up of UnitedNetworks means that data is partly available for the current utilities for the 2003 financial year. For the Australian utilities many of the final approvals have occurred recently with 2003 as the first year of the time series reported. Extending data backwards for these utilities would require matching 2003 actual data with forecast data from the first round of approvals. Where possible we have limited reliance on forecast rather than actual data. Since the purpose of this study is to establish differences in productivity levels across distributors rather than differences in productivity growth rates, the limited time available has been concentrated on obtaining as consistent data as possible for the most recent year. Some time–series data is reported for transmission businesses where there has been less industry restructuring and more consistent data can be obtained.

New Zealand gas pipeline businesses are required to provide a range of Disclosure Data information which is gazetted each year. The variables included in the Disclosure Data and Section 70E responses cover the main output and input categories and provide the basic data required for an efficiency study. These variables cover the basic output categories used in previous studies including energy throughput and customer numbers. In future work it may be desirable to move to a broader specification of outputs along the lines of Meyrick and Associates (2003) to better reflect the role of the network in delivering the potential to provide deliveries at different locations. This would require access to more detailed data than that currently available, including pipeline length by capacity.

The current Disclosure Data and Section 70E responses also include the basic input categories used by IPART (1999) of operations and maintenance expenses and capital. They do not include separate information on labour inputs as used in most US based studies such as PEG (2001). In this case labour costs are subsumed within operating and maintenance expenditure, a more appropriate treatment where levels of contracting out vary substantially between utilities.

As with the electricity lines business Disclosure Data discussed in Meyrick and Associates (2003), while the quality of the data has improved over time, there is scope for considerable improvement in both the consistency of the gas data and the detail provided in some categories. For instance, while the direct and indirect costs reported in the Disclosure Data include broad definitions of operating and maintenance expenditure, inquiries indicated that some of the gas distributors are including some capital costs in these Disclosure items. For this variable we have used Section 70E information to obtain a higher degree of consistency and ensure that no capital related costs are included. The coverage of the Disclosure Data for efficiency study purposes would be improved by including data on energy supplied and revenue received by customer type – residential, commercial and industrial – and peak demand information such as peak day energy sent out. Further disaggregation of operations and maintenance expenditure data is also required to facilitate direct comparisons with overseas data.

It should also be noted that data for two of the New Zealand distributors – Powerco and Wanganui Gas – include metering activities. It has not been possible to exclude these activities on a robust basis in the time available. Consequently, these two distributors will be somewhat disadvantaged relative to other distributors who do not undertake metering activities.

The final approvals by jurisdictional regulators in Australia present data for the Australian pipelines on a building blocks basis. Information is presented on forecast revenue, throughput, non-capital (operating and maintenance) costs, the initial capital base and roll forward. Additional information required but not presented in the final approvals is sourced from the AAIs. The data used for the Australian gas utilities covers only the regulated activities. In some cases, data relating to large industrial users whose supply is not regulated is not included. Inclusion of this data would require access to information not generally in the public domain and has been beyond the timeframe of this study.

Despite the existence of a National Gas Code, the amount of detail provided by both the regulators and the utilities differs and data is typically not drawn together in the one location. Some differences remain in the coverage of distribution activities across states although this is now more consistent than in earlier years with metering activities generally allocated to retail businesses.

In many cases the jurisdictional regulators' final approvals have used data substantially different from that presented by the utilities in their initial AAIs. Only a few jurisdictions have required the utilities to supply revised AAIs consistent with the final approvals. We have decided to use the final approval information as the most consistent and objective source of information available. While we have used the latest available information, in some cases the data relating to 2003 is forecast from a number of years out and may differ from the actual results for 2003. Confirming the accuracy of the forecasts would require detailed input from the relevant businesses.

While the publicly available data used in this study is broadly consistent and provides a reasonably accurate picture of the utilities' operations, more input from the utilities themselves is required to ensure complete consistency. Consequently, the results of the comparative benchmarking presented here should be considered as broadly indicative rather than as definitive.

4.1 Output and input definitions

The distribution productivity analyses reported in section 5 of the report contain two outputs and two inputs.

Output quantities

Throughput: The quantity of the distributor's throughput is measured by the number of terajoules of gas supplied.

Connections: Connection dependent and customer service activities are proxied by the distributor's total number of customers.

Output weights

To aggregate the two outputs into an aggregate output index we use the cost elasticity shares from the PEG (2001) translog cost function estimated for US gas distributors. This produces a throughput share of 14 per cent and a share for customer numbers of 86 per cent. The US information is used as there are insufficient observations available to undertake robust econometric estimation using the Australasian database.

Input quantities

Operating expenditure: The quantity of the distributor's operating expenses is proxied by its operating and maintenance expenditure (excluding all capital costs) to capture purchases of actual labour, materials and services used in operating the pipelines business. As all the data relates to a common financial year, there is no need to deflate the values by a price index. Australian dollars are converted to New Zealand dollars using the OECD (2004) average purchasing power parity for 2002 and 2003.

Capital: In most cases the quantity of capital input is proxied by the kilometres of mains. As we are only using the most recent year's data where revaluation problems will be at a minimum, in some models we use the ODV of fixed assets for the New Zealand businesses and the depreciated optimised replacement cost (DORC) for the Australian businesses as an alternative measure. In our earlier electricity lines business study using an asset value based proxy for the capital quantity was not feasible due to the extensive revaluations undertaken, implied depreciation profile assumptions aside.

Input weights

The value of total costs is formed by summing the estimated value of operating expenditure and 12.5 per cent of total ODV. We follow Meyrick and Associates (2003) and NZIER (2001) in assuming a common depreciation rate of 4.5 per cent and an opportunity cost rate of 8 per cent for capital assets. Input weights were then formed from the share of the cost of each of the inputs in total cost. The average share of operating expenditure in total cost for the sample of 14 distributors was 31 per cent.

Transmission data

For transmission we again have two outputs: throughput and system capacity. As indicated in section 3, it is essential to have a measure of pipeline capacity incorporating both delivery capacity and length dimensions. Most Australian regulators require pipelines to supply a maximum feasible capacity estimate in terajoules per day. This can then be multiplied by pipeline length to form the desired measure. However, there appears to be some debate over what constitutes maximum feasible terajoules per day and this figure is not available for some transmitters, including NGC Transmission. For those pipelines where this information is not available we have used observed peak demands instead. However, this capacity measure remains imperfect and we also use asset values as a proxy for system capacity in an alternate model. In the absence of any other information, the two outputs are weighted together using the PEG (2001) cost function weights used for distribution. That is, throughput receives a weight of 14 per cent while system capacity receives a weight of 86 per cent.

The same input specification is used for transmission pipelines as for distribution. The average share of operating expenditure in total cost for the sample of 8 transmitters was 23 per cent.

4.2 Distributors included in the study

Natural gas provides around 30 percent of New Zealand's primary energy requirements (Hodgson 2002). The Maui gas field dominates gas supply, contributing almost 80 percent of total annual production of 241 petajoules in 2001. Electricity generation (113 petajoules) and petrochemical production (88 petajoules) are the main components of gas demand. Gas–fired electricity generation has accounted for about 22 percent of total electricity generation over the period 1997 to 2000, but rises significantly in a dry year (eg in 2001 it rose to about 30 percent).

The database formed for the study includes 4 New Zealand and 10 Australian distributors. A brief summary of the operations of the included distributors follows.

New Zealand distributors

Natural Gas Corporation (NGC)

NGC distributes gas to around 30 towns and cities in the North Island. Based on data for 2003, it is the third largest distributor in terms of customer connections which were estimated to be [ ] residential customers and [ ] other customers – and the largest distributor measured in terms of gas supplied of 11,069 terajoules. NGC's distribution system comprises 2,739 kilometres of mains.

Powerco Limited

Powerco is based in New Plymouth (population of 49,500) and distributes gas in the upper central and lower central North Island. It is a dual gas and electricity operator, and is the largest gas distributor measured in terms of customer connections (Powerco 2003, p.3). Powerco's service area includes Taranaki, Wanganui (population of 40,000), Manawatu, Wairarapa, the Hutt Valley, Porirua (district population of 50,300), Wellington (population of 363,400) and Tauranga (population of 103,600).

Powerco acquired part of UnitedNetworks' gas operations in 2002 comprising the Hawkes Bay, Wellington, Horowhenua and Manawatu networks. In 2003 Powerco's gas distribution network was estimated as serving [ ] customers comprising [ ] residential customers and [ ] other customers. Gas supplied was [ ] terajoules using 3,820 kilometres of mains.

Wanganui Gas

Wanganui Gas supplies gas in Wanganui, Marton and Bulls. Wanganui, with an estimated population in 2003 of 40,000 (Statistics New Zealand), is the largest part of the distribution network. Using a distribution system of 354 kilometres of mains, in 2003 gas supplied was estimated to be 1,108 terajoules. The total number of customers was 10,921 including [ ] residential customers and [ ] other customers.

Vector Ltd

Vector Ltd operates the gas distribution network in Auckland, the most populous city in New Zealand (estimated population in 2003 of 1,199,300). Vector acquired the remaining part of UnitedNetworks' gas operations in 2002 comprising its Auckland network. In 2003, Vector supplied 10,670 terajoules to a total of 68,651 customers of which [ ] were residential customers and [ ] were other customers. The distribution network consists of 4,802 kilometres of mains.

Australian distributors

ACTEWAGL, Australian Capital Territory

ACTEWAGL is the main utility supplying gas and electricity in the Australian Capital Territory (ACT). The total number of households in the ACT in 2001 was 122,589 (ABS 2003). Gas is distributed to a predominantly residential population with Canberra the largest market. There are few industrial users of any significance. Canberra covers a large geographical area and the majority of urban development is low density. This results in a commensurately low density distribution network measured in terms of customer per kilometre of main and gigajoules supplied per customer. In 2003 ACTEWAGL's estimated number of customers was 90,908 of which 88,924 were residential customers. Gas supplied was estimated to be 6,950 terajoules. The distribution network comprises 3,410 kilometres of mains.

AGL Gas Networks (AGLGN), NSW

AGLGN distributes gas to Newcastle (population of 497,458 in 2002), north of Sydney, Sydney (population of 4,170,927 in 2002 and estimated number of households in 2001 of 1,503,663), and Wollongong, south of Sydney (population of 272,089 in 2002), along with several smaller population centres located between these larger markets and regional country centres in NSW. AGLGN has the largest distribution network and customer base of the Australian gas distributors.

In 2003 the total number of customers served was 892,919 comprising 892,454 residential customers and 465 other customers. The distribution network consists of 22,836 kilometres of mains with a total of 97,128 terajoules of gas supplied.

Envestra Albury, NSW

Envestra Albury operates in the large regional centre on the border of NSW and Victoria often referred to as Albury–Wodonga. In 2002 the population of the region was estimated to be 99,250 (ABS 2003). Gas is supplied to around 16,336 residential customers and 451 other customers from a distribution network of 341 kilometres of mains. Total gas supplied in 2003 was estimated to be 1,578 terajoules.

Country Energy, Wagga Wagga, NSW

Country Energy supplies gas to the city of Wagga Wagga (population of 52,533 in 2002) in southern regional NSW. A distribution network of 559 kilometres serves 16,657 residential customers and 215 other customers. Total gas supplied in 2003 was estimated to be 1,404 terajoules.

Envestra Victoria

Envestra Victoria serves the Melbourne gas market (population of 3,524,103 in 2002 and estimated number of households in 2001 of 1,316.935) along with Multinet and TXU Networks. Envestra Victoria also serves several areas in north central Victoria. As described by Envestra Victoria (2002, p.1) in their AAI, 'the Distribution System serves the northern, outer eastern and southern areas of Melbourne, Mornington Peninsula and rural communities in northern and north–eastern Victoria. The Distribution System is divided into three Zones – North, Central and Murray Valley.'

Melbourne's gas market is well established and cool to mild climatic conditions favour 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 2003, Envestra Victoria's estimated customer numbers were 464,566 comprising 452,054 residential customers and 12,512 other customers served by a distribution network of 7,943 kilometres of mains. Total gas supplied was estimated to be 38,526 terajoules.

TXU Networks, Victoria

TXU Networks delivers gas to over 450,000 customers across a geographically diverse region spanning 110,000 square kilometres and servicing the western half of Victoria, from the Hume highway in metropolitan Melbourne west to the South Australian border and from Bass Strait to Horsham and just north of Bendigo (TXU Networks 2002, p.45).

The estimated total number of customers in 2003 was 472,788 consisting of 459,732 residential customers and 13,056 other customers. Total gas supplied was estimated to be 40,038 terajoules. The distribution network comprises 8,281 kilometres of mains.

Multinet, Victoria

The Multinet distribution system covers the eastern and south–eastern suburbs of Melbourne extending over an area of approximately 1,600 square kilometres (Multinet 2002, p.68). In 2003 the estimated total number of customers served was 630,787 of which 614,024 were residential customers and 16,763 were other customers. The total quantity of gas supplied was 50,059 terajoules through a distribution network of 9,100 kilometres of mains. Multinet has the highest customer density of the Australasian distributors.

Allgas Energy Limited (Allgas), Queensland

Allgas supplies gas to consumers in several areas in and around Brisbane, Queensland, along with several regional areas. The Queensland Competition Authority (QCA 2001, p.40) states that, 'the Allgas distribution system is separated into four operating regions. These are:

- the Brisbane region (south of the Brisbane river);
- the Western region (including the townships of Toowoomba and Oakey);
- the South Coast region (including Surfers Paradise and Coolangatta); and,
- the Tweed Heads region in north east New South Wales.'

The network comprises 1,965 kilometres of low, medium and high pressure mains. About 68 per cent of the network is located in Brisbane, 19 per cent in the Western region and the remaining 13 per cent on the South Coast and Tweed Heads.

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 2001 the number of households in Brisbane was 642,212 (ABS 2003). The estimated total number of Allgas customers in 2003 was 58,904 with 57,295 residential customers and 1,609 other customers. More than 70 per cent of Allgas' gas demand of 9,660 terajoules was from large customers with annual consumption in excess of 10 terajoules (QCA 2001, p.40).

Envestra Limited (Envestra Queensland), Queensland

Envestra Queensland's distribution network can be divided into two regions:

- the Brisbane region (including Ipswich and suburbs north of the Brisbane river); and,
- the Northern region (serving Rockhampton and Gladstone).

The network consists of 2,068 kilometres of low, medium, high and transmission pressure mains. Assets used to service the Brisbane region comprise 89 per cent of the network with the balance of 11 per cent attributable to the Northern region (QCA 2001, p.41).

Envestra Queensland is subject to the same climatic influences on residential gas demand as is Allgas. Customer numbers are greater than those for Allgas but volumes are smaller with industrial volumes substantially less than Allgas'. In 2003 total customer numbers were estimated to be 73,736 comprising 68,756 residential customers and 4,980 other customers. Total gas supplied was around 4,836 terajoules.

Envestra SA, South Australia

Envestra SA's distribution network services the Adelaide (including the Barossa Valley), Peterborough, Port Pirie, Riverland, South–East and Whyalla Regions (Envestra SA 2002, p.1). Adelaide's population in 2002 was 1,114,285 and the estimated number of households in 2001 was 454,467. As with Melbourne, Adelaide's winter climate is conducive to relatively high residential gas demand for heating.

In 2003 it was estimated that the Envestra SA distribution network of 6,897 km of mains served 339,881 residential customers and 8,363 other customers. Estimated total gas supplied in 2003 was 28,666 terajoules.

4.3 Transmission pipelines included in the study

The database formed for the study includes one New Zealand and 7 Australian gas transmitters. A brief summary of the operations of the included transmitters follows.

New Zealand

NGC Transmission

NGC Transmission is the sole operator of New Zealand's 2,187 kilometres of transmission pipelines (excluding the Maui Development Ltd pipeline to Huntly) and conveyed around 93,000 terajoules of gas in 2003. From the Maui and Kapuni gas fields near New Plymouth NGC's transmission lines extend north to Auckland and further north to Whangarei. From Kihikihi another pipeline extends eastwards to service Tauranga, Rotorua, Taupo and Gisborne. Another pipeline system extends south from the New Plymouth area to service Wanganui and Wellington. A lateral pipeline extends eastwards from this pipeline to service Palmerston North and Hastings.

Australian transmitters

EAPL Moomba to Sydney

The Moomba to Sydney natural gas pipeline system, owned and operated by East Australian Pipeline Limited (EAPL) comprises the 1,299 kilometre, 864 mm diameter pipeline from

Moomba in outback South Australia to Wilton (south–west of Sydney) as well as smaller diameter, lateral pipelines serving Wagga, Culcairn, Griffith, Canberra and Lithgow. The pipeline system's total length in 2003 was 2,025 kilometres and it conveyed around 96,000 terajoules of gas.

Epic Moomba to Adelaide

The Moomba to Adelaide pipeline was commissioned in 1969 and runs 1,056 kilometres from the Moomba gas field in outback South Australia to Adelaide. In 2003 it conveyed around 83,000 terajoules of gas. The pipeline has lateral offtakes to the industrial centres of Port Pirie and Whyalla, and to Murray Bridge and the Riverland area in south–eastern South Australia.

APT Central West (NSW)

The Central West pipeline runs from Marsden on the Moomba to Sydney pipeline to the NSW regional centre of Dubbo (population around 40,000), a length of 255 kilometres. The pipeline was commissioned in 1998 after its construction was funded in part by a grant from the Federal Government to the Orana Regional Economic Development Organisation. In 2003 the pipeline conveyed around 1,200 terajoules of gas. The pipeline also serves the smaller towns of Forbes, Parkes and Narromine.

Envestra Riverland (South Australia)

The Riverland pipeline was constructed in 1995 and originates at the end of Epic's Angaston lateral which runs off the Moomba to Adelaide Pipeline. The Riverland Pipeline runs in a generally easterly direction from Angaston to Berri (the centre of a large fruit growing area), with a spur line running south from Sedan to Murray Bridge. The Mildura pipeline also interconnects with the Riverland pipeline. The total length of the Riverland pipeline is 237 kilometres and in 2003 it conveyed 544 terajoules of gas.

GasNet and VENCorp (Victoria)

GasNet operates the Victorian gas transmission system comprising 1,933 kilometres with injection points at Longford (near Bass Strait), Culcairn in southern NSW (an interconnect with the Moomba to Sydney pipeline), Port Campbell in south–west Victoria and a liquefied natural gas plant at Dandenong in eastern Melbourne. In 2003 the system conveyed over 216,000 terajoules of gas. VENCorp is the independent operator of the Victorian gas market.

NT Gas Amadeus Basin to Darwin (Northern Territory)

The Amadeus Basin to Darwin pipeline transports gas from the Palm Valley and Mereenie gas fields in central Australia to Darwin. The pipeline is fully contracted until 2011, with the majority of gas transported (99.7 per cent) used in the generation of electricity, principally at

Channel Island near Darwin. The pipeline was commissioned in 1986 and subsequent laterals were built to fuel the power station at the McArthur River mine near the Gulf of Carpentaria in 1995, to supply gas to industrial users in the Darwin environs in 1996 and to fuel the power station at the Mt Todd mine in 1996 although this mine has subsequently ceased operations. The pipeline is 1,513 kilometres in length and in 2003 conveyed around 17,000 terajoules of gas.

Goldfields (Western Australia)

The Goldfields pipeline was commissioned in 1996 to supply gas from the Pilbara region in north–west Western Australia to the major goldfields region surrounding Kalgoorlie and Kambalda in the south of the state. The pipeline also serves remote mine sites at Newman, Mt Keith and Leinster along its total length of 1,378 kilometres. In 2003 it conveyed over 26,000 terajoules of gas. The gas is used principally to fuel power stations at mine sites.

5 DISTRIBUTION RESULTS

While there are several alternative methods available to compare cost efficiency, the limited number of observations available for gas distributors in Australia and New Zealand restrict the techniques usable in practice to indexing methods. In this study we use the multilateral TFP index method for 2003 data on a total of 14 gas distributors. This indexing method is described in the following section. We then go on to examine some of the key characteristics of the distributors before examining a range of partial productivity measures and the more comprehensive TFP measure. Finally, we examine the scope to adjust for key operating environment differences beyond that incorporated in the index specification.

5.1 Total factor productivity indexes

Total factor productivity indexes are one of the methods most commonly used to measure cost efficiency. A TFP index is generally defined as the ratio of an index of output growth divided by an index of input growth. Growth rates for individual outputs and inputs are weighted together using revenue and cost shares, respectively. In other words, the TFP index is essentially a weighted average of changes in output quantities relative to a weighted average of changes in input quantities. TFP indexes have a number of advantages including:

- indexing procedures are simple and robust;
- they can be implemented when there are only a small number of observations;
- the results are readily reproducible;
- they have a rigorous grounding in economic theory;
- the procedure imposes good disciplines regarding data consistency; and
- they maximise transparency in the early stages of analysis by making data errors and inconsistencies easier to spot than using some of the alternative techniques.

For benchmarking purposes in the gas inquiry where the main focus is on cross sectional comparisons and there is no natural ordering of the data as is the case with time–series comparisons for the one organisation, we need to use multilateral TFP indexing methods. These indexes allow the comparison of productivity levels across firms as well as productivity growth rates over time (where time–series data are available) which are invariant regardless of the ordering of the observations in the sample. Meyrick and Associates (2003) have recently used the multilateral TFP method to estimate the cost efficiency of New Zealand electricity distributors.

Traditional measures of TFP (such as the Tornqvist index) have enabled comparisons to be made of rates of change of productivity between organisations but have not enabled comparisons to be made of differences in the absolute levels of productivity in either cross–section or combined time–series, cross–section data. This is due to the failure of conventional TFP measures to satisfy the important technical property of transitivity. This property states that direct comparisons between observations *m* and *n* should be the same as indirect comparisons of *m* and *n* via the intermediate observation *k*. In practical terms, this means that with cross–sectional data we should get the same relative result between two utilities regardless of the ordering of the data.

Caves, Christensen and Diewert (1982) developed the multilateral translog TFP index measure to allow comparisons of the absolute levels as well as growth rates of productivity. It satisfies the technical properties of transitivity and characteristicity which are required to accurately compare TFP levels within both cross–sectional and panel data. Lawrence, Swan and Zeitsch (1991) and the Bureau of Industry Economics (BIE 1996) have used this index to compare the productivity levels and growth rates of the five major Australian state electricity systems and the United States investor–owned system. Zeitsch and Lawrence (1996) use the method to compare the efficiency of electricity generation plants in the United States, Canada and Australia.

The Caves, Christensen and Diewert (CCD) multilateral translog index is given by:

(1)
$$\begin{aligned} \log (TFP_m/TFP_n) = \; & \textstyle\sum_i (R_{im}+R_i^*) (\log Y_{im} - \log Y_i^*)/2 - \\ & \textstyle\sum_i (R_{in}+R_i^*) (\log Y_{in} - \log Y_i^*)/2 - \\ & \textstyle\sum_j (S_{jm}+S_j^*) (\log X_{jm} - \log X_j^*)/2 + \\ & \textstyle\sum_j (S_{jn}+S_j^*) (\log X_{jn} - \log X_j^*)/2 \end{aligned}$$

where R_i^* (S_j^*) is the revenue (cost) share averaged over all utilities and time periods and $logY_i^*$ ($log\ X_j^*$) is the average of the log of output *i* (input *j*). Using equation (3) comparisons between any two observations *m* and *n* will be both base–utility and base–year independent. Transitivity is satisfied since comparisons between the utilities A and B will be the same regardless of whether they are compared directly or via, say, utility C. An alternative interpretation of this index is that it compares each observation to a hypothetical utility with output vector $log\ Y_i^*$, input vector $log\ X_j^*$, revenue shares R_i^* and cost shares S_j^*, ie the geometric mean of the sample.

With the index number multilateral TFP approach there is scope to capture some operating environment conditions in the specification of outputs. For example, by choosing multiple outputs such as energy delivered, system capacity and customer numbers, it is possible to incorporate aspects of density such as customers per kilometre and energy delivered per customer into the multilateral TFP measure. However, since no consistent measure of system capacity is available for the gas distributors, in–built operating environment adjustments will be limited to energy density. The limited number of observations available means it is not possible to undertake robust econometric adjustments for operating environment differences. However, we do undertake some proxy adjustments to allow for differences in customer density.

Like any quantitative method, TFP indexes have limitations as well as advantages. These include the fact that they are a non–parametric technique and, hence, cannot produce confidence intervals and other statistical information, the need to aggregate heterogeneous outputs and inputs and the need to estimate the annual physical input and cost of capital goods.

5.2 Characteristics of the distributors

Despite operating in broadly similar climatic and geographic environments, the distributors vary widely in the key size and density characteristics presented in table 1.

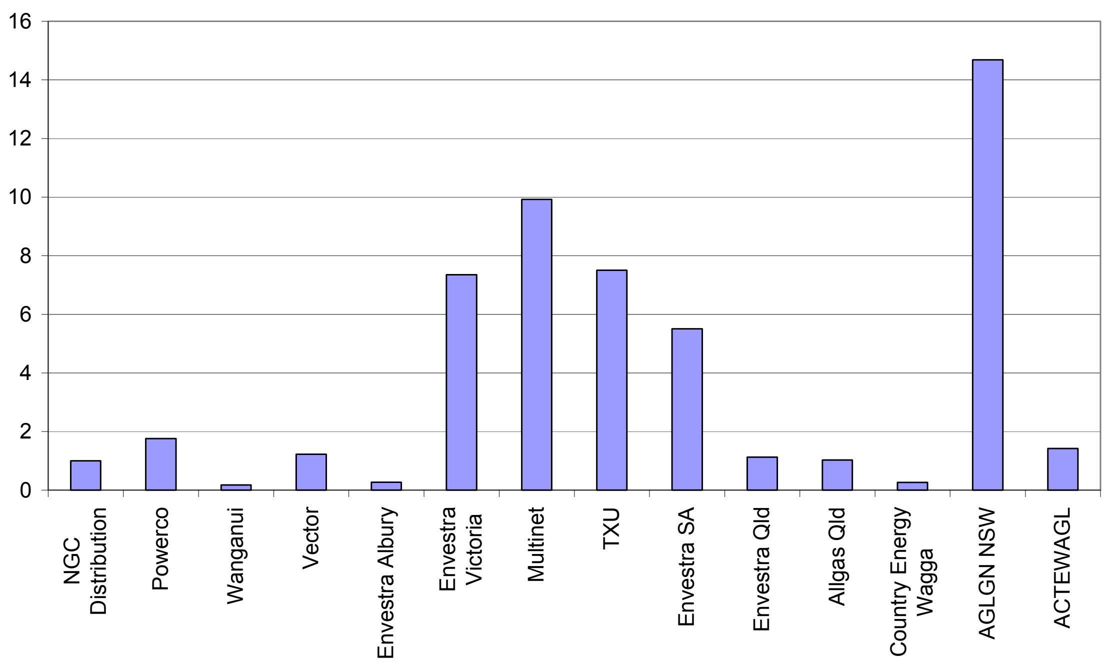
Table 1: **Key characteristics of the distributors, 2003**

Distributor	*Output index*	*Density GJ/Customer*	*Density Customers/km*	*Density TJ/km*	*O&M/km $*	*ODV/KM $*
NGC Distribution	1.000	197.8	20.4	4.0	[ ]	46,374
Powerco	1.759	[ ]	[ ]	[ ]	[ ]	[ ]
Wanganui	0.178	101.4	30.9	3.1	2,777	50,811
Vector	1.230	163.5	14.1	2.3	3,406	[ ]
Envestra Albury	0.270	94.0	49.3	4.6	3,754	80,642
Envestra Victoria	7.354	82.9	58.5	4.9	4,966	95,558
Multinet	9.923	79.4	69.3	5.5	5,260	97,696
TXU	7.506	84.7	57.1	4.8	5,587	102,921
Envestra SA	5.507	82.3	50.5	4.2	5,761	113,632
Envestra Qld	1.129	65.6	35.7	2.3	5,479	106,085
Allgas Qld	1.031	169.6	30.0	5.1	4,459	124,719
CE Wagga	0.267	83.2	30.2	2.5	3,795	77,145
AGLGN NSW	14.681	108.8	39.1	4.3	4,458	79,474
ACTEWAGL	1.423	76.5	26.7	2.0	2,917	68,649

Source: Meyrick and Associates gas utility database

As illustrated in figure 1, the major NSW, Victorian and South Australian distributors are several times larger than the other utilities using the output index based on throughput and customer numbers. The three main New Zealand distributors - NGC Distribution, Powerco and Vector – are of broadly similar size and each much larger than Wanganui Gas which is less than 20 per cent the size. AGLGN is around 15 times larger than NGC Distribution and nearly half as big again as the next largest distributor, Multinet. However, the three Melbourne-based distributors combined are around 70 per cent larger than AGLGN reflecting the importance of gas as an energy source in Victoria. Envestra SA is around 40 per cent the size of AGLGN but over five times larger than NGC Distribution. The two Queensland gas distributors are of comparable size to NGC Distribution and Vector while ACTEWAGL lies around halfway between Vector and Powerco. The two small NSW distributors - Envestra Albury and Country Energy Wagga – are around half as large again as the very small Wanganui Gas.

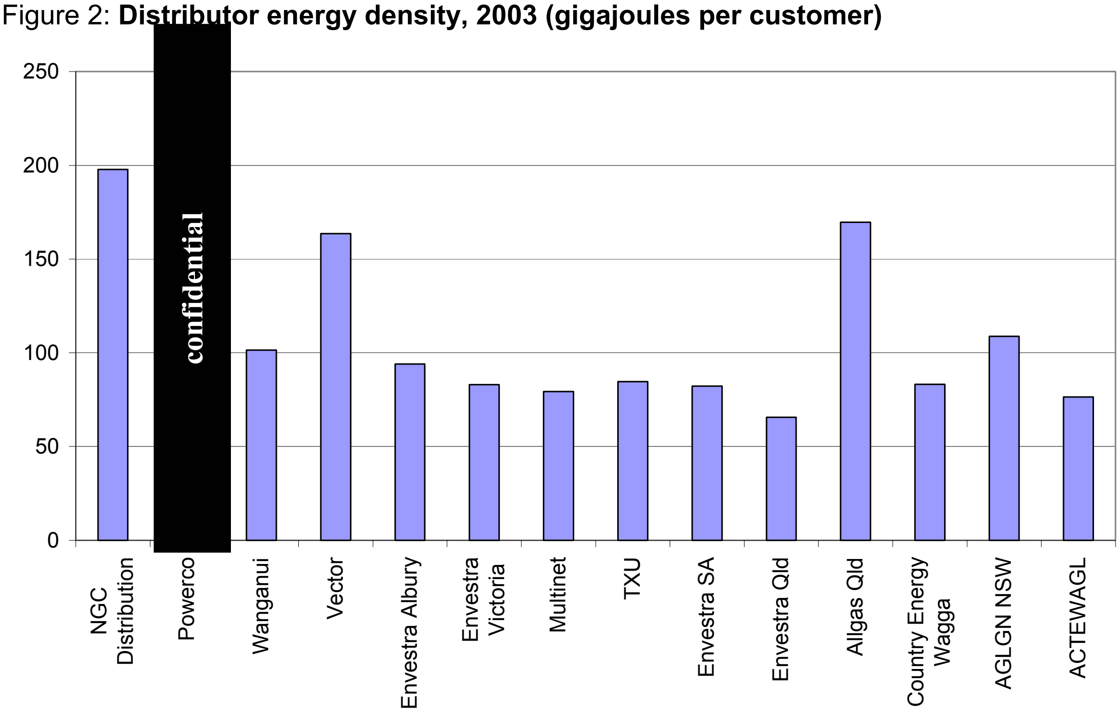
Figure 1: **Distributor output indexes, 2003**



Source: Meyrick and Associates gas utility database

The energy densities presented in figure 2 show that with the exception of three distributors – NGC Distribution, Vector and Allgas Queensland – the average consumption per customer is relatively uniform. These three distributors have substantially higher average consumption per customer reflecting the likely relative importance of a few large industrial customers relative to their smaller residential customer bases. The three large Victorian distributors, on the other hand, have average energy density figures overall despite a high degree of industrial usage reflecting the more intensive domestic use of gas in Victoria as a space heating source. Powerco, which has the lowest energy density of the New Zealand distributors, still has higher energy density than all but three of the Australian distributors again reflecting the relatively low penetration of gas in New Zealand for domestic space heating use. ACTEWAGL has the second lowest energy density reflecting the relative lack of an industrial base in its service territory. Envestra Queensland has the lowest energy density reflecting its smaller industrial base relative to Allgas Queensland and the low use of gas for domestic heating in Queensland.

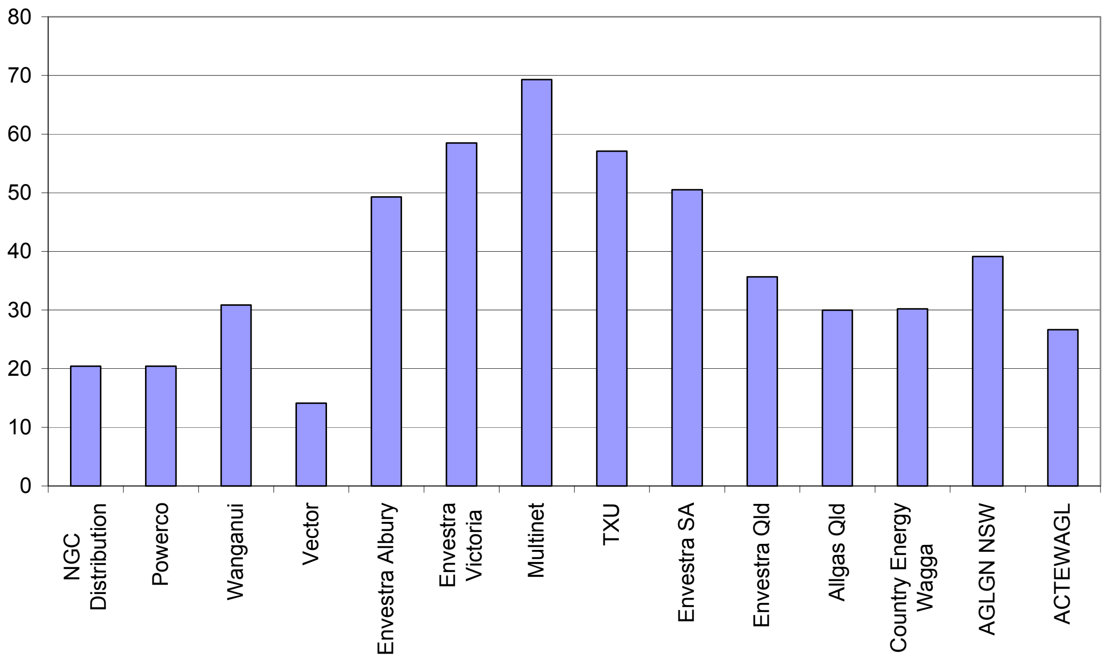
Figure 2: **Distributor energy density, 2003 (gigajoules per customer)**



Source: Meyrick and Associates gas utility database

From figure 3 we see that the New Zealand distributors generally have lower customer densities than their Australian counterparts. Wanganui Gas has the highest customer density of the New Zealand distributors at 30 customers per kilometre. This is around [ ] per cent higher than those for NGC Distribution and Powerco and around double that for Vector. Wanganui's higher density probably stems from its history of having previously had town gas with associated higher rates of domestic penetration and its compact service area. Vector's lower density, on the other hand, probably reflects Auckland's milder climate and lower domestic penetration rates. Wanganui's customer density is, however, roughly equal to the three lowest Australian customer densities – those of Allgas Queensland, Country Energy Wagga and ACTEWAGL. Allgas has relatively low domestic penetration rates while Wagga and Canberra are both very spreadout, low density cities. The three Victorian distributors have the highest customer densities with Multinet having over twice Wanganui's density at around 70 customers per kilometre. Envestra Victoria and TXU follow closely behind with just under 60 customers per kilometre. Envestra SA and Envestra Albury each have around 50 customers per kilometre, the latter despite its small size. All else equal, a higher customer density will allow the distributor to operate more efficiently as a smaller volume of inputs are required to deliver a given quantity of gas to a given number of customers.

Figure 3: **Distributor customer density, 2003 (customers per kilometre)**



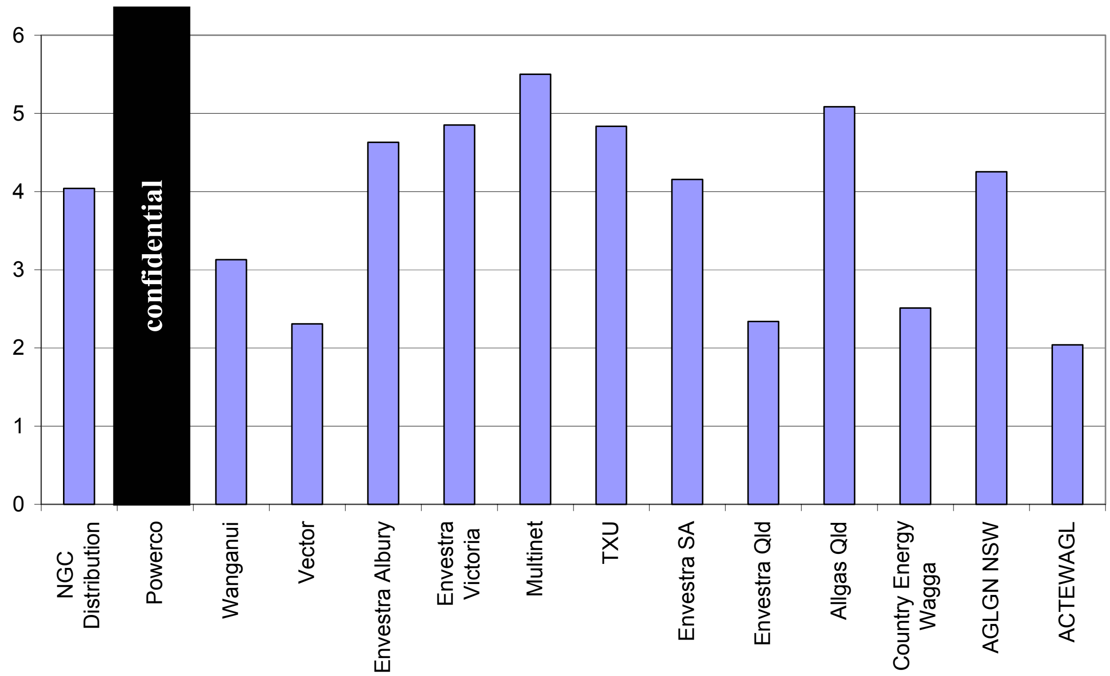
Source: Meyrick and Associates gas utility database

A final density measure – throughput per kilometre – is presented in figure 4. This is a combination of the previous two density measures and follows a similar pattern to customer density except for those distributors with unusual energy densities. Consequently, NGC Distribution and Allgas Queensland perform well on this measure due to their high energy densities but Vector's high energy density is offset by its very low customer density. AGLGN has a higher throughput density due to its above average energy and customer densities.

5.3 Distributor partial productivities

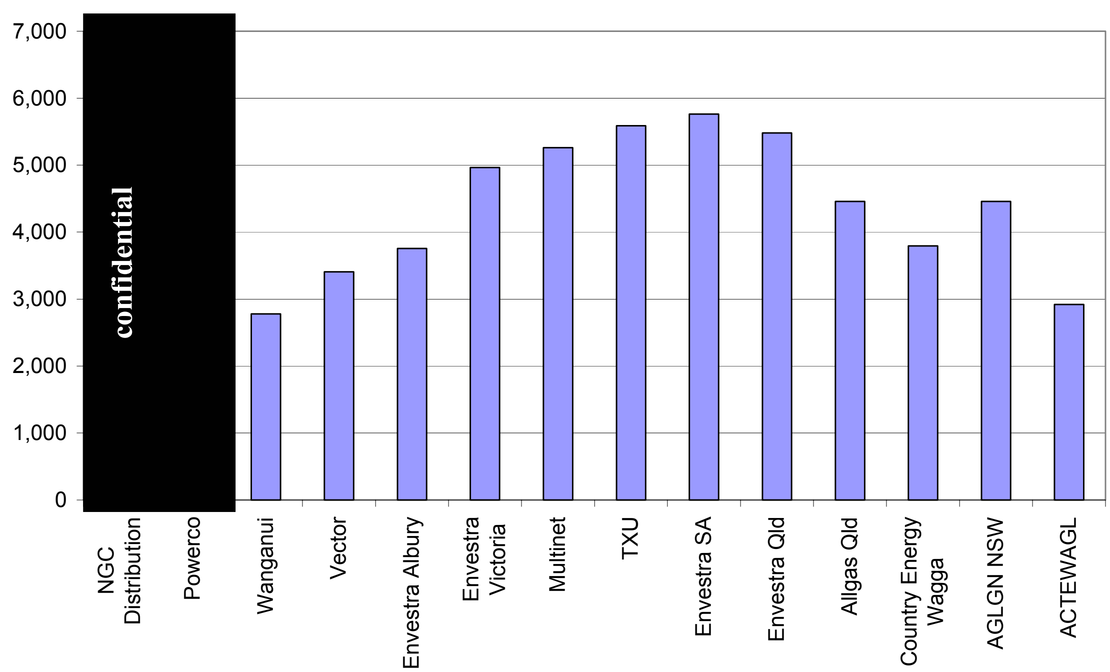
Before looking at the comprehensive measures of cost efficiency, we will examine two commonly used cost measures and the partial productivity measures relating to operating expenditure and capital.

Figure 4: **Distributor throughput density, 2003 (terajoules per kilometre)**



Source: Meyrick and Associates gas utility database

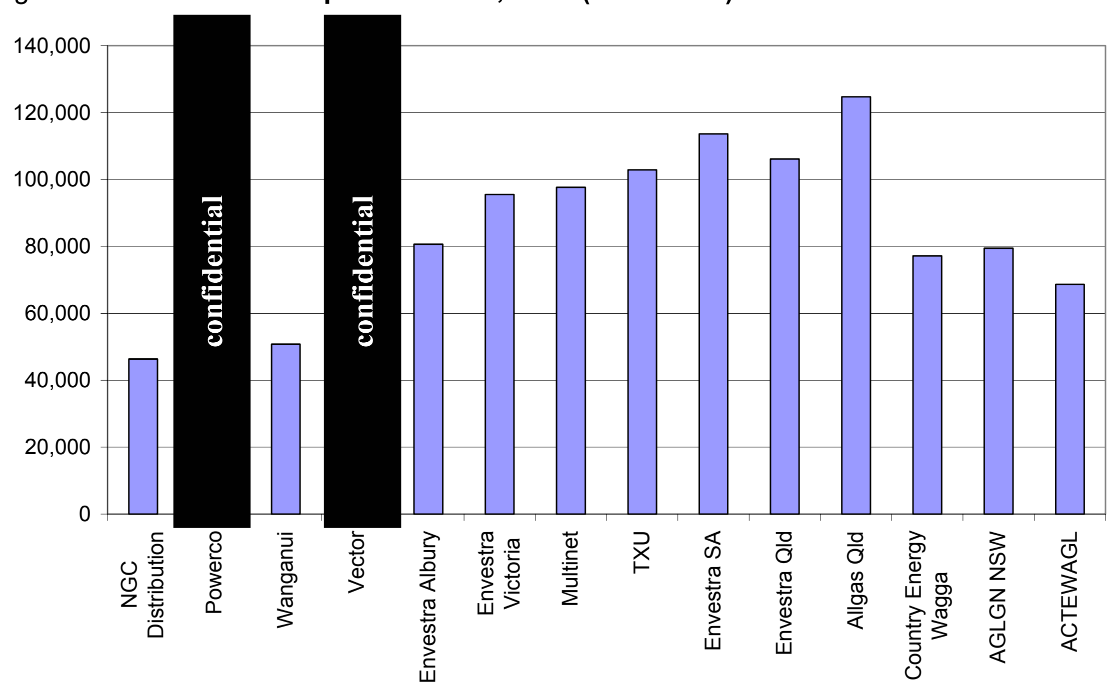
Figure 5: **Distributor operating expenditure per kilometre, 2003 (NZ dollars)**



Source: Meyrick and Associates gas utility database

Operating expenditure per kilometre of main is presented in figure 5 and table 1. The New Zealand distributors generally have lower operating expenditure per kilometre compared to the Australian distributors. Wanganui Gas has the lowest reported operating expenditure per kilometre at $2,777, marginally ahead of ACTEWAGL at $2,917. [ ] These are followed by the two small NSW distributors, Envestra Albury and Country Energy Wagga. [ ] Envestra SA has the highest operating expenditure per kilometre at $5,761. The throughput weighted average operating expenditure per kilometre for the New Zealand distributors is $3,650 compared to the Australian weighted average of $4,940. This difference will in part reflect the lower customer density of the New Zealand industry as having more customers per kilometre will involve more offtakes, more maintenance and more customer service expenditure.

Figure 6: **Distributor ODV per kilometre, 2003 (NZ dollars)**



Source: Meyrick and Associates gas utility database

In figure 6 and table 1 we present the capital asset values per kilometre of main. For the New Zealand distributors asset values are represented by the optimised deprival value (ODV) while for the Australian distributors an analogous figure is generally the depreciated optimised replacement cost (DORC). In most instances these valuation bases will give equivalent figures. The New Zealand distributors have considerably lower ODV per kilometre values than do the Australian distributors. The throughput weighted average New Zealand figure is $41,744 per kilometre compared to the equivalent Australian figure of

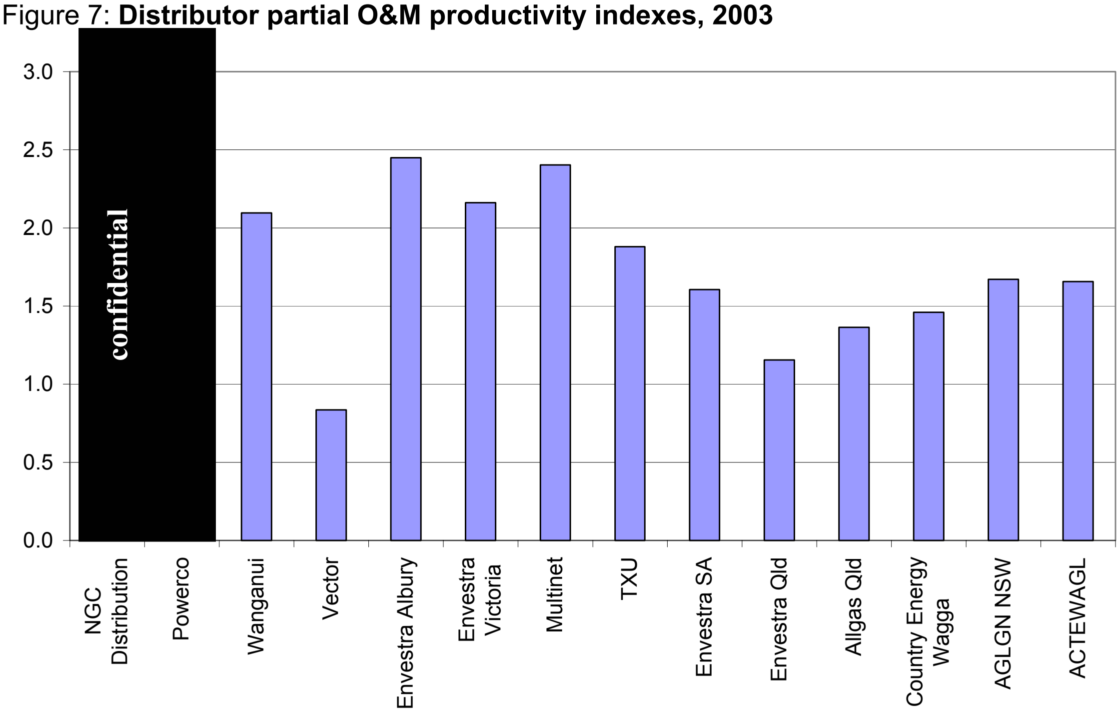
$93,637 per kilometre. That is, the Australian systems have a per kilometre asset value of over twice that of the New Zealand utilities. This could be explained by a number of factors. Firstly, the New Zealand systems could be considerably older than the Australian systems on average but this is not the case given that most of the New Zealand systems have been laid out over the last 25 years since the Maui gas field came on stream. Secondly, the Australian systems could be faced with considerably more difficult climatic and geographic operating environment conditions or face considerably tougher environmental regulations but again this is not the case given the similarities between the two countries. In fact, the New Zealand utilities are likely to face more demanding operating environment conditions and regulations due to the higher risk of earthquake damage in New Zealand.

The explanation for this sizable difference in asset values per kilometre lies instead in the differences in customer density between the two countries. Higher customer density systems are more expensive per kilometre of main because there have to be more offtake points and small lines running into customers' premises than is the case with a less dense system. The Australian distributors with the lowest customer densities (ACTEWAGL and Country Energy Wagga) also have the lowest asset values per kilometre of the Australian systems. Allgas Queensland is an exception to this as despite having one of the lowest customer densities in Australia it also has the highest asset value per kilometre. This can be explained by it having the highest energy density of the Australian systems with a correspondingly high cost per kilometre associated with larger pipelines required to supply its large industrial customers. Allgas does not have a large residential base to offset the higher unit cost of supplying industrial customers.

In figure 7 and table 2 we present the partial productivity indexes of operating and maintenance expenditure (O&M). A partial productivity index is formed by dividing the multilateral output index of throughput and customer numbers[1] by the quantity of one particular input, in this case that of operating and maintenance expenditure. [ ] Wanganui Gas, on the other hand, has the fourth highest partial O&M productivity. In terms of the throughput weighted averages, the Australian distributors' partial O&M productivity exceeds that of the New Zealand utilities by over 80 per cent.

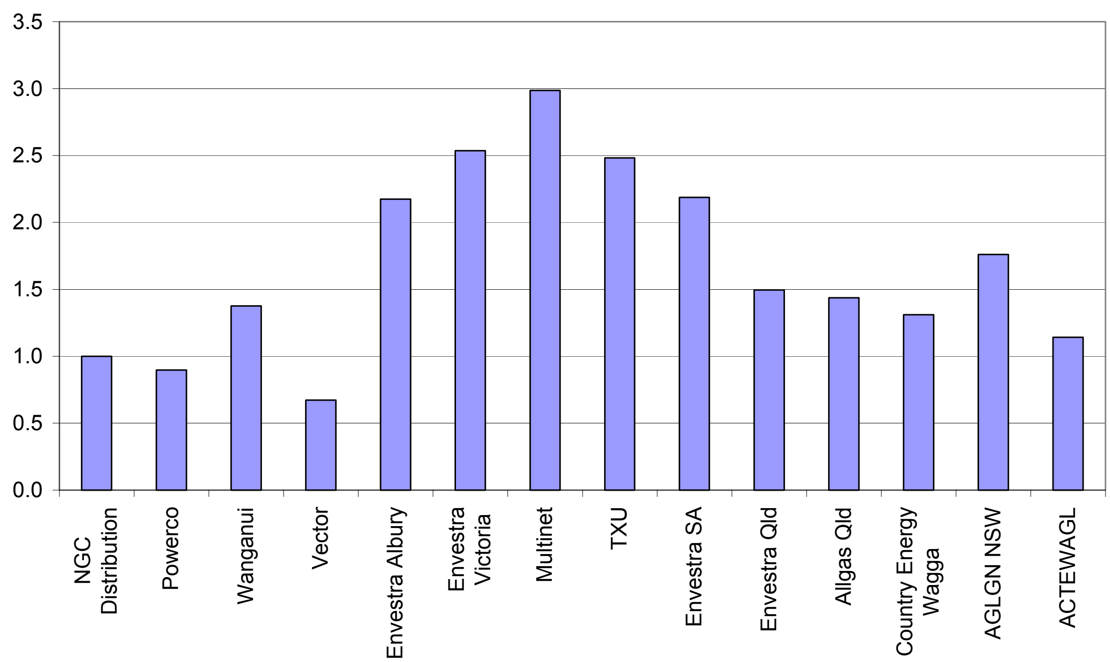
[1] Excluding the capacity component of output will tend to disadvantage the less customer dense networks on partial productivity comparisons as they do not receive any credit for their relatively longer systems.

Figure 7: **Distributor partial O&M productivity indexes, 2003**



Source: Meyrick and Associates gas utility database

Figure 8: **Distributor partial capital (kilometres) productivity indexes, 2003**



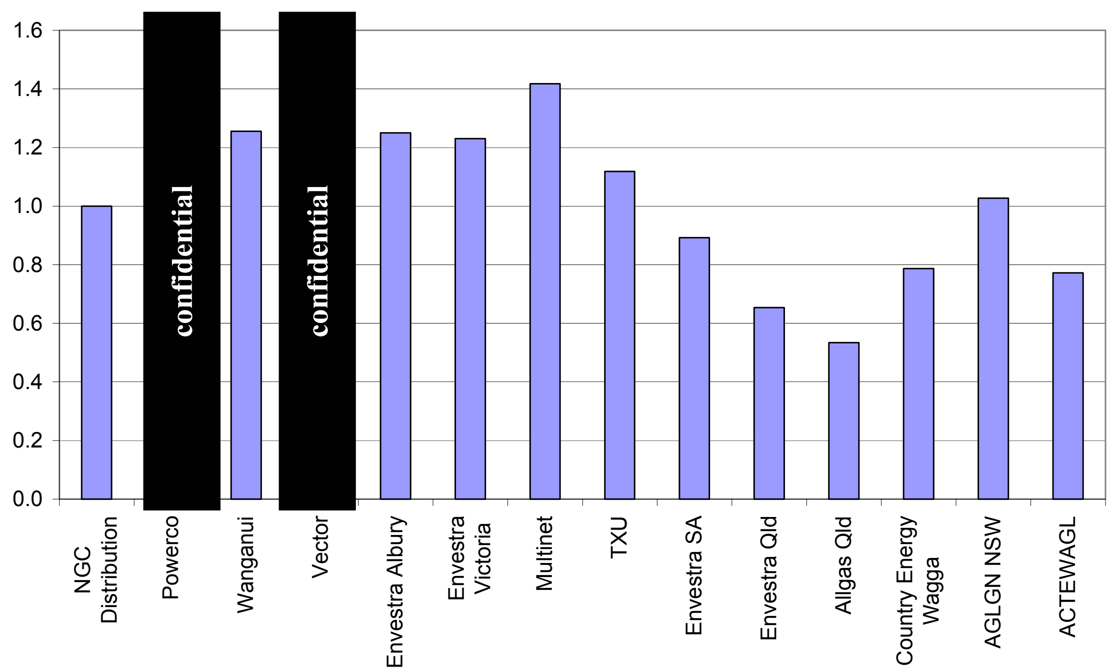
Source: Meyrick and Associates gas utility database

The partial productivity of capital (measured as kilometres of main) is presented in figure 8 and table 2. Distributors which have a high customer density do well on this measure as they are able to produce a high level of output for each kilometre they possess and there is no differentiation between the resources tied up in a kilometre of main in a high density network and that in a low density network. Consequently, the Victorian and South Australian distributors who have high customer densities have the highest partial capital productivities using this measure while the New Zealand distributors have the lowest partial productivities along with the lowest customer densities. On a throughput weighted average basis, the Australian distributors have around 150 per cent higher capital productivity than their New Zealand counterparts reflecting their higher customer densities which are a key driver of this measure.

The equivalent results using asset values as the measure of capital input are presented in figure 9 and table 2. Using this alternate measure of capital input quantity changes the partial productivity picture considerably. Wanganui Gas now has the second highest capital productivity [

] Multinet still has the highest capital productivity but by a much narrower margin than previously.

Figure 9: **Distributor partial capital (ODV) productivity indexes, 2003**



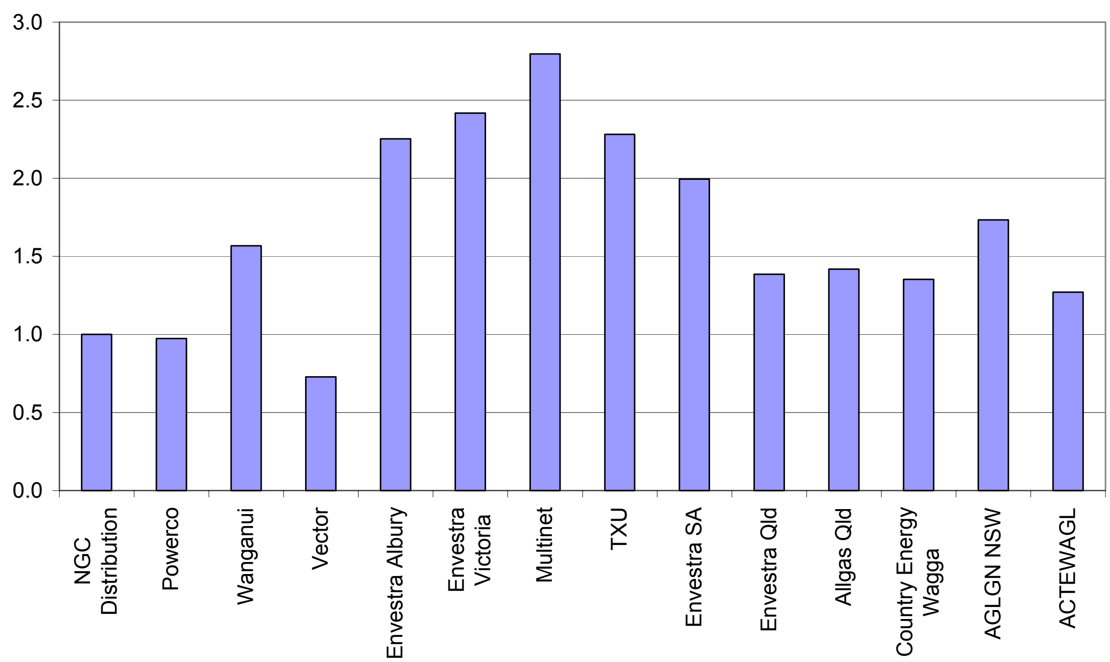
Source: Meyrick and Associates gas utility database

On a throughput weighted average basis, the Australian distributors now have only 14 per cent higher capital productivity than their New Zealand counterparts. The large reduction in the partial productivity gap occurs because of the recognition that networks with higher customer density use more resources per kilometre of main than less dense networks. In other words, the asset value based measure recognises that kilometres of main are not homogeneous.

5.4 Distributor total factor productivity

To examine distributor total productivity we need to form a comprehensive measure of inputs as well as the comprehensive output measure used in the preceding section. We start by forming a total input quantity index based on operating expenditure and kilometres of main in Model 1. The results of this model are presented in figure 10 and table 2. All of the Australian distributors are more efficient than the three larger New Zealand distributors on this measure. Wanganui Gas outperforms the two Queensland distributors, ACTEWAGL and Country Energy Wagga.

Figure 10: **Distributor total factor productivity indexes – Model 1, 2003**



Source: Meyrick and Associates gas utility database

The three large Victorian distributors, Envestra Albury and Envestra SA – all of which have relatively high customer densities – perform best on this measure. This can be explained by the relatively high weights which are given to customer numbers on the output side and kilometres of main on the input side. On a throughput weighted average basis, the Australian distributors have 128 per cent higher TFP using this specification than their New Zealand counterparts.

Table 2: **Distribution partial and total factor productivity indexes, 2003**

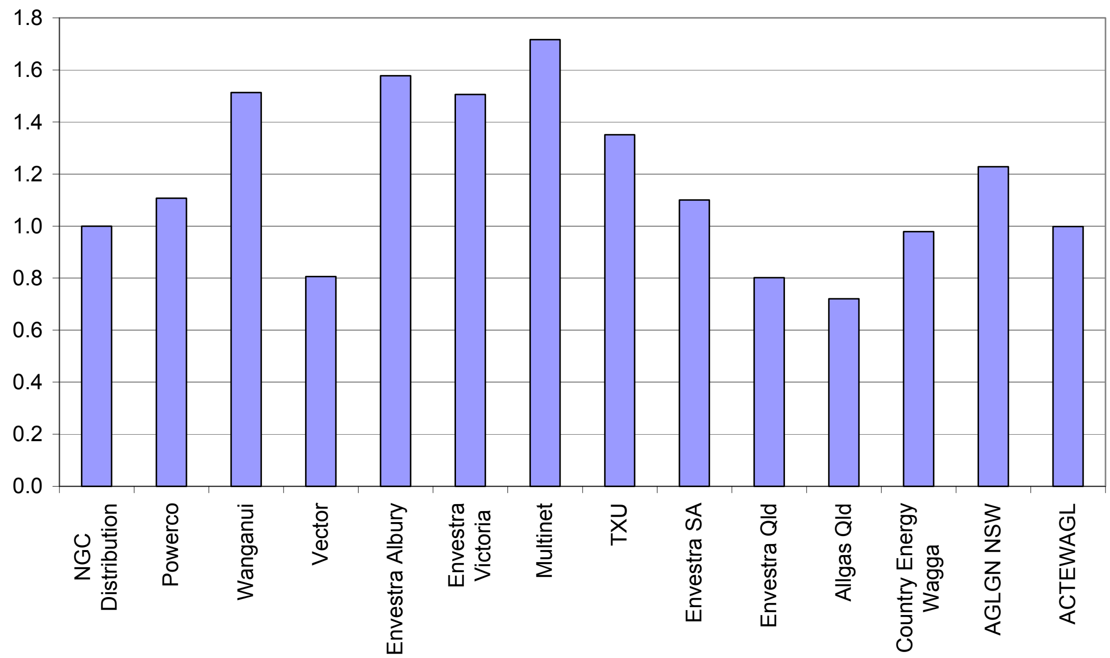
	Partial Productivities			*Total Factor Productivities*		
Distributor	*O&M*	*Kms*	*ODV*	*Model 1*	*Model 2*	*Model 3*
NGC Distribution	[ ]	1.000	1.000	1.000	1.000	1.000
Powerco	[ ]	0.898	[ ]	0.974	1.107	1.285
Wanganui	2.096	1.376	1.256	1.567	1.513	1.372
Vector	0.835	0.673	[ ]	0.727	0.806	0.934
Envestra Albury	2.450	2.173	1.250	2.252	1.578	1.406
Envestra Victoria	2.160	2.536	1.231	2.417	1.506	1.353
Multinet	2.403	2.987	1.418	2.796	1.716	1.387
TXU	1.880	2.483	1.119	2.281	1.351	1.302
Envestra SA	1.606	2.187	0.892	1.994	1.100	1.243
Envestra Qld	1.155	1.496	0.654	1.384	0.802	1.110
Allgas Qld	1.363	1.437	0.534	1.418	0.720	1.181
CE Wagga	1.460	1.309	0.787	1.353	0.978	1.206
AGLGN NSW	1.671	1.761	1.028	1.733	1.228	1.264
ACTEWAGL	1.657	1.143	0.772	1.270	0.998	1.259

Source: Meyrick and Associates gas utility database

As noted in the preceding section, the problem with Model 1 is that it implicitly treats kilometres of main as homogeneous whereas a kilometre of main in a network with high customer density will have more offtakes and consume more resources in construction than a kilometre in a low density network. While there will still be significant economies of density in a network with higher customer density, they will not be as large as this simple model implies. Consequently, to achieve a more accurate representation of underlying distributor cost efficiency we need to either recognise that kilometres of main are not homogeneous or else undertake further adjustment for operating environment conditions beyond management control. We examine both these options in the remainder of this section.

In Model 2 presented in figure 11 and table 2 we use the same output specification but now use operating and maintenance expenditure and asset values as the two input quantities. Changing to the asset value measure of capital input recognises that main kilometres are not homogeneous and, hence, goes part of the way to adjusting for differences in customer density but there will still be some residual density economies such as those related to operating and maintenance expenditure not captured by this model. As noted in section 4, depreciation profile issues aside, using asset values as a measure of the capital input quantity is feasible in this case because we are only using the most recent year's data and revaluation issues are much less of a problem than when using combined cross–section, time–series data as was the case with our earlier electricity lines businesses study.

Figure 11: **Distributor total factor productivity indexes – Model 2, 2003**



Source: Meyrick and Associates gas utility database

The effect of changing from kilometres to asset values as the measure of capital input is to compress the spread of TFP scores and to remove part of the disadvantage faced by less dense networks in Model 1 which treated all kilometres of main as being homogeneous. Wanganui Gas now comes in as the third most productive distributor and Powerco as the seventh. Vector is now the third least productive network ahead of the two Queensland distributors and NGC Distribution is in the equal fifth least productive. Multinet remains the most productive distributor but by a much narrower margin than in Model 1. On a throughput weighted average basis, the Australian distributors now have 35 per cent higher TFP than their New Zealand counterparts.

As noted in section 4, one approach to allowing for density differences is to incorporate a broader measure of output which covers system capacity as well as throughput and customer numbers. This was the approach adopted by Meyrick and Associates (2003) where a measure of electricity distribution system capacity was included as a third output. In that case system capacity was measured by MVA-kilometres, an engineering measure which takes account of the type of line construction and local climatic conditions to calculate a carrying capacity for the distributors' lines. The factors affecting the carrying capacity of gas mains are more straight forward but there is correspondingly less data available in the public domain. The capacity of a gas distribution system will be determined by the length of pipelines, their diameter or bore, the pressure of the system and type of pipeline (eg cast iron versus polyethylene). Unfortunately this level of detail is not available in the public domain in either New Zealand or Australia.

If system capacity data were available for gas distributors, incorporation of a third output would go a large part of the way towards allowing for customer density differences as well as the energy density differences already incorporated in the current output specification. Attempts to include asset value as a proxy for the capacity component on the output side proved unsuccessful as it produced results little different from Model 1. This arises from the correlation between asset value per kilometre and customer density which means that asset value is most likely picking up costs associated with customer connections rather than the overall capacity of the system per se. In the absence of information on system capacity in the public domain and the infeasibility of sourcing it directly from distributors in the timeframe of this study, we proceed to look at other means of adjusting for density differences in the next section.

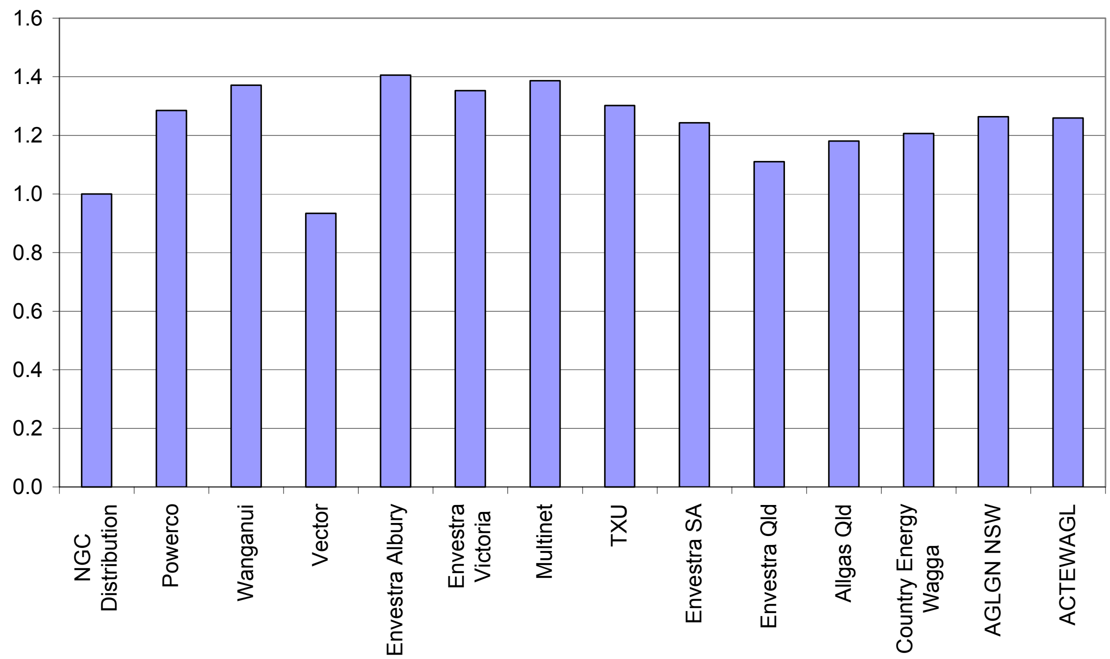
5.5 Adjusting for operating environment differences

The relatively small number of observations available on gas distributors in Australia and New Zealand limits the scope to undertake robust econometric adjustment exercises. However, a reasonable approximation can be made by making an adjustment to output and input data to place all distributors on a common density footing. We do this by adjusting output levels for each distributor to give them the same implied energy and customer densities as AGLGN, a distributor with around average energy and customer density for the sample. We start with TFP Model 1 which measures capital input by kilometres of main and calculate AGLGN's throughput per kilometre and customer numbers per kilometre. We then assume the other 13 distributors retain their existing numbers of mains kilometres but their outputs are changed to give them the same throughput per kilometre and customers per kilometre as AGLGN.

While the number of kilometres is held at its actual value for each distributor, input use will, of course, have to change to accommodate the hypothesised changed output level. We do this by assuming that operating and maintenance expenditure changes by a weighted average of the changes in throughput and customer numbers implied for each distributor. The weights used are the same as those used to form the output index which were derived from the PEG

(2001) cost function estimated using US data, ie 14 per cent for throughput and 86 per cent for customer numbers. It should be noted that this approach is likely to be conservative, as it does not allow for economies of size. If there are economies of size then operating and maintenance expenditure would change by less than the weighted average of the two output components. All else equal, this would provide an advantage to the smaller distributors. However, as we have no information on the extent of economies of size in the sample range, we assume there are constant returns to scale in the adjustment exercise. Consequently, the actual gap between the small distributors and larger ones on a fully like–with–like comparison basis are likely to be less than indicated here.

Figure 12: **Distributor adjusted total factor productivity indexes – Model 3, 2003**



Source: Meyrick and Associates gas utility database

The adjusted TFP results are presented in figure 12 and table 2 as Model 3. The effect of the adjustment process is to further compress the range of TFP scores. Wanganui Gas now comes in as the third most productive distributor on the adjusted basis behind Envestra Albury and Multinet, and Powerco as the sixth most productive behind Envestra Victoria and TXU. However, Vector and NGC Distribution perform less well on the adjusted basis coming in, respectively, as the least and second least productive overall. Envestra Queensland is the least productive of the Australian distributors on the adjusted basis. On a throughput weighted average basis, the Australian distributors now have 21 per cent higher TFP than their New Zealand counterparts.

The relativities between the distributors remain the same regardless of which distributor is chosen as the base for adjusting densities to. However, the scale of the gaps does change with the gaps being largest when using the distributor with the highest customer density (Multinet) as the base and the gaps being lowest when using the distributor with the lowest customer density (Vector) as base. On a throughput weighted average basis, the Australian distributors have between 5 and 32 per cent higher TFP than their New Zealand counterparts depending on which distributor's densities are used as the base. In the cost function efficiency analysis reported in Meyrick and Associates (2003), the dependency of the scores on the numeraire chosen was addressed by taking a weighted average of the results using all possible numeraires. In this case we adopt the simpler approach of taking a firm with around average densities as the numeraire.

In summary, making no allowance for customer density differences in Model 1 leads to the Australian distributors having over twice the observed productivity of the New Zealand distributors on average. Recognising that a kilometre of main in a more customer dense network will be more resource intensive than one in a less dense network (and that Model 1 thus overstates economies of density by a wide margin) reduces the observed gap between the New Zealand and Australian distributors to around 35 per cent on average in Model 2. This will be a partial adjustment for customer density differences as some residual density economies will remain unaccounted for. Undertaking a more comprehensive proxy adjustment for both customer and energy density differences in Model 3 leads to the productivity gap between the New Zealand and Australian distributors being further reduced to around 21 per cent.

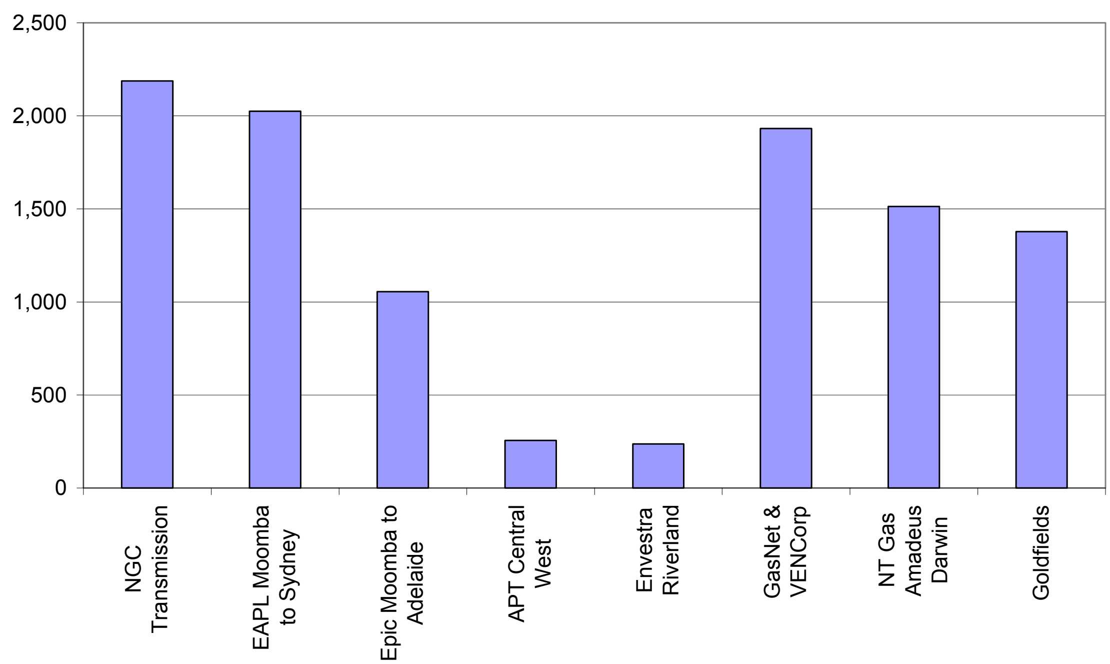
6 TRANSMISSION RESULTS

There have been very few cost efficiency studies undertaken of gas transmission pipelines. Those that have examined gas transmission tend to have combined transmission and distribution pipelines in the one sample (such as BIE 1994). Apart from the relatively small number of separate transmission firms, gas transmission pipelines tend to be quite different in their characteristics making it hard to compare them in a useful way. The existence of the access arrangements for transmission pipelines in Australia under the jurisdiction of the federal regulator gives us an opportunity to make a start on performance measurement in this area. In this section we start by looking at the key characteristics of NGC Transmission and the 7 Australian transmitters included in this study before moving on to look at partial productivity measures and alternative TFP measures.

6.1 Characteristics of the transmitters

The key output and density characteristics of the 8 included transmission pipelines are presented in table 3 while pipeline lengths are depicted in figure 13.

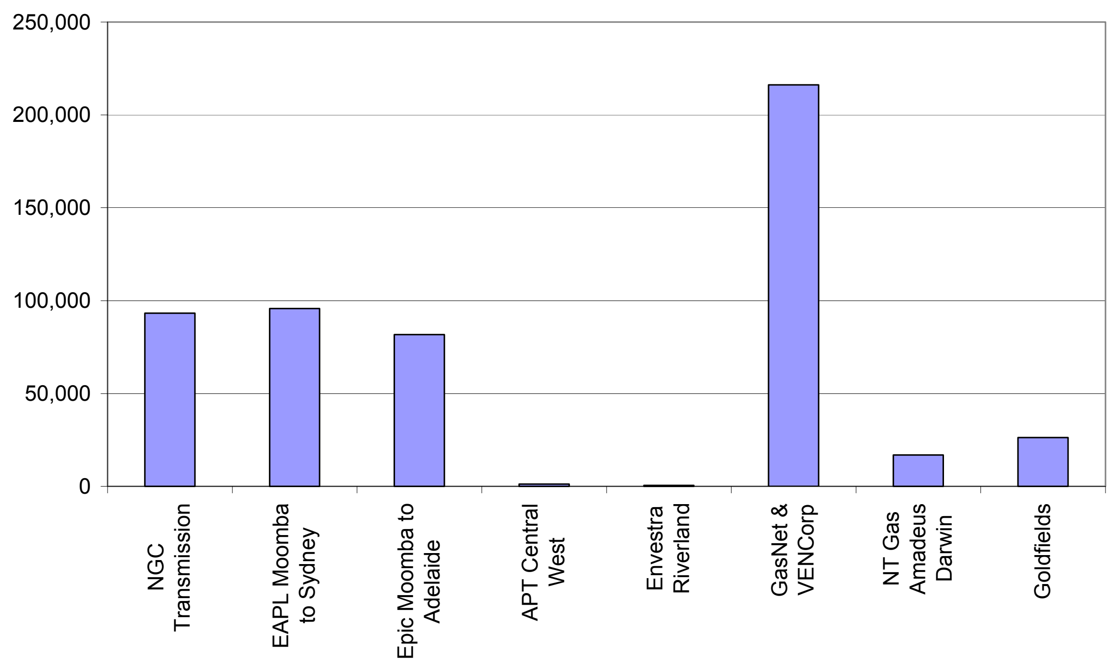
Figure 13: **Transmission pipeline lengths, 2003 (kilometres)**



Source: Meyrick and Associates gas utility database

NGC Transmission has the longest pipeline length of the included transmitters although EAPL Moomba to Sydney and GasNet/VENCorp (Victoria) have only marginally shorter lengths. NT Gas Amadeus to Darwin and Goldfields (Western Australia) have around three quarters of NGC Transmission's length and Epic Moomba to Adelaide has around half the length. The two small Australian pipelines included – Envestra Riverland and APT Central West – each have less than one eighth of NGC's length and are unlikely to be good comparators for NGC. Importantly, the configurations of the Australian pipelines differ from NGC Transmission in most cases. The Australian pipelines tend to be long single pipelines going from a gas source such as Moomba to one of the major cities or sources of industrial use with possibly a few small lateral offtakes. NGC Transmission, on the other hand, has pipelines going in several directions from the Maui gas field area to different parts of the North Island. This configuration is more similar to the Victorian structure than those of the other Australian pipelines.

Figure 14: **Transmission pipeline throughputs, 2003 (terajoules)**

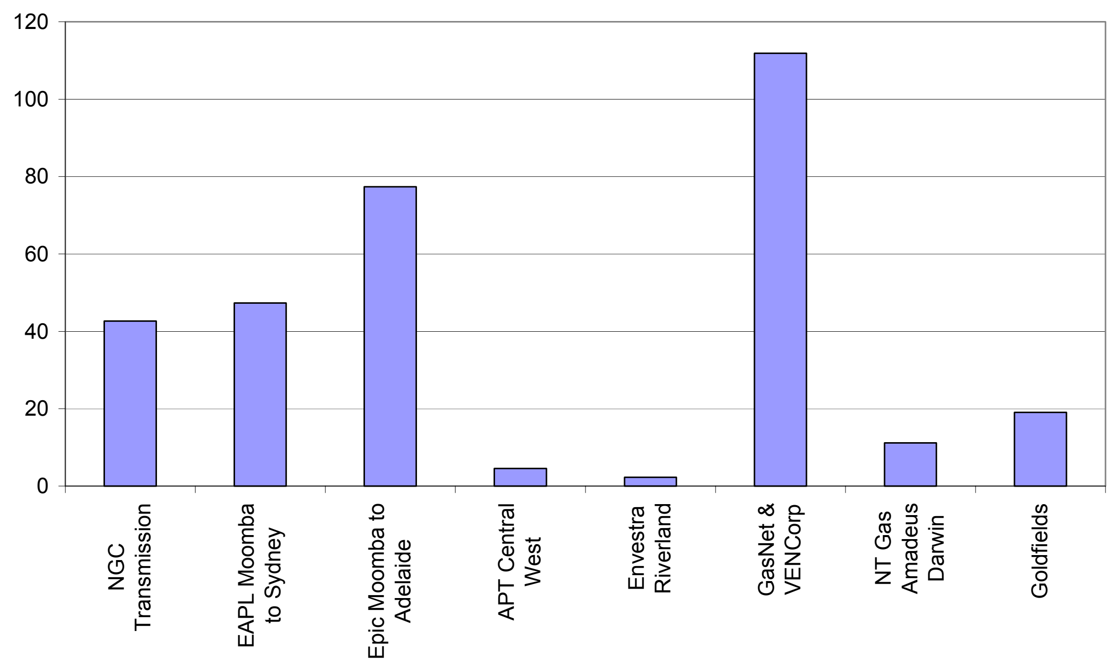


Source: Meyrick and Associates gas utility database

Transmission throughputs are presented in figure 14 where it can be seen that the Victorian transmission system has more than twice the throughput of the next largest systems, EAPL Moomba to Sydney and NGC Transmission. Epic Moomba to Adelaide has nearly 90 per cent the throughput of NGC while NT Gas and Goldfields have around 20 and 30 per cent, respectively, of NGC's throughput. The two small transmitters have less than 1.5 per cent the throughput of NGC confirming their probable lack of usefulness as comparators.

Density measures are less relevant for transmission pipelines than they are for distributors but throughput density in terms of terajoules per kilometre is presented in figure 15. We see that the Victorian system has nearly three times the throughput density of NGC Transmission while Epic Moomba to Adelaide has around twice the density. EAPL Moomba to Sydney has nearly the same density as NGC while Goldfields and NT Gas have around a half and a quarter the density, respectively.

Figure 15: **Transmission pipeline throughput density, 2003 (terajoules per km)**



Source: Meyrick and Associates gas utility database

Table 3: **Transmission characteristics and partial productivities, 2003**

					Partial Prod'y	
Transmitter	*Kms*	*TJ*	*TJ per km*	*O&M / km*	*O&M*	*Kms*
NGC Transmission	2,187	93,311	42.7	12,277	1.000	1.000
EAPL Moomba to Sydney	2,025	95,800	47.3	9,686	1.875	1.480
Epic Moomba to Adelaide	1,056	81,700	77.4	15,745	1.495	1.917
APT Central West	255	1,165	4.6	3,426	1.984	0.554
Envestra Riverland	237	544	2.3	1,654	1.996	0.269
GasNet & VENCorp	1,933	216,200	111.9	16,601	1.190	1.609
NT Amadeus Darwin	1,513	16,900	11.2	5,050	1.692	0.696
Goldfields	1,378	26,280	19.1	8,379	2.329	1.590

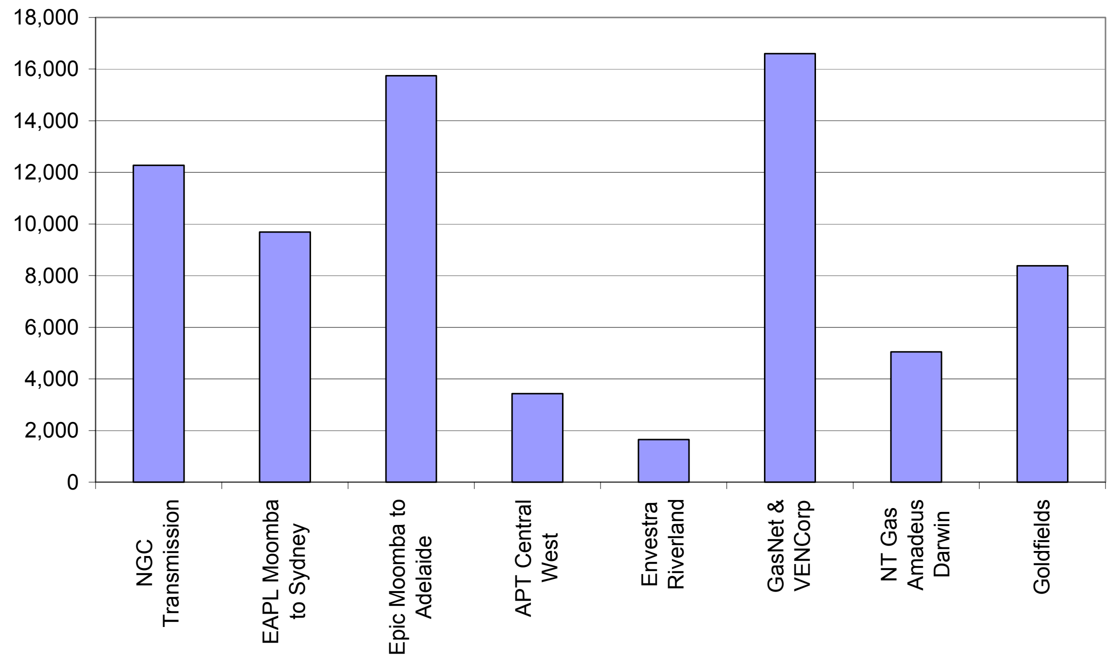
Source: Meyrick and Associates gas utility database

Overall, the EAPL Moomba to Sydney pipeline is the most similar to NGC Transmission in terms of size although its configuration is quite different. Epic Moomba to Adelaide is the next closest comparator while the Victorian and Goldfields systems are each somewhat comparable in terms of length but have very different throughputs.

6.2 Transmitter partial productivities

Transmission operating and maintenance expenditure per kilometre is presented in figure 16 and table 3.

Figure 16: **Transmission O&M expenditure per kilometre, 2003 (NZ dollars)**



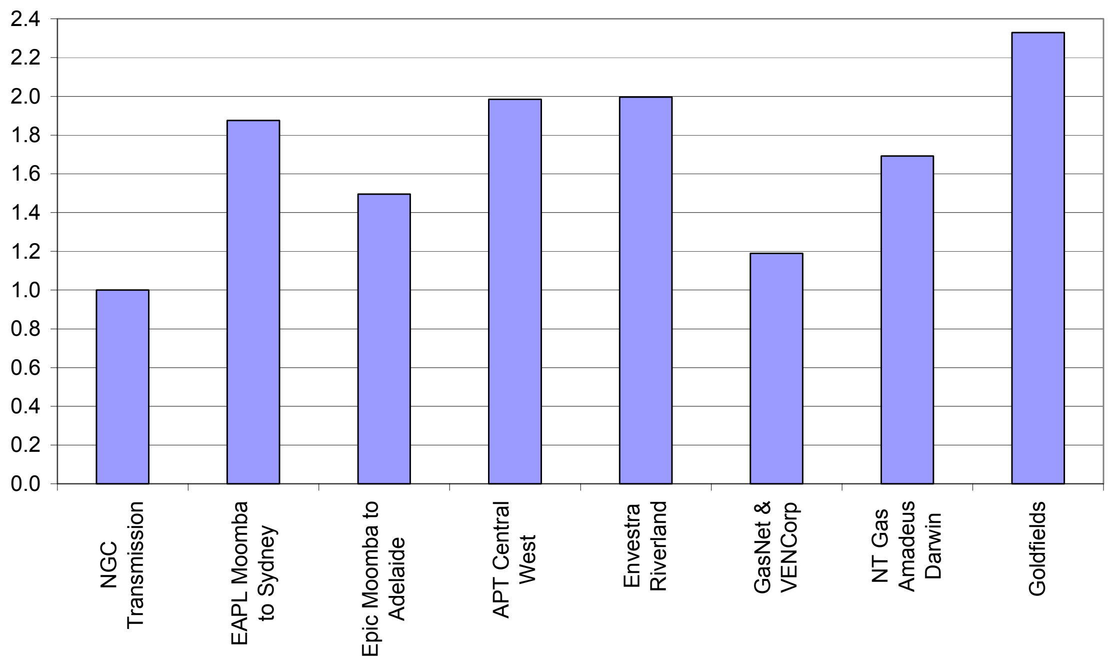
Source: Meyrick and Associates gas utility database

O&M expenditure per kilometre follows a similar pattern to throughput density but is more compressed. NGC's figure of around $12,300 per kilometre is around half as high again as Goldfield's while NGC has over twice the throughput density. EAPL Moomba to Sydney's figure is around 20 per cent less than NGC's, despite EAPL Moomba to Sydney having 11 per cent higher throughput density. Victoria and Epic Moomba to Adelaide have the highest O&M expenditure per kilometre at around $16,000.

To calculate the partial productivity of O&M expenditure and capital, we use a measure of output that includes throughput and system capacity as proxied by asset value. From figure 17 we see that Goldfields has the highest O&M partial productivity followed by the two small transmission pipelines and EAPL Moomba to Sydney. NGC Transmission's O&M

productivity is the lowest of the group followed by the Victorian transmission system. The throughput weighted average of the Australian transmitters' partial O&M productivity lies around 49 per cent above that of NGC.

Figure 17: **Transmission partial O&M productivity indexes, 2003**



Source: Meyrick and Associates gas utility database

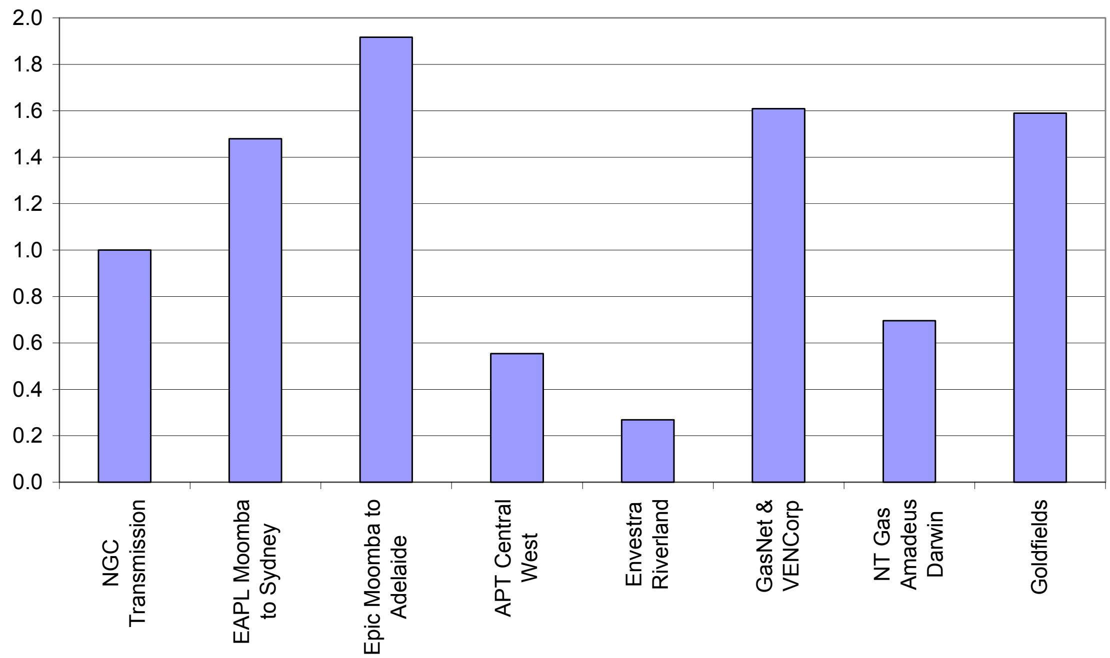
A somewhat similar situation emerges in the case of capital partial productivity using kilometres as the measure of capital input presented in figure 18. Here Epic Moomba to Adelaide has the highest capital productivity followed by the Victorian system, Goldfields and EAPL Moomba to Sydney all lying close together. EAPL Moomba to Sydney pipeline's capital productivity lies around 48 per cent above that of NGC Transmission. The Australian pipelines' throughput weighted average capital productivity is 60 per cent higher than NGC's.

To gain a more holistic impression of comparative transmission pipeline performance we turn now to measures of total factor productivity.

6.3 Transmitter total factor productivity for 2003

To construct a comprehensive measure of transmission pipeline output we need to include throughput and system capacity. In the case of distribution we also needed to include customer numbers. No measures of distribution pipeline capacity were available so we proceeded by forming an output measure from throughput and customer numbers, pending information on system capacity becoming available. Since the length of a transmission line is a key feature of the service it provides and customer numbers are not relevant for transmission pipelines, it is essential to have a measure of system capacity in the output index.

Figure 18: **Transmission partial capital (kms) productivity indexes, 2003**

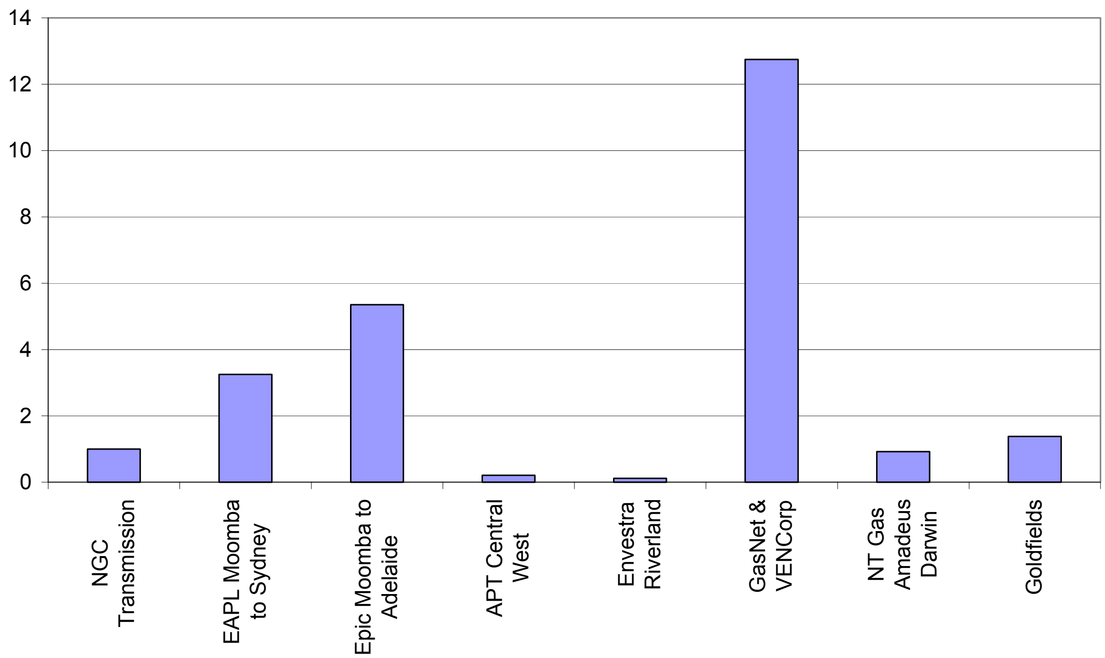


Source: Meyrick and Associates gas utility database

As noted in section 4, some Australian transmitters present a figure for maximum capacity in their AAIs in terms of terajoules per day. This is then multiplied by the number of kilometres to form an overall system capacity figure. However, not all transmitters provide this information and it is not available for NGC Transmission. There also seems to be some debate over what constitutes maximum sustainable capacity. For those transmitters where the maximum capacity figure is not available we proceed initially by using observed daily peak demand. While far from ideal, this measure of system capacity is examined to assess its usefulness in this context.

We present the TFP results for transmission Model 1 in figure 19 and table 4. This model has throughput and the maximum capacity measure as output quantities with the same weights as derived from the PEG (2001) cost function in the absence of any other information. The input quantities are operating and maintenance expenditure and kilometres of main. The cost of capital for weighting purposes is again derived as 12.5 per cent of asset value. Model 1 produces a very wide range of TFP scores. The Victorian system attains a score of over 12 relative to NGC Transmission's score of one. Epic Moomba to Adelaide pipeline attains a score of over 5 while EAPL Moomba to Sydney attains over 3. The two small pipelines - Envestra Riverland and APT Central West – attain scores of only 12 and 21 per cent, respectively, of NGC Transmission's score.

Figure 19: **Transmission total factor productivity indexes – Model 1, 2003**



Source: Meyrick and Associates gas utility database

Table 4: **Transmission output, input and total factor productivity indexes, 2003**

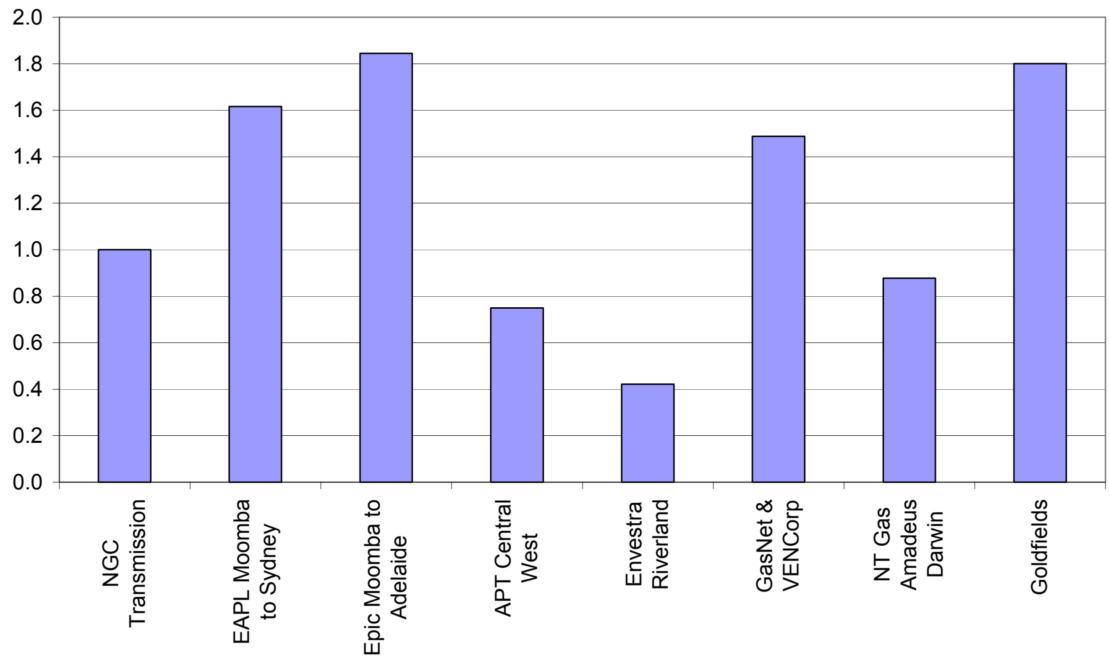
	Output indexes			*TFP indexes*	
Transmitter	*Model 1*	*Model 2*	*Input index*	*Model 1*	*Model 2*
NGC Transmission	1.000	1.000	1.000	1.000	1.000
EAPL Moomba to Sydney	2.772	1.370	0.848	3.271	1.616
Epic Moomba to Adelaide	2.697	0.925	0.502	5.377	1.845
APT Central West	0.018	0.065	0.086	0.207	0.750
Envestra Riverland	0.008	0.029	0.069	0.119	0.421
GasNet & VENCorp	12.245	1.422	0.956	12.812	1.488
NT Amadeus Darwin	0.507	0.481	0.548	0.925	0.878
Goldfields	0.772	1.002	0.556	1.388	1.801

Source: Meyrick and Associates gas utility database

The range of productivity scores obtained in Model 1 is implausibly large and indicates that the problems with the estimated maximum capacity variable are insurmountable. This is most likely exacerbated by the fact that the Victorian system (as well as NGC Transmission) is one of the systems for which the proxy of observed peak demand has had to be substituted. This opens up several avenues of potential inconsistency in the way the maximum capacities are calculated on top of the debate which already exists among those firms that do supply a maximum terajoules per day figure.

Rather than persist with this attempt to measure transmission capacity explicitly, we move to look at potential proxies for system capacity. One readily available and relatively consistent proxy is asset value. The longer the pipeline length and the larger the pipes and associated throughput potential are, the more costly the asset will be. Hence, asset value will be directly related to system capacity. In Model 2 we use asset value (ODV for NGC Transmission and DORC for the Australian pipelines) to proxy system capacity. The output quantities are, hence, throughput and asset value and the input quantities are operating and maintenance expenditure and kilometres of main. The same output and input weights are used as in Model 1.

Figure 20: **Transmission total factor productivity indexes – Model 2, 2003**



Source: Meyrick and Associates gas utility database

The Model 2 results are presented in figure 20 and table 4. Epic Moomba to Adelaide pipeline is now found to be the most productive with around 85 per cent higher productivity than NGC Transmission. Goldfields is the next most productive pipeline at 80 per cent higher than NGC followed by EAPL Moomba to Sydney at around 62 per cent higher than NGC.

The Victorian system is found to have around 49 per cent higher TFP than NGC while the two small pipelines - Envestra Riverland and APT Central West – attain scores of 42 and 75 per cent, respectively, of NGC Transmission's score. These results appear to be much more plausible than those of Model 1. The pipelines that do best on this measure are the 'straight line' operations while the large Victorian system which has a configuration more similar to NGC's radial pattern does slightly less well but still considerably better than NGC Transmission.

The Australian pipelines' throughput weighted average TFP is around 57 per cent higher than NGC's using Model 2. While constructing a variable that accurately reflects system capacity using agreed engineering principles remains a high priority, we believe Model 2 represents a reasonable proxy to the specification needed using currently available information. It is not possible to adjust for operating environment differences for transmission pipelines given the small number of observations and the limited data currently available. Future work may develop measures to capture system configuration that have an impact on measured TFP such as radial versus straight line operations.

6.4 Time–series transmitter total factor productivity results

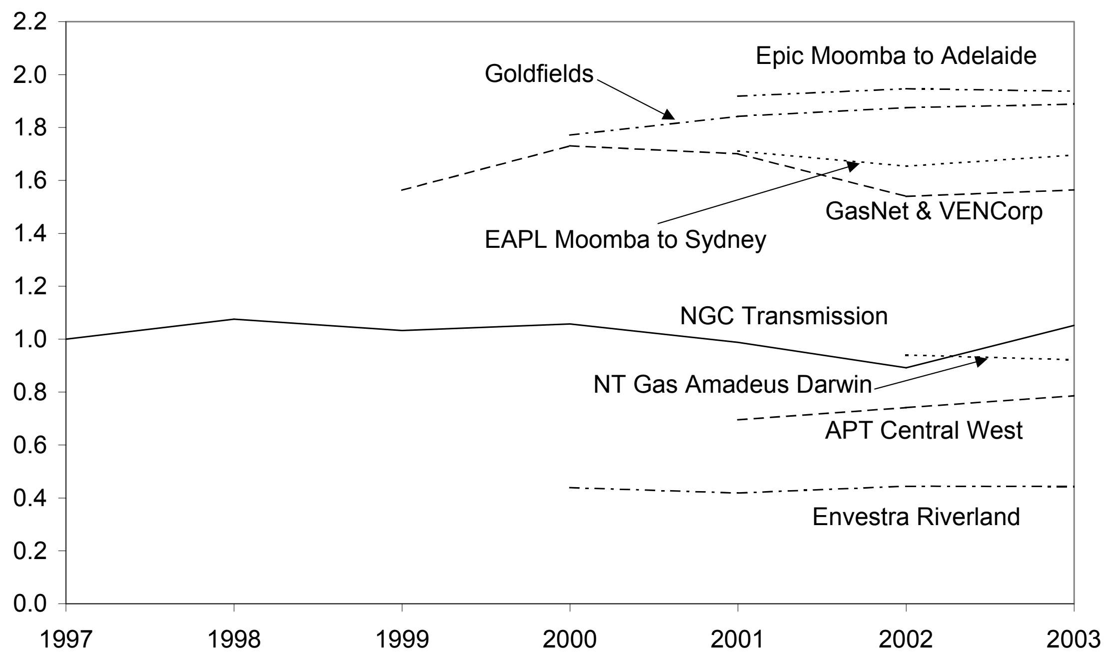
Given the more stable structure of the gas transmission pipeline industry in both New Zealand and Australia in recent years, time–series of data can be constructed for the various pipeline businesses. In the case of NGC Transmission, Disclosure Data are available for the seven years 1997 to 2003. Data are also available from NGC's response to the Section 70E request for a similar period. Where differences between the two data sources exist we have used the Section 70E information. This principally affects the operating and maintenance expenditure series.

Most of the Australian transmission pipelines included are about to enter their second period of access regulation. Consequently, in most cases time–series information has had to be assembled form a number of sources including initial and second period final approvals by regulators and corresponding AAIs. For some pipelines this process has been more straight forward than for others. For instance, ACCC (2002) contains data for the period 2001 to 2003 for the Epic Moomba to Adelaide pipeline. For the Riverland pipeline the only source of information was the Envestra Ltd (1999) AAI but this provided data for four years from 2000 to 2003. For the EAPL Moomba to Sydney pipeline there were sizable differences, particularly for revenue and O&M expenditure, between the initial ACCC (2000b) approval and the ACCC (2003) approval. In this case we have scaled the ACCC (2003) figures for 2003 by the changes from ACCC (2000b) to obtain the estimated series for earlier years. Similarly, for the Victorian system more complete information for the five year period 1999 to 2003 is available for GasNet than for VENCorp. In this case we have proceeded by scaling up the relevant GasNet series for earlier years by the share of VENCorp in the total for 2003.

The length of consistent and useable information varies from 5 years for the Victorian system (1999 to 2003) to only two years for the NT Gas Amadeus to Darwin pipeline (2002 and 2003). In many cases the data are forecasts rather than actual data as we have had to rely on regulatory information in the public domain rather than seeking actual data from the individual businesses.

Constant price series are derived using the indexes of labour costs for the electricity, gas and water sector in the two respective countries. Constant price series are expressed in 2003 prices and the average purchasing power parity for 2002 and 2003 of 1.066 is used to convert Australian dollars to New Zealand dollars.

Figure 21: **Transmission total factor productivity index time–series – Model 2**



Source: Meyrick and Associates gas utility database

We present the results of TFP Model 2 in figure 21. This model has throughput and ODV (as a proxy for system capacity) as the two outputs and operating and maintenance expenditure and kilometres of main as the two inputs. The multilateral output, input and TFP indexes are presented in table 5.

The transmission TFP time–series are relatively stable for Epic Moomba to Adelaide, Goldfields, EAPL Moomba to Sydney, NT Gas Amadeus to Darwin, APT Central West and

Envestra Riverland. The NGC Transmission time–series exhibits some volatility. The NGC Transmission TFP index increases by 6 per cent between 1997 and 2000 before falling by 6 per cent in 2001 and a further 10 per cent in 2002. It then recovers by a very large 18 per cent in 2003. The falls in 2001 and 2002 are driven by increases in operating and maintenance expenditure of 23 per cent and 28 per cent, respectively, in those years. The recovery in 2003 is driven by an increase in ODV of 22 per cent following the latest revaluation. Smoothing

Table 5: **Transmission time–series output, input and total factor productivity indexes**

Transmitter	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Multilateral output index							
NGC Transmission	1.000	1.040	1.046	1.073	1.061	1.035	1.214
EAPL Moomba to Sydney					1.680	1.651	1.663
Epic Moomba to Adelaide					1.129	1.128	1.123
APT Central West					0.070	0.074	0.078
Envestra Riverland				0.037	0.036	0.036	0.035
GasNet & VENCorp			1.654	1.717	1.726	1.720	1.726
NT Amadeus Darwin						0.597	0.584
Goldfields				1.147	1.189	1.207	1.216
Multilateral input index							
NGC Transmission	1.000	0.966	1.012	1.015	1.074	1.160	1.154
EAPL Moomba to Sydney					0.982	0.999	0.980
Epic Moomba to Adelaide					0.589	0.579	0.580
APT Central West					0.100	0.100	0.100
Envestra Riverland				0.083	0.086	0.080	0.080
GasNet & VENCorp			1.058	0.992	1.015	1.117	1.103
NT Amadeus Darwin						0.635	0.634
Goldfields				0.647	0.645	0.644	0.644
Multilateral TFP index							
NGC Transmission	1.000	1.076	1.033	1.057	0.988	0.892	1.052
EAPL Moomba to Sydney					1.711	1.654	1.696
Epic Moomba to Adelaide					1.918	1.946	1.937
APT Central West					0.695	0.742	0.787
Envestra Riverland				0.439	0.419	0.445	0.442
GasNet & VENCorp			1.563	1.731	1.701	1.540	1.564
NT Amadeus Darwin						0.941	0.922
Goldfields				1.771	1.842	1.875	1.888

Source: Meyrick and Associates gas utility database

the ODV series between revaluation points would remove much of this volatility as the increase in output would be smoother and offset the large increases in operating expenditure in 2001 and 2002 to some extent.

The Victorian transmission system also exhibits some volatility with a temporary increase to an 11 per cent higher TFP level in 2000 and 2001 before falling back to around its 1999 TFP level for 2002 and 2003. This result is driven by a combination of factors. Both throughput and ODV increased in 2000 while operating expenditure fell by 16 per cent in the same year. Operating expenditure then increased by over one third between 2001 and 2002 to return TFP to its 1999 level.

EAPL Moomba to Sydney's TFP falls by around 3 per cent in 2002 before recovering in 2003 due to a combination of a decrease in throughput and a temporary increase in operating expenditure.

The results for 2003 are likely to be the most accurate given the asset revaluation for NGC Transmission in that year and the second round of final approvals for a number of the Australian transmission pipelines around that year. However, the transmission model remains less well developed than the distribution model due to the absence of reliable capacity data in the public domain, the need to rely on proxies for capacity and the inability to adjust for operating environment differences given the small number of observations available.

7 CONCLUSIONS AND FUTURE PRIORITIES

In this report we have estimated the cost efficiency of the New Zealand gas pipeline businesses relative to a range of their Australian peers using publicly available information. The purpose of the comparative benchmarking study has been to provide the Commerce Commission with information on the relative efficiency performance of New Zealand gas pipeline businesses for use in its inquiry into whether gas pipelines businesses should be controlled.

Comparative benchmarking can be used to inform decisions on whether control should be introduced but does not provide a mechanistic basis for such decisions. For instance, suppose the New Zealand businesses were found to be operating at similar or superior levels of cost efficiency, once operating environment conditions and service quality levels were taken into account, compared to overseas businesses thought to be achieving high efficiency levels. There would then appear to be less of a case for imposing control (provided profitability levels were not excessive). Conversely, if the New Zealand businesses were found to be consistently less cost efficient than the normalised performance of overseas businesses then this would lend support to the case for imposing control.

In the time available for the current study we have been restricted to using information from the Disclosure Data and responses to Section 70E information requests for the New Zealand businesses and from regulatory decisions and access arrangement information filings for the Australian businesses. Ideally three outputs should be included in the distribution model and two in the transmission model. These are throughput, system capacity and customer numbers for distribution and throughput and system capacity for transmission. However, data on system capacity outputs have generally not been available. As a result we have estimated a distribution model that contains two outputs (throughput and customer numbers) and used a proxy adjustment method to allow for differences in energy and customer density. For the transmission model we have used a proxy for system capacity. While the approaches adopted make the best use of the data available, the results of the study should be considered indicative rather than definitive until the data limitations can be addressed more systematically.

Making no allowance for customer density differences leads to the Australian distributors having over twice the observed productivity of the New Zealand distributors on average. However, much of this difference will be due to operating environment differences beyond management control. Recognising that a kilometre of main in a more customer dense network will be more resource intensive than one in a less dense network reduces the observed gap between the New Zealand and Australian distributors to around 35 per cent on average. This will be a partial adjustment for customer density differences as some residual density economies will remain unaccounted for. Undertaking a more comprehensive proxy adjustment for both customer and energy density differences leads to the productivity gap between the New Zealand and Australian distributors being further reduced to around 21 per cent. The Australian transmission pipelines' throughput weighted average TFP is found to be around 57 per cent higher than NGC Transmission's.

Priorities for further refinement of the New Zealand and Australian gas pipeline business database include:

- developing consistent measures of distribution and transmission system capacity consistent with agreed engineering principles;
- obtaining consistent data on residential, commercial and industrial customer numbers, sales and revenue to allow formation of a more detailed output specification;
- ensuring complete uniformity of activity coverage in the New Zealand and Australian operating and maintenance expenditure data;
- incorporating any remaining unregulated gas network activities in the Australian data to provide a more comprehensive picture of firm performance; and,
- obtaining consistent capital data on optimised replacement cost for possible use in capital input quantity variables.

Limiting overseas comparisons to largely publicly available Australian data has restricted the techniques that can feasibly be used to TFP indexes given the relatively small number of observations available. Given that the operating environments between Australia and New Zealand are largely similar, except for the Australian businesses having larger scale, the multiple output TFP indexes used should provide an accurate picture of the scope for potential productivity improvements. However, extension of the database to include US utilities would greatly increase the number of observations available and provide more confidence that best practice was being captured in the sample and increase the scope to use multiple techniques, including econometric methods. Provided the data supported the necessary estimation, it may then be possible to incorporate more operating environment differences.

APPENDIX 1: GAS UTILITIES DATABASE

Table A1: **Distribution outputs and inputs, 2003**

Distributor	*Revenue* *$NZ mil*	*Throughput* *Terajoules*	*Customer* *Numbers*	*O&M* *$NZ mil*	*ODV/DORC* *$NZ mil*	*Capital* *kms*
NGC Distribution	[ ]	11,062	55,938	[ ]	127	2,739
Powerco	[ ]	[ ]	109,540	[ ]	[ ]	5,368
Wanganui	3.4	1,108	10,921	1.0	18	354
Vector	43.9	11,555	70,656	17.1	[ ]	5,008
Envestra Albury	3.9	1,578	16,787	1.3	27	341
Envestra Victoria	112.4	38,526	464,566	39.4	759	7,943
Multinet	145.5	50,059	630,787	47.9	889	9,100
TXU	126.4	40,038	472,788	46.3	852	8,281
Envestra SA	115.4	28,666	348,244	39.7	784	6,897
Envestra Qld	33.5	4,836	73,736	11.3	219	2,068
Allgas Qld	33.0	9,992	58,904	8.8	245	1,965
CE Wagga	8.1	1,404	16,872	2.1	43	559
AGLGN NSW	351.6	97,128	892,919	101.8	1,815	22,836
ACTEWAGL	36.1	6,950	90,908	9.9	234	3,410

Source: Meyrick and Associates gas utility database

Table A2: **Transmission outputs and inputs, 2003**

Transmitter	*Revenue* *$NZ mil*	*Throughput* *Terajoules*	*Capacity* *TJ/day*kms*	*O&M* *$NZ mil*	*ODV/DORC* *$NZ mil*	*Capital* *kms*
NGC Transmission	78.5	93,311	136,263	27	405	2,187
EAPL Moomba to Syd.	73.4	95,800	444,069	20	581	2,025
Epic Moomba to Adel.	57.0	81,700	441,366	17	378	1,056
APT Central West	3.0	1,165	2,576	1	34	255
Envestra Riverland	2.1	544	1,183	0	15	237
GasNet & VENCorp	99.9	216,200	2,187,930	32	532	1,933
NT Amadeus Darwin	48.3	16,900	81,702	8	229	1,513
Goldfields	61.6	26,280	124,020	12	499	1,378

Source: Meyrick and Associates gas utility database

Table A3: **Time–series transmission outputs and inputs**

Transmitter	*Year*	*Revenue $NZ mil*	*Throughput Terajoules*	*O&M $NZ mil*	*ODV/DORC $NZ mil*	*Capital kms*
NGC Transmission	1997	62.7	61,272	15.2	346.2	2,169
	1998	63.2	68,075	13.1	356.1	2,174
	1999	62.7	79,699	16.3	349.3	2,166
	2000	68.8	99,404	16.2	347.2	2,187
	2001	69.1	105,396	20.1	339.4	2,187
	2002	76.0	101,440	25.8	331.8	2,187
	2003	78.5	93,311	26.9	405.0	2,187
EAPL Moomba to Sydney	2001	70.4	104,185	18.3	580.5	2,025
	2002	73.1	94,123	20.3	578.5	2,025
	2003	73.4	95,800	19.6	581.4	2,025
Epic Moomba to Adelaide	2001	54.7	80,200	16.4	381.6	1,056
	2002	55.9	81,700	16.1	379.9	1,056
	2003	57.0	81,700	16.6	378.1	1,056
APT Central West	2001	1.7	720	0.8	32.2	255
	2002	2.4	942	0.8	33.1	255
	2003	3.0	1,165	0.9	34.2	255
Riverland	2000	2.1	530	0.5	16.0	237
	2001	2.3	534	0.6	15.8	237
	2002	2.0	539	0.4	15.5	237
	2003	2.1	544	0.4	15.3	237
GasNet & VENCorp	1999	94.6	198,600	24.9	513.2	1,933
	2000	97.3	210,500	20.9	531.0	1,933
	2001	99.7	210,400	23.4	534.3	1,933
	2002	99.6	211,200	32.2	531.8	1,933
	2003	99.9	216,200	32.1	531.8	1,933
Amadeus Darwin	2002	48.1	16,400	7.3	235.5	1,513
	2003	48.3	16,900	7.6	228.7	1,513
Goldfields	2000	56.5	25,915	10.5	466.9	1,378
	2001	59.0	25,915	10.7	486.9	1,378
	2002	60.1	27,010	11.1	492.5	1,378
	2003	61.6	26,280	11.5	498.7	1,378

Source: Meyrick and Associates gas utility database

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